THE

ENGINEERING JOURNAL

Index to Volume XIX

January to December, 1936

THE ENGINEERING JOURNAL

THE JOURNAL OF THE ENGINEERING INSTITUTE OF CANADA

Published monthly at 2050 Mansfield Street, Montreal, by The Engineering Institute of Canada, Incorporated in 1887 as The Canadian Society of Civil Engineers.

Entered at the Post Office, Montreal, as Second Class Matter.

"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."

January, 1936 — **Volume XIX, No. 1**

CONTENTS

Price 50 cents a copy, $3.00 a year, in Canada, British Possessions, United States and Mexico. $4.50 a year in Foreign Countries.
To Members and Affiliates, 25 cents a copy, $2.00 a year.

Published Monthly at 2050 Mansfield St., Montreal

THE ENGINEERING INSTITUTE OF CANADA

Incorporated in 1887 as The Canadian Society of Civil Engineers

BRANCHES:

Halifax Branch, Halifax, N.S.
Cape Breton Branch, Sydney, Cape Breton.
Moncton, Branch, Moncton, N.B.
Saint John Branch, Saint John, N.B.
Saguenay Branch, Kenogami, Que.
Quebec Branch, Quebec, Que.
St. Maurice Valley Branch, Three Rivers, Que.
Montreal Branch, Montreal, Que.
Ottawa Branch, Ottawa, Ont.
Kingston Branch, Kingston, Ont.
Peterborough Branch, Peterborough, Ont.
Toronto Branch, Toronto, Ont.
Hamilton Branch, Hamilton, Ont.
Niagara Peninsula Branch, Niagara Falls, Ont.
London Branch, London, Ont.
Border Cities Branch, Windsor, Ont.
Sault Ste. Marie Branch, Sault Ste. Marie, Ont.
Lakehead Branch, Port Arthur, Ont.
Winnipeg Branch, Winnipeg, Man.
Saskatchewan Branch, Regina, Sask.
Lethbridge Branch, Lethbridge, Alta.
Edmonton Branch, Edmonton, Alta.
Calgary Branch, Calgary, Alta.
Vancouver Branch, Vancouver, B.C.
Victoria Branch, Victoria, B.C.

Members of Council 1935

PRESIDENT
F. A. GABY, Montreal, Que.

VICE-PRESIDENTS
†E. V. CATON, Winnipeg, Man.
†P. L. PRATLEY, Montreal, Que.
*E. G. CAMERON, St. Catharines, Ont.
*A. B. NORMANDIN, Quebec, Que.
*A. GRAY, Saint John, N.B.

PAST-PRESIDENTS
CHAS. CAMSELL, Ottawa, Ont.
O. O. LEFEBVRE, Montreal, Que.
F. P. SHEARWOOD, Montreal Que.

COUNCILLORS

†C. G. R. ARMSTRONG, Windsor, Ont.
†C. B. BROWN, Montreal, Que.
†G. H. BURBIDGE, Port Arthur, Ont.
*J. L. BUSFIELD, Montreal, Que.
*C. S. CLENDENING, Diamond City, Alta.
*H. CIMON, Quebec, Que.
†J. R. COCKBURN, Toronto, Ont.
†A. COUSINEAU, Montreal, Que.
‡A. B. CREALOCK, Toronto, Ont.
*H. J. CRUDGE, Moncton, N.B.
*R. L. DOBBIN, Peterborough, Ont.
*For 1935

‡A. FRIGON, Montreal, Que.
*F. G. GOODSPEED, Winnipeg, Man.
†L. F. GOODWIN, Kingston, Ont.
†B. GRANDMONT, Three Rivers, Que.
*C. S. L. HERTZBERG, Toronto, Ont.
*W. JACKSON, Niagara Falls, Ont.
†G. H. KIRBY, Riverbend, Que.
†H. S. JOHNSTON, Halifax, N.S.
*J. A. McCRORY, Montreal, Que.
*F. W. PAULIN, Hamilton, Ont.
*A. E. PICKERING, Sault Ste. Marie, Ont
†For 1935-36

*C. M. PITTS, Ottawa, Ont.
‡E. A. RYAN, Montreal, Que.
*C. M. SMYTH, Sydney, N.S.
†E. W. STEDMAN, Ottawa, Ont.
*F. M. STEEL, Calgary, Alta.
*H. L. SWAN, Victoria, B.C.
†J. A. VANCE, Woodstock, Ont.
†G. A. VANDERVOORT, Saint John, N.B.
†H. R. WEBB, Edmonton, Alta.
†A. S. WOOTTON, Vancouver, B.C.
‡S. YOUNG, Regina, Sask.
‡For 1935-36-37

TREASURER
J. B. CHALLIES, Montreal, Que.

SECRETARY
R. J. DURLEY, Montreal, Que.

OFFICERS OF BRANCHES

HALIFAX
Chairman, H. FELLOWS
Sec.-Treas., R. R. MURRAY, 87 Cambridge St., Halifax, N.S.
Executive, C. S. BENNETT, R. M. McKINNON, W. H. NOONAN, J. R. KAYE, F. C. WIGHTMAN, E. L. MILES, G. MEDFORTH, J. D. FRASER, J. H. M. JONES
(Ex-Officio) R. L. DUNSMORE, H. S. JOHNSTON

CAPE BRETON
Chairman, W. E. BOWN
Sec.-Treas., SYDNEY C. MIFFLEN, 60 Whitney Ave., Sydney, N.S.
Executive, M. R. CHAPPELL, W. S. WILSON, C. M. ANSON, W. E. CLARKE
(Ex-Officio) C. M. SMYTH

SAINT JOHN
Chairman, V. S. CHESNUT
Vice-Chair., J. R. FREEMAN
Sec.-Treas., F. A. PATRIQUEN, 19 Horsfield St., Saint John, N.B.
Executive, S. HOGG, C. S. MacLEAN, G. H. THURBER
(Ex-Officio) E. J. OWENS, A. GRAY, G. A. VANDERVOORT

MONCTON
Chairman, H. B. TITUS
Vice-Chair., G. L. DICKSON
Sec.-Treas., V. C. BLACKETT, Engrg. Dept., C.N.R., Moncton, N.B.
Executive, F. O. CONDON, JAS. PULLAR, T. H. DICKSON, C. S. G. ROGERS, A. S. GUNN, G. C. TORRENS
(Ex-Officio) H. J. CRUDGE, J. G. MacKINNON

SAGUENAY
Chairman, J. SHANLY
Vice-Chair., S. J. FISHER
Sec.-Treas., L. R. BEATH, P.O. Box 211, Kenogami, Que.
Executive, W. L. YACK, E. LAVOIE, H. B. PELLETIER, M. G. SAUNDERS
(Ex-Officio) G. E. LaMOTHE, J. W. WARD, G. H. KIRBY

QUEBEC
Hon. Chair., A. R. DECARY
Chairman, ALEX. LARIVIERE
Vice-Chair., J. T. F. KING
Sec.-Treas., J. JOYAL, Quebec Public Service Comm., Court House, Quebec, Que.
Executive, R. B. McDUNNOUGH, L. P. METHE, L. BEAUDRY, A. G. SABOURIN, J. G. O'DONNELL, A. ROBERGE
(Ex-Officio) A. B. NORMANDIN, HECTOR CIMON

ST. MAURICE VALLEY
Chairman, B. GRANDMONT
Vice-Chair., J. E. FLEURY
Sec.-Treas., J. A. HAMEL, 642 Notre Dame St., Three Rivers, Que.
Executive, F. W. BRADSHAW, C. L. ARCAND, H. J. WARD

MONTREAL
Chairman, F. S. B. HEWARD
Vice-Chair., J. B. D'AETH
Sec.-Treas., C. K. McLEOD, 1440 St. Catherine St. W., Montreal, Que.
Executive, F. E. V. DOWD, J. A. LALONDE, J. G. HALL, B. R. PERRY, J. H. LANDRY, R. H. FINDLAY
(Ex-Officio) C. B. BROWN, A. COUSINEAU, O. O. LEFEBVRE, F. A. GABY, J. A. McCRORY, P. L. PRATLEY, J. L. BUSFIELD, E. A. RYAN, A. FRIGON, F. P. SHEARWOOD

OTTAWA
Chairman, R. W. BOYLE
Sec.-Treas., F. C. C. LYNCH, Dept. of Mines, Victoria Memorial Museum, Ottawa, Ont.
Executive, B. F. HAANEL, A. V. GALE, T. A. McELHANNEY, J. H. PARKIN, G. R. TURNER
(Ex-Officio) A. K. HAY, C. M. PITTS, E. W. STEDMAN, C. CAMSELL

PETERBOROUGH
Chairman, A. L. DICKIESON
Sec.-Treas., W. T. FANJOY, 223 Crescent St., Peterborough, Ont.
Executive, V. R. CURRIE, A. L. KILLALY, E. J. DAVIES, E. R. SHIRLEY
(Ex-Officio) J. W. PIERCE, H. R. SILLS, R. L. DOBBIN

KINGSTON
Chairman, R. A. LOW
Vice-Chair., Lt.-Col. N. C. SHERMAN
Sec.-Treas., Major L. F. GRANT, Royal Military College, Kingston, Ont.
Executive, G. G. CARR-HARRIS, S. STEPHENSON, J. E. GOODMAN
(Ex-Officio) W. CASEY, L. F. GOODWIN

TORONTO
Chairman, W. E. BONN
Vice-Chair., O. HOLDEN
Sec.-Treas., W. S. WILSON, Mining Bldg., University of Toronto, Toronto, Ont.
Executive, N. MacNICOL, W. G. CHACE, A. M. REID, J. M. OXLEY, C. E. SISSON, A. U. SANDERSON
(Ex-Officio) R. E. SMYTHE, A. B. CREALOCK, J. ROY COCKBURN, C. S. L. HERTZBERG

HAMILTON
Chairman, W. HOLLINGWORTH
Vice-Chair., J. STODART
Sec.-Treas., A. LOVE, 40 Paisley Ave. S., Hamilton, Ont.
Asst. Sec., A. B. DOVE
Executive, W. J. W. REID, V. S. THOMPSON, E. G. MacKAY, D. W. CALLANDER
(Ex-Officio) F. W. PAULIN, H. B. STUART

LONDON
Chairman, S. W. ARCHIBALD
Vice-Chair., J. FERGUSON
Sec.-Treas., S. G. JOHRE, 153 Kent St., London, Ont.
Executive, V. A. McKILLIP, E. V. BUCHANAN, W. C. MILLER, H. A. BRAZIER, J. R. ROSTRON
(Ex-Officio) F. C. BALL, H. A. McKAY, J. A. VANCE

NIAGARA PENINSULA
Chairman, P. E. BUSS
Vice-Chair., G. H. WOOD
Sec.-Treas., P. A. DEWEY, 1224 Ontario Ave., Niagara Falls, Ont.
Executive, C. G. MOON, E. P. MURPHY, C. W. WEST, C. S. BOYD, S. HAIRSINE, J. H. JACKSON, J. C. STREET, L. C. McMURTRY, H. WELLWOOD
(Ex-Officio) E. G. CAMERON, W. JACKSON, W. R. MANOCK

BORDER CITIES
Chairman, H. J. COULTER
Vice-Chair., T. H. JENKINS
Sec.-Treas., C. F. DAVISON, 32 Indian Road, Sandwich, Ont.
Executive, E. M. KREBSER, D. T. ALEXANDER, B. CANDLISH
(Ex-Officio) C. G. R. ARMSTRONG, H. J. A. CHAMBERS

SAULT STE. MARIE
Chairman, F. SMALLWOOD
Vice-Chair., J. L. LANG
Sec.-Treas., H. O. BROWN, Abitibi Power & Paper Co., Sault Ste. Marie, Ont.
Executive, C. W. HOLMAN, H. W. SUTCLIFFE, C. J. RUSSELL, A. A. ROSE
(Ex-Officio) E. M. MacQUARRIE, A. E. PICKERING

LAKEHEAD
Chairman, R. J. ASKIN
Vice-Chair., F. C. GRAHAM
Sec.-Treas., G. R. McLENNAN, 80 High St., North, Port Arthur, Ont.
Executive, H. G. O'LEARY, K. A. DUNPHY, G. R. DUNCAN, G. ERICKSEN
(Ex-Officio) G. H. BURBIDGE, GEO. P. BROPHY

WINNIPEG
Chairman, F. V. SEIBERT
Vice-Chair., G. E. COLE
Sec.-Treas., J. F. CUNNINGHAM, 918 Somerset Ave., Fort Garry, Man.
Executive, A. CAMPBELL, H. L. BRIGGS, A. E. MACDONALD, R. W. McKINNON, WM. WALKDEN
(Ex-Officio) A. J. TAUNTON, F. G. GOODSPEED, E. W. M. JAMES, E. V. CATON

SASKATCHEWAN
Chairman, A. P. LINTON
Vice-Chair., W. E. LOVELL
Sec.-Treas., R. J. FYFE, 618 Broder Bldg., Regina, Sask.
Executive, J. W. D. FARRELL, W. E. LOVELL, H. S. CARPENTER, J. J. WHITE, S. R. MUIRHEAD, H. C. RITCHIE
(Ex-Officio) R. A. SPENCER, S. YOUNG

LETHBRIDGE
Chairman, W. L. McKENZIE
Vice-Chair., J. M. CAMPBELL
Sec.-Treas., E. A. LAWRENCE, 207-7th St. S., Lethbridge, Alta.
Executive, G. S. BROWN, R. F. P. BOWMAN, J. HAIMES
(Ex-Officio) C. S. CLENDENING, C. S. DONALDSON, J. B. deHART

EDMONTON
Chairman, F. K. BEACH
Vice-Chair., E. STANSFIELD
Sec.-Treas., R. M. HARDY, University of Alberta, Edmonton, Alta.
Executive, C. E. GARNETT, A. J. GAYFER, R. J. GIBB, H. P. KEITH, C. A. ROBB
(Ex-Officio) H. R. WEBB

CALGARY
Chairman, J. HADDIN
Vice-Chair., J. DOW
Sec.-Treas., JAS. McMILLAN, Calgary Power Co. Ltd., Insurance Exchange Bldg., Calgary, Alta.
Executive, F. J. HEUPERMAN, H. W. TOOKER, J. R. WOOD
(Ex-Officio) G. P. F. BOESE, F. M. STEEL

VANCOUVER
Chairman, JAS. ROBERTSON
Vice-Chair., H. N. MACPHERSON
Sec.-Treas., G. M. GILBERT, 930 Birks Bldg., Vancouver, B.C.
Executive, C. T. HAMILTON, J. P. McKENZIE, P. SANDWELL, E. C. THRUPP, G. L. TOOKER, F. O. MILLS
(Ex-Officio) A. S. WOOTTON, P. H. BUCHAN, A. E. GORDON

VICTORIA
Chairman, D. MacBRIDE
Vice-Chair., J. C. McDONALD
Sec.-Treas., KENNETH REID, 1336 Carnsew St., Victoria, B.C.
Executive, G. M. DUNCAN, G. M. TRIPP, H. L. LEVERIN, C. W. GAMBLE
(Ex-Officio) H.L. SWAN, I. C. BARLTROP

THE

ENGINEERING JOURNAL

The Institute as a body is not responsible either for the statements made
or for the opinions expressed in the following pages.

Volume XIX | Montreal, January, 1936 | Number 1

The Superstructure of the Reconstructed Second Narrows Bridge, Vancouver

P. L. Pratley, M.E.I.C.,
Monsarrat and Pratley, Consulting Engineers, Montreal.

Paper to be presented before the General Professional Meeting of The Engineering Institute of Canada, at Hamilton, Ontario, on February 6th and 7th, 1936.

SUMMARY.—This bridge had to be reconstructed following navigation accidents, the last of which resulted in the destruction of one of the main spans. The paper first discusses the factors affecting the design and construction of the new portions of the superstructure, particularly the 282-foot lifting span and its operating equipment. These matters are treated from the designer's point of view and are followed by details as to the procedure and difficulties in erection.

The general problem at this site was rehearsed in the paper on the substructure delivered by the author in July, 1934,* and it will, therefore, not be repeated here.

Figure 7 of the earlier paper is reproduced, however, as Fig. 1 and indicates the layout finally recommended and adopted after much study. This layout definitely contemplated the abandonment of the bascule as a movable span although the counterweight tower and overhead frame and block were not to be dismantled. A movable span of the vertical lift type, situated in the principal navigation channel, was installed in place of the bascule, and the superstructure problem thus resolved itself into the design of this span with its towers and flanking spans, its counterweights, its guiding and locking devices, and its operating machinery. Subsidiary considerations were the use of existing materials as far as economically practicable, these arising from the shortening of the bascule moving leaf and the abandonment of the machinery in the bascule cabin, and in addition the safe preservation of those portions of the old bascule that were to remain undisturbed in the reconstructed bridge.

Design

The capacity of the new portion was naturally determined by the design of the old. The alignment of roadways also determined the lateral spacing of the trusses and tower legs, while continuity of appearance suggested the retention of the "Warren" system of truss-framing and served to establish the minimum depth within a narrow range. Lightness of the suspended structure was an obvious requirement, so that high tensile steel was adopted at the outset for as much of the lifting span as could be benefited by its use. The engineers' specifications for material in the lift span demanded silicon steel as per Canadian Engineering Standards Association Specification A1-1928, Appendix VIII, or an equivalent steel definitely approved for this purpose. This steel was stipulated for the truss members, gusset plates, splices, lacing, and also for the flange angles and flange plates of the railway stringers and cross beams. During the processes of ordering material the contractors asked for the privilege of substituting high carbon steel lacing for silicon steel lacing, which privilege, after examination of stresses and details, was allowed them. For the remaining items of the lifting span, special carbon steel, to either B.E.S.A. 153-1927, Canadian National Railways SW1.1-1928, or the Montreal Harbour Bridge Specification-1925, clause 10, was specified, with the further exception that minor details such as ladders, railings, cabin floor, etc., might be made of standard structural carbon steel C.E.S.A. A1-1928, Appendix VII. Rivets were specified to conform to the Montreal Harbour Bridge Specification or the C.N.R. Standard.

The engineers prepared, besides complete specifications, a set of design drawings showing all new material and details together with the work to be done on the old structure, indicating the items to be salvaged and reused, and gave the bidders copious instructions regarding the work to be undertaken and tendered upon. Options were allowed in certain instances as to whether new material or old would be preferred by the bidder in certain parts of the 70-foot north flanking span; and he was required to state in his tender whether he would require the use of the old pier No. 2 during his erection work, whether he would be propping up the counterweight by means of supports from the riverbed or the substructure, and what time he would require to hold up navigation during his processes of floating in the lifting span, completing its connections and raising it, and thus reopening the channel to river traffic. The engineers' estimates on the work involved in the superstructure contract were given to the Department of Marine as $420,000 but the lowest bid received, namely that of the Dominion Bridge Company, was $445,-510. The successful bidders submitted, as their silicon steel, the Dorman Long product known as "Chromador" which had just been accepted by the Danish State Railways for use in a large government bridge project and which was specified in the makers' booklet as being a chrome-copper steel with the following chemical analysis:—

Carbon	not exceeding 0.3 per cent
Manganese	0.7-1.0 per cent
Chromium	0.7-1.1 per cent

*The Substructure of the Reconstructed Second Narrows Bridge, P. L. Pratley, M.E.I.C., Engineering Journal, August 1934, page 343.

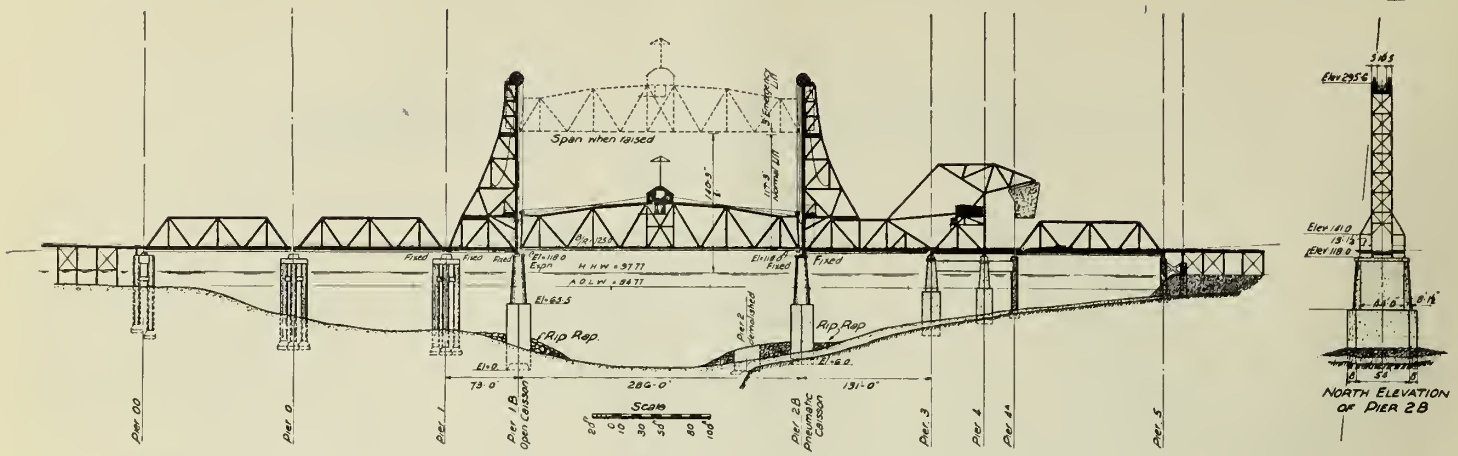


Fig. 1—Elevation of Reconstructed Bridge.

Copper..................0.25-0.5 per cent
Silicon..................not exceeding 0.2 per cent
Sulphur.................not exceeding 0.05 per cent
Phosphorus..............not exceeding 0.05 per cent

and with the following physical properties:—

Ultimate tensile strength.........from 37 to 43 long tons (83,000-96,000 pounds) per square inch
Yield point...........23 tons (51,500 pounds) per square inch
Elongation...........17 per cent on 8 inches
Reduction...........40 per cent minimum.

The above values are higher than those demanded by the engineers' specifications and typical test reports of material actually supplied showed, for example, in the case of 8-inch by 6-inch angles (heat 2866):—

Ultimate.............39.6 to 40.7 tons per square inch
Yield................23.8 tons per square inch
Elongation...........17 per cent in 8 inches
Reduction...........37 to 42.3 per cent
Carbon.............. .240 per cent
Manganese........... .750 per cent
Copper.............. .350 per cent
Chromium........... 1.03 per cent
Sulphur............. .039 per cent
Phosphorus.......... .027 per cent.

In the case of plates (heat 3159):—

Ultimate.............38.0 to 41.2 tons per square inch
Yield................24.3 to 24.6 tons per square inch
Elongation...........16 to 20.5 per cent in 8 inches
Reduction...........51.4 to 55.5 per cent
Carbon.............. .240 per cent
Manganese........... .840 per cent
Copper.............. .35 per cent
Chromium........... .94 per cent
Sulphur............. .034 per cent
Phosphorus.......... .024 per cent.

The carbon steels were all obtained in Canada with the exception of a few items and the Algoma Steel Company also supplied 111 tons of silicon steel rolled to the C.E.S.A. Specification above mentioned.

As an item of interest, it may be stated that the specifications called for all the steel to be rolled within the Empire, and as much as possible in Canada having due regard to quality and delivery. The actual tonnages of rolled material were approximately as follows:—

740 tons Canadian, distributed between Dominion Steel Foundries and Algoma Steel Corporation.

310 tons from Great Britain, distributed between Dorman Long, Steel Company of Scotland, and the mills co-operating under the British Steel Export Association.

Rivets were largely obtained from Calgary by the Vancouver shops of the Dominion Bridge Company.

The stress sheet, as issued, indicated that the railway loading was E-50 as for the remainder of the structure, and as far as the track stringers and railway cross beams were concerned the standard impact formulæ of the C.E.S.A. Specification 21, 1928, clause 30, were used. For this loading the flexural unit stress on silicon steel in the flanges of these members was specified as 22,000 pounds per square inch tension on the net section and 22/18ths of $(18,000 - 170\, l/b)$ compression on the gross section.

The highway loading for all planking, roadway stringers, cantilever brackets, cross beams, and stringers was the same 15-ton truck for which the original bridge had been designed, the axles at 10-foot centres, the gauge being 6 feet, and 10 tons carried on the rear wheels. A uniform load of 100 pounds per square foot was specified for all sidewalk members and, as an alternative to the trucks, on the roadway stringers, brackets and cross beams. When considering the truss, an assumed uniform load was stated to represent the highway traffic, the figures varying for the different lengths of span. To the lift span, which was 282 feet centre to centre in length, 800 pounds per linear foot per lane was allotted; to the 129-foot old bascule span 900 pounds per linear foot per lane; and to the new 70-foot tower span on the north side, 1,000 pounds per linear foot per lane. The sidewalk load to the truss was uniformly set up at 80 pounds per linear foot and, as the sidewalk only occurs on the east or upstream side, the east truss was computed and both trusses made alike as to material and detail. Provision was included for the cantilever effect of the highway and footwalk, this affecting not only the load on the truss but also the dead load moment on the main cross beams.

The impact allowance on members carrying roadway trucks directly was taken as 30 per cent of the live load item, but for the truss a modification was introduced to provide for the variety of loads actually carried. On the tower spans and for the hangers only of the lifting spans, the whole impact was specified as:—$I = \frac{R^2}{D + R + H}$ where R is the railway live load stress, H is the highway live load stress, and D is the dead load stress. For other members of the lifting span the impact I was established as 2/3rds of that given by $\frac{R^2}{D + R + H}$.

Wind and traction forces were considered and also the effect of temperature changes on the bottom chords of the flanking spans seeing that both these latter were fixed at both ends. Computations were made on the basis that temperature strain would be taken up partly by play in the joints, partly by elastic bending of the pier shafts, and partly by stress in the bottom chord members.

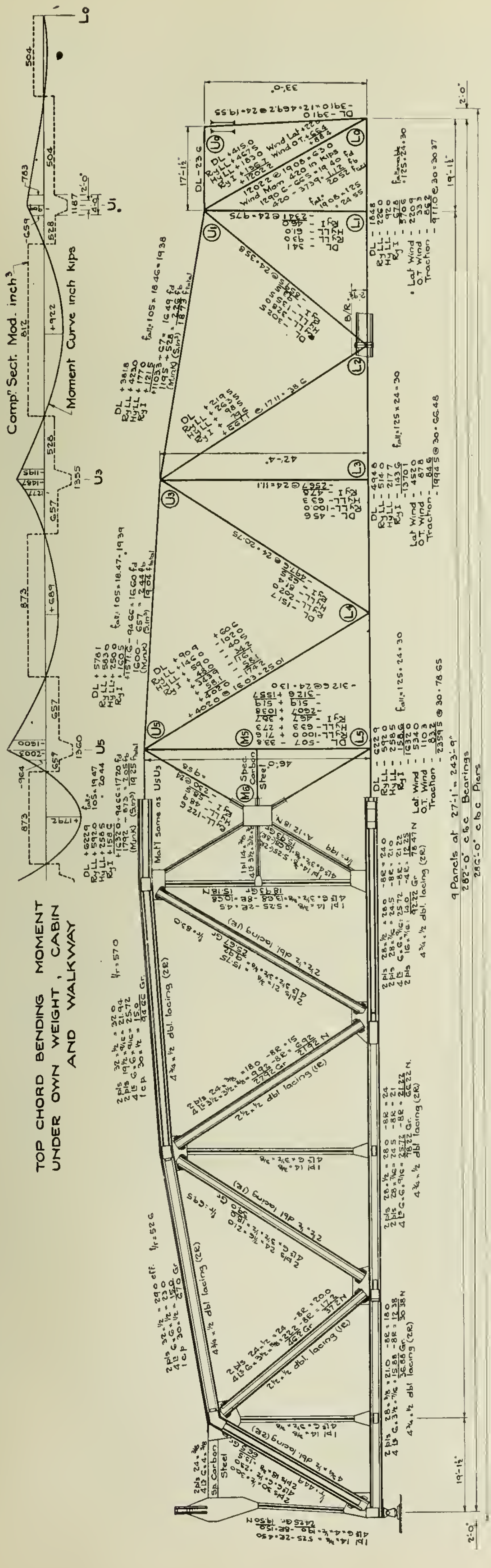


Fig. 2—Stress and Material Sheet for Lifting Span.

The basic unit stress for special carbon steel stringers and floor beams carrying the railway loading was laid down as:—

18,000 pounds per square inch tension,
18,000 − 170 l/b flexural compression in the flanges,
12,000 pounds per square inch shear in the web.

For special carbon steel in the highway members, in truss members carrying all types of load simultaneously, and in bracing members, the permissible units were 20/18ths of those just stated. For silicon steel members in trusses and bracing, permissible units were 24/18ths of those specified for carbon steel.

Furthermore, for abnormal combinations, such as wind with live load and impact, the usual 25 per cent excess unit was allowed but in the case of long top chords the bending stresses induced by the weight of the member were figured and additional material provided if the combination of dead load stress, live load stress, impact allowances, and this "own-weight" bending induced units over 1.05 times the normal. Secondary stresses from deformation were also computed in the 232-foot lift span and detailing at gussets and splices was studied with these figures in view. No direct increase in section was, however, required from this cause. The general requirements as to workmanship and detail were those of the C.E.S.A. Specification for Movable Bridges A-20-1927, except where modified by the engineers in the drawings and specifications or during approval.

The timber floor, carrying the roadways and sidewalk, as well as the ties and guards of the railway deck, was specified to be creosoted timber using an 8-pound empty-cell treatment, incised all over. This treatment was considered as rendering the timber fire-resistant and as assuring a forty-year life under proper maintenance. The use of a timber floor not only accorded with the existing bridge condition but served to aid in keeping the lifted structure as light as possible. A stress and material diagram for the trusses is included as Fig. 2, and a cross section with the calculations for the typical floor members is given in Fig. 3. From the latter it will be noticed that the brackets carrying the roadway were directly cantilevered from cross beams, flange plates or straps being passed through the truss to accomplish this end. These straps varied at the different panel points and were single or double, horizontal or vertical as conditions dictated. Slots were burned in the main gusset plates and the loose straps were field riveted to the top flange of both the outside bracket and the inside cross beam.

The truss was divided into eleven panels of which the end ones were 19 feet 1½ inches in length and the nine intervening ones 27 feet 1 inch. This short end panel had certain advantages in that the end cross beams did not become unduly heavy in their build-up compared with the remaining floor beams, as might otherwise have been the case due to the severe impact requirements imposed by the specification upon the members at the end of the span receiving shock loadings. Further, the end diagonal was kept correspondingly shorter and at a convenient angle of inclination, the bottom laterals were more readily dealt with, and in general the span could be made more rigid at the ends where the lifting and locking gear were located.

The top chord of the truss was built of 32-inch deep web plates, four 6-inch by 6-inch angles and a 30-inch by ½-inch cover plate. For "own weight" bending the chord was taken as a continuous beam of seven spans from L0 to L0 and the resulting maximum theoretical moment was computed as 2,003 inch-kips, this occurring over panel point U5. The values entering into figures, for proportioning the chord, however, were 1,655 inch-kips on the top flange of U3-U5 near U5 and 1,792 inch-kips on the bottom flange of U5-U5 at its mid point, because the higher values at the apex of the moment curve are applicable to the stiffer and heavier section which lies within the district occupied by the gusset plates. The chords were held laterally at points vertically over L2-L4, etc., so that their slenderness ratios were about 52.5 and their permissible units 19,390 pounds per square inch on the extreme fibre for combinations of stress including the "own weight" bending.

The lateral wind pressure on the lift span and the cabins was given very ample consideration in view of the location of the structure. The specifications of the C.E.S.A. for Movable Bridges were closely followed as to units and general considerations but generous allowance was made in respect of exposed areas, and the disposition of the reactions to the tower was carefully studied. The guide system finally adopted made it possible for wind to be transferred from the span to the tower posts at the U0 points as well as the L0 points so that the concentrations applied on the top chord of the spans were considered as having two paths at their disposal. An approximate survey of the relative stiffness of these paths led to the assumption that 2/3rds of the shear would travel via the top chord laterals to the upper guides and 1/3rd would travel via the vertical sway bracing and diagonal portal bracing to the bottom laterals and thence to L0 and the lower guides.

For proportioning the tower and its anchorage system the wind load received from the span was further increased above that used in proportioning the span bracing and other details of the trusses insofar as twice the exposed area of one truss was included instead of one and a half times. The exposed area of the floor and cabins remained unchanged but the effect of wind on the counterweight ropes was also included and the variation of this item with the position of the span was considered. Wind on the live load does not arise as the span moves up the tower legs. All possible positions of the span were studied in determining the stability of the tower legs and bracing and generous provision was also made for wind on the tower itself and on the moving counterweight.

On the trusses of the lift span, consideration of the wind loads entered into the proportioning of the whole bottom chord, this being due largely to the fact that the spacing of trusses was only 20 feet and considerable overturning moment arose from pressure on the exposed area of the cabins. The central panels of the bottom chord were governed by the following combination of stresses:—

Dead load	622.9
Railway live load	592.0
Highway live load	258.5
Railway impact	158.6
Lateral wind	534.0
Overturning wind	110.3
Railway traction	83.2
Total	2,359.5 kips

for which 92¼ square inches of material was provided, yielding a net area of 78½ square inches.

In the end posts the bending stress arising from the transfer of wind load down to L0 fails to enter into the determination of the section, the governing feature being the combined stress from dead and live loads which totals 1,202.2 kips and for which 66.5 gross square inches is provided. The detailing, however, has to accommodate a wind moment of some 420 foot-kips at the foot of the end post and also at the foot of the portal knee braces.

The lacing of the chords and end posts was determined from specification requirements and by sketching as 4¾-inch by ½-inch double lattice with two rivets per bar whilst that in the web members was stipulated as being 2½ inches by ½ inch double lattice with a single rivet at each end and centre connection. The gusset plates were specified as ⅝-inch silicon steel planed on all edges and the general run of rivets was ⅞ths inch diameter, although some inch rivets were used.

As regards "camber," the shop lengths were computed so as to produce normal geometry under stress conditions expressed by $D + \frac{1}{2}(R + H)$, where D is the dead load, R the railway live load, and H the highway live load, except the hangers which were shortened by the extension due to $(D + R + H)$. In computing the dead load stresses, provision was made for creosoted lumber throughout, gas mains, water mains, light and power conduits, walkways,

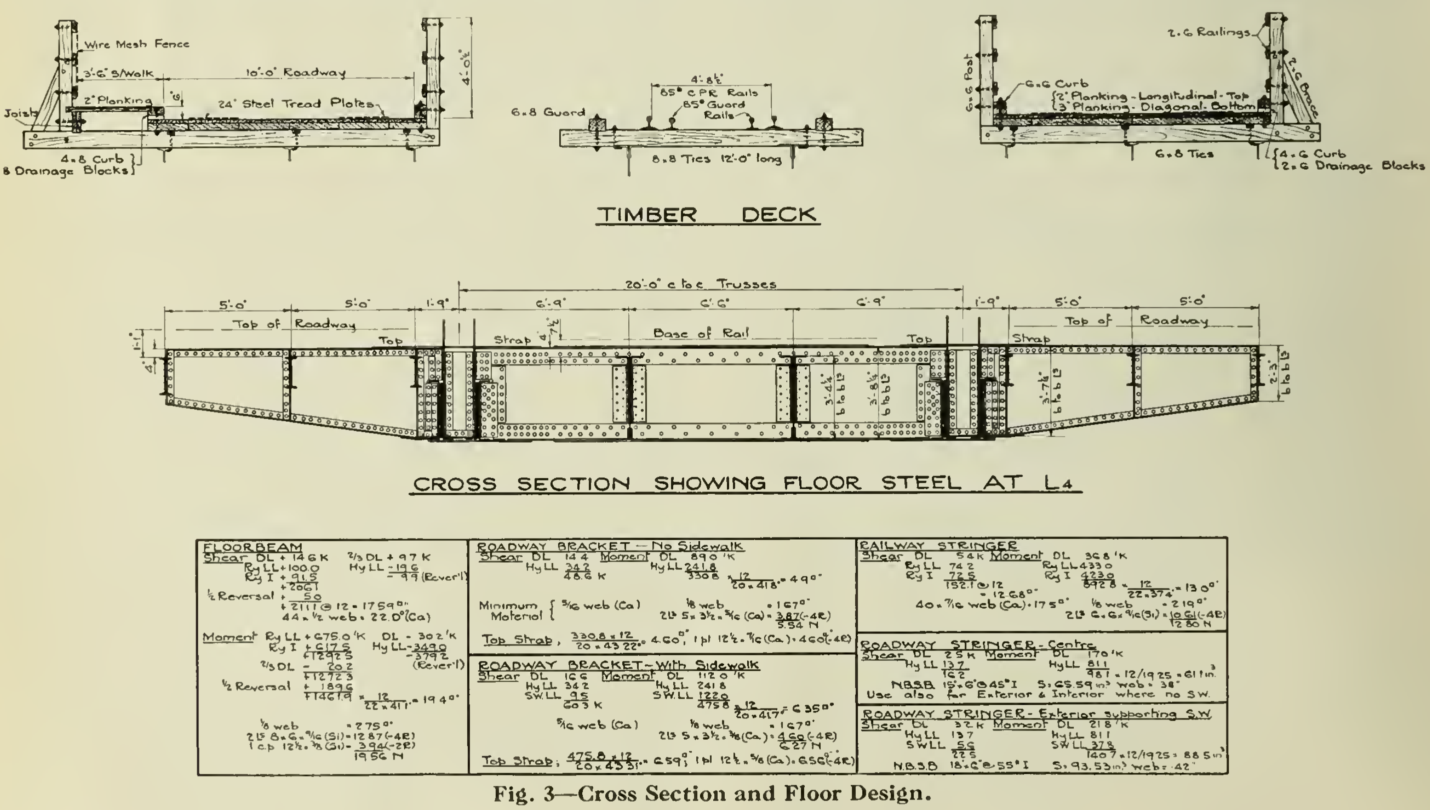


Fig. 3—Cross Section and Floor Design.

ladders, and all cabin equipment, signal systems, mechanical and electrical gear, etc., but *not* snow.

The estimated weight to be lifted by the counterweight ropes, as prepared for stress sheet purposes, was 403,900 pounds at the heavy corners and 386,700 pounds at the light corners, or a total of 1,581,200 pounds at the bottom of the counterweight ropes, this being exclusive of certain fence-rails and tread plates which were added later. These latter consisted of 24-inch by ¼-inch plates laid in four lanes, two to each highway. The actual weight estimated after completion of the drawing office work was 1,623,710 pounds also exclusive of tread plates; the excess, 42,500 pounds, which is about 2½ per cent, being accounted for largely by extra equipment, and over-run of detail.

Air buffer cylinders are installed in the end floor beams of the lifting span, one at each corner, and serve to ease the impact with which the span makes contact with the stationary shoe plates. These cylinders are of cast steel and were somewhat troublesome in the foundry because of their shape, more than one being lost before four acceptable castings were secured. The stroke of the piston was specified to be not less than 2 feet 6 inches which resulted in a cylinder with an overall length of 3 feet 2¼ inches. Wings, or lugs, were cast on the outside to provide connection to the flanges of special bracket details attached to the end floorbeams and the mouth of each cylinder is closed by a cast steel cover bolted to the rim and bored for BB bushing through which the piston rod passes. This rod is turned to $3\frac{5}{16}$ inches diameter and has an adjustable end piece of hardened steel which bears on a special bed plate anchored to the pier tops. The outside diameter of the cylinder is 17 inches and the bore is nominally 15 inches, the interior surface being polished very smooth and accurate for contact with the piston rings. The difficulties in casting resulted in slight differences in this bore as between the four cylinders, and the piston rings were varied accordingly. Each cylinder has a needle valve for slow exhaust and two check valves. The cylinders were tested hydraulically to 1,000 pounds pressure per square inch before final machining as a protection against pin holes or shrinkage defects. The specification for workmanship demanded that the weight of the cylinder with its appurtenances should be completely sustained by the confined air for five minutes with a definitely limited piston travel. An annular groove on the piston serves as a setting indicator, this groove coinciding with the lower end of the cast steel mouth cover when the moving span is settled down to its normal traffic carrying position.

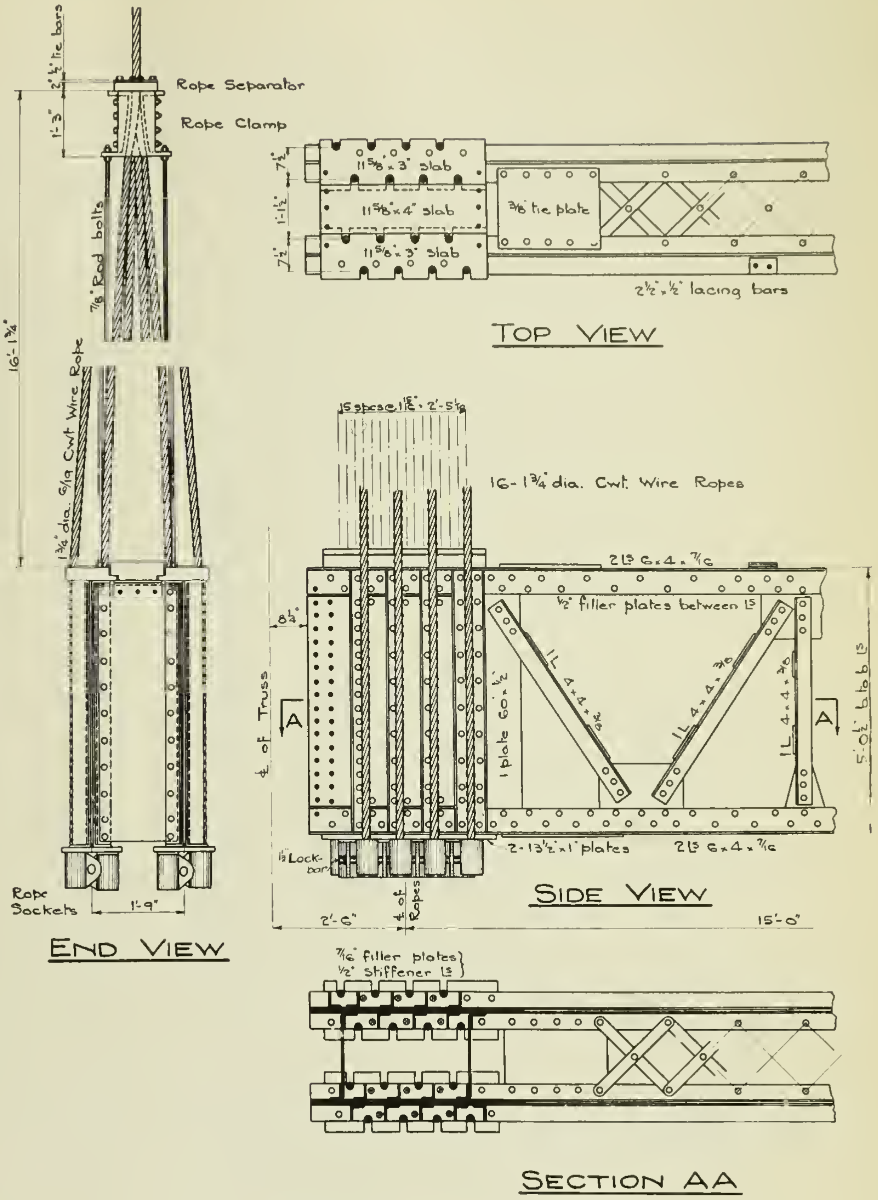


Fig. 4—Lifting Girder and Rope Attachments.

Lifting Girders

The lifting girders at U0 and the rope connections thereto were given considerable study with an idea of simplification as compared with the more usual practice. With the 12-foot diameter of sheave definitely adopted, the 6-foot dimension between the centreline of the counterweight ropes and the axis of the front tower legs was divided into two portions, 4 feet and 2 feet, the former between the centres of bearing of the tower legs and those of the lift span shoes, and the 2 feet being the inclination of the end member L0-U0 to permit the panel point U0 to come directly under the centreline of the lifting ropes. The sheaves were set at 15-foot centres, transversely; and the 16 counterweight ropes at each corner, which were 1¾ inches nominal diameter, were spaced at $1\frac{15}{16}$-inch centres. These ropes were pre-stressed and socketed at both ends as will be mentioned later, and at the span end each 16 were led into four groups of four after passing through a spacing clamp situated some 15 feet above the lifting girder, each four being guided into slots prepared in the inner and outer edges of both flanges of the double-webbed lifting-girder. This detail is the result of using pre-stressed ropes which makes it possible to dispense with equalizers, and makes for simpler erection, particularly when time is strictly limited.

The lifting girder, shown in Fig. 4, was heavily plated and stiffened for some 4 feet at each end, but between these end web plates was of the open type with single Warren system bracing. The two webs are 21-inch centres and the depth over flange angles is 5 feet 0¼ inch, these angles being 6 inches by 4 inches by $\frac{7}{16}$ inch with the 4-inch legs outstanding and the space between the 6-inch legs filled with flats between gusset plates. The flanges were covered at the ends by heavy plates, those on top being 11⅝ inches by 3 inches thick and 3 feet 0½ inch long and those on the bottom being 13½ inches by 1 inch thick, and 3 feet 3½ inches long. The ropes, after having been splayed out in groups of four to pass through slots in the edges of the upper plates, continued vertically to similar slots in the lower plates, underneath which they simply bore on their sockets. The spacing of the groups of four ropes across the lifting girder and longitudinally with the main span, was thus brought to 7½ inches-13½ inches-7½ inches.

After the ropes were in place, an intermediate slab, bolted, at its ends only, to the top flanges of the girder between the inner two groups of ropes, served as a positive spacer and keeper device. This slab was suitably bevelled on its edges to lead the ropes easily as they change direction at the top flange. Heavy connection angles were used to attach this lifting girder to the inside gusset plates and, through suitable diaphragms, to the outer gusset plates at panel point U0, between which gusset plates the slightly inclined members U0-L0 are entered from below bringing in the suspended weight of the span. These members were increased by 20 per cent over theoretical requirements to take care of dynamic effects, etc., during lifting and all the connections were quite liberally proportioned.

Ropes

The main lifting ropes were calculated on the basis of equal distribution of 418,000 pounds between 16 ropes, the direct tension thus being 26,100 pounds per rope. A special plough steel wire rope of 6 by 19 construction was specified with an impregnated hemp centre and a breaking strength of 97½ per cent of 133 short tons as listed in the Dominion Wire Rope catalogue under their trade name of "Samson Blue Strand." The resulting figure of 259,000 was, therefore, included in the requirements as the minimum value to be shown by any full sized destruction tests. The wire was specified as being required to exhibit the following physical properties besides being definitely of acid open-hearth steel of uniform quality:—

Tensile strength not less than 244,000 pounds per square inch.

Elongation not less than 2.4 per cent on 12 inches.

In torsion the wire shall withstand 25 complete turns in a length of 100 diameters without breaking or showing any signs of splitting or other defect.

In bending the wire shall stand, without fracture, not less than 6 bends alternately in opposite directions over a jaw the radius of which is equal to twice the diameter of the wire.

The diameter of the wire shall be uniform within reasonable limits, a tolerance of .005 inch oversize being allowed for wires over .064 inch in diameter, and a tolerance of .003 inch oversize being allowed in wires below .064 inch in diameter; wire measuring less than the nominal diameter not to be acceptable.

The specification also laid down the number and types of tests to be made on wire samples and upon the completed rope, and in addition gave the pertinent data with respect to the pre-stressing operations.

It was originally anticipated that the metallic area of the rope would be about 1.225 square inches and the direct tensile stress unit about 21,300 pounds per square inch with a factor of about 10 on the rope strength and 11½ on the wire value. The bending stress induced by passing the rope over the 12-foot diameter sheave was tentatively assumed as $E \times \frac{d}{D}$ where E is in pounds per square inch after pre-stressing, d is the diameter of the outer wires which make up the rope, and D is the sheave diameter.

Using:—

E = 18,000,000

d = .116 which was the result of dividing 1.75 by 15

D = 144 inches

the bending unit appeared to be 14,500 pounds per square inch so that the total approximate fibre stress might reach 35,800 equivalent to the wire value divided by a factor of 6.82. It was felt that this would be amply safe for specification purposes and that any variations either in wire diameter, modulus, or even in lifted load would not seriously impair this safety factor.

The counterweight ropes were actually supplied by Wright's (Canadian) Ropes, of Vancouver; pre-stressed and socketed in Longueuil, Quebec, by the Dominion Bridge Company, while the full-size test pieces were pulled in Seattle, Washington. The test specimens yielded values of 255,000; 263,000; 281,900; the first of these three being slightly low on the specification but the author, who witnessed the tests, was quite satisfied that the socketing was to some extent responsible for this figure and, in view of the other two specimens being socketed in a fair and a good manner respectively, every satisfaction was felt that with careful socketing under direct control at Longueuil, the ropes would be amply strong. As a matter of fact a fourth test was obtained when pulling a length of rope at the Anglo-Canadian Rope works at Rockfield, Quebec, on April 3rd, when tests were being made on the sockets. In this case the rope broke at 287,000 pounds without bursting the sockets and thus confirmed the values obtained in Seattle. In addition to pulling specimens of the completed rope, a number of lengths of the strands of the rope were pulled to destruction in the laboratories of the University of British Columbia. It was the original intention to pull twelve full sized specimens, but in view of the inconvenience of having to send these to Seattle for test, arrangements were made with the rope contractors whereby a subsidiary specification for strand strength was provided and a number of such tests carried out in place of those full sized tests omitted. Twelve strands were pulled to destruction and the specified strength of 47,000 pounds was exceeded in every case, the actual figures running from 49,350 to 52,220, the average being 51,466. A comparison of the wire value, strand value, and the rope value is interesting and can be expressed in the following manner. The average tensile value of the main wires making up the counterweight rope was 118 long tons per square inch and for the six small filler wires 90 tons per square inch. On this basis the metal value at wire units was 325,742 pounds, the strand value was six times the average figure of 51,466 or 308,796, and the corresponding full strength rope value was 281,900. Expressed in percentages of the metal value, these figures represent 100, 94.8 and 86.54 per cent respectively; whilst in percentages of the rope value the figures show that the wire value is approximately 115.5 per cent and the strand value 109.5 per cent of the value found in the full-sized destruction tests. The 47,000 given to the contractors as a satisfactory strength to be shown by strands pulled to destruction was based on 9 per cent increase above 1/6th of the specified rope value.

The 64 ropes, roughly 183 feet 4 inches long, were manufactured at Vancouver from English-drawn wire, in five lengths, four of which were about 2,400 feet and one about 2,215 feet after cutting off the test pieces. These lengths were reeled and shipped to Montreal, as above mentioned, for pre-stressing and socketing. Each strand consisted of one centre wire .130, six inner wires .118, six filler wires .048, and twelve outer wires .112, the theoretical area including the fillers being 1.248 square inches, the lay of the outer wires being 11⅞ inches and that of the inner wires 5½ inches. The wire tests showed values running from 115 tons to 122 tons per square inch for the main wires both in England at the rolling mills and when retested in Vancouver at the rope making plant. The filler wires, on account of their smaller diameter, being rolled to a slightly lower specification, showed values in Sheffield of from 86 to 92 tons per square inch and on retest in Vancouver from 89 to 95 tons per square inch, all these tons being long tons of 2,240 pounds. The torsion tests were also very satisfactory, the reports from the English mills

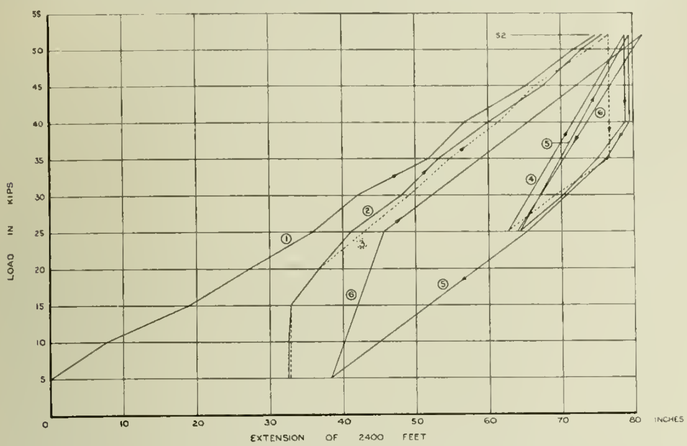


Fig. 5—Stress-Strain Curve for Rope No. 3 During Pre-stressing.

merely stating that they all showed at least 25 turns whereas in Vancouver every coil was again tested and the exact number of turns noted. The number varied between 34 and 47 complete turns in a length of 100 diameters. Similarly, all the bend tests were repeated in Vancouver as a matter of local satisfaction and in all cases with perfect success. In Montreal the reeled lengths above referred to were socketed temporarily for pre-stressing purposes, and after the latter process had been completed the ropes were cut to the proper service lengths and re-socketed with the greatest of care under strict supervision and inspection. The completed ropes were then painted longitudinally so that any subsequent coiling or uncoiling would be rendered visible and could be corrected when the ropes were being assembled at the site.

The final requirement for pre-stressing was to stretch all ropes gradually to a tension of 52,000 pounds which meant about 42,000 pounds per square inch tension, a unit safely over the maximum value likely to occur in service. It was required to hold this load for thirty minutes and then to reduce the tension to 25,000 pounds per rope at which stress measurements were made and markings placed on the material. After the ropes were cut and re-socketed they were all again directly measured and listed so that in case of small variations occurring the uneven ropes could be distributed between the four corners of the span. This point will be referred to again later on.

Pre-stressing beyond the service loads was part of the scheme adopted when it was decided to dispense with equalizers and the figures chosen were such as to be definitely above those liable to arise in practice and yet not too high to damage in any way the impregnated hemp centre. It was at first considered desirable to take the original pull up to 100,000 pounds per rope, but in view of this latter consideration and on the urgent advice of the rope makers the tension at which the rope was to be held at thirty minutes was reduced to 52,000 pounds as above stated. Very careful records were kept of the behaviour of the rope under this treatment, the contractors being interested also in the performance of their pre-stressing plant which was new for this purpose. Due undoubtedly to this newness the resulting graphs as between pull and stretch were not too uniform, the difficulty being the disturbance involved in the sticking of the ram at the pulling end after any particular load had been held for any appreciable length of time. The actual experience of the ropes in this pre-stressing process was such that several cycles of stress up to 52,000 pounds were given to each rope before the modulus had steadied enough to give acceptable results. Where the load was increased without stopping, from 25,000 to 52,000 and was decreased without stopping between these same limits, apparently higher values of E were obtained in some cases, but on examination it was evident that some unrecorded sticking had occurred which fogged the results. The third, fourth, and fifth ropes were given six cycles and the graph for number three is indicated in Fig. 5, the information on which may be regarded as being fairly typical. This 2,400-foot length was pulled by increments of 5,000 pounds in about ten minutes to 52,000 pounds at which time it had extended 75 inches. It was released quickly to 5,000 pounds pull, but $32\frac{1}{2}$ inches of the stretch remained. The load was then taken up again by 5,000-pound increments in ten minutes to 52,000 pounds at which point the extension was $75\frac{15}{16}$ inches from the original zero. Released to 5,000 pounds again the extension remained at $32\frac{3}{4}$ inches; and on a third run up by 5,000-pound increments to 52,000 pounds during nineteen minutes, the extension rose slightly to read $76\frac{3}{4}$ inches. The load was held here for thirty minutes after which the extension was re-measured and found to be $75\frac{7}{8}$ inches. On release, sticking occurred until the load had been reduced to 35,000 pounds. At 25,000 pounds pull the load was held again and the extension recorded as $62\frac{3}{4}$ inches. The fourth run up to 52,000 pounds, without stops for intermediate measurements, resulted in an extension of 79 inches but upon release this extension again stuck until 40,000 pounds was reached on the fourth downward trip. At 25,000 pounds pull on this trip downward, the stretch was recorded as $64\frac{3}{8}$ inches; and on the fifth run up, straight to 52,000 pounds, the extension reached $79\frac{1}{2}$ inches which again stuck until 40,000 was reached on the fifth downward trip. At 25,000 pounds pull on this downward trip the stretch was recorded as $65\frac{3}{8}$ inches and the trip was continued downward to 5,000 pounds where the residual extension was measured as $38\frac{3}{8}$ inches. A sixth run up, stopping at 25,000, yielded a stretch of $45\frac{3}{4}$ inches at this point and $81\frac{3}{8}$ inches at 52,000, but on the run down the figures showed $64\frac{1}{16}$ extension at 25,000 pounds pull.

It was at this point that both load and extension were held while marking took place. In this case, therefore, the load actually passed through the 25,000 pounds value twelve times, on eight of which occasions the extension was measured during this cycle of operations, and the lengths of a 2,400-foot portion, measured originally at no load, had the following eight different values in chronological order as the load passed through 25,000 pounds pull:—

2,403 feet 0 inch on way up first time.
2,403 feet $5\frac{3}{16}$ inches on way up second time.
2,403 feet 7 inches on way up third time.
2,405 feet $2\frac{3}{4}$ inches on way down third time.
2,405 feet $4\frac{3}{8}$ inches on way down fourth time.
2,405 feet $5\frac{3}{8}$ inches on way down fifth time.
2,403 feet $9\frac{3}{4}$ inches on way up sixth time.
2,405 feet $4\frac{1}{16}$ inches on way down sixth time.

It may be added here that the pre-stressing machine was overhauled after this usage and improved means of relating the stress in the rope to the extension were devised for future service. Although great care was taken in marking off the lengths of rope in the pre-stressing trough, after these ropes had been re-reeled, un-reeled, cut and socketed, small variations in measurements as between the reels appeared. All the ropes were laid off reel by reel on the shop floor and subjected to a 4-ton pull. They were then measured with a calibrated tape which was under 20 pounds pull, and the respective lengths were as follows:—

Ropes off reel No. 1 measured 181 feet $8\frac{11}{16}$ inches.
Ropes off reel No. 2 measured 181 feet 9 inches.
Ropes off reel No. 3 measured 181 feet $8\frac{1}{8}$ inches.
Ropes off reel No. 4 measured 181 feet $8\frac{3}{8}$ inches.
Ropes off reel No. 5 measured 181 feet $8\frac{5}{16}$ inches.

While these lengths are comparative among themselves they do not correspond to the length between sockets under service conditions, which was theoretically 182 feet 0 inch for all ropes. The impression obtained during this work of pre-stressing and re-measuring is that the re-reeling and un-reeling had some effect on the final length and this same impression was confirmed by a similar experience on another bridge where the strands of the suspension cable showed similar slight variations after reeling and un-reeling a second time. At the site, after erection, it was possible to detect the ropes which were slightly longer than the average, by observations on vibration. The 13 ropes off reel two, which appeared to be the longest, had been deliberately distributed so that 3 of them occurred at each of three corners and 4 at the fourth, and under operating conditions it could be noticed, on close examination, that these ropes were slightly slacker than the others. The variation in unit stress resulting from this variation in length is, however, quite a trivial matter. Assuming, for example, that fifteen ropes were all one length and the other rope was $\frac{5}{8}$ths of an inch longer, each of the fifteen ropes would carry 27,800 pounds and the sixteenth rope 21,200 pounds at the heaviest corner under the worst conditions, instead of all sixteen taking 27,400 pounds each. As this assumption regarding variation is distinctly severe, and the resulting overload on the shorter ropes only 400 pounds, it is quite obvious that the recorded departure from exact equality of length is of no practical importance.

Locks

Parallel to the lifting girders but in the plane of the top chord and outward from the panel point U0 are placed certain transverse struts which act as lateral bracing and also support the mechanical and electrical equipment such as locks and lock motors, collector gear, etc. (Fig. 6). The four locks are of the toggle type and are so designed that the contacting arms or hooks, of which there is but one to each lock, are swung outward and upward in the driving operation until they bear up against special brackets mounted on the front legs of the towers. As the toggle straightens under this power stroke these arms can develop enough pressure to force the span down tight on to its shoes and so line up the rails and roadways vertically. In design'ng the lock and lock mechanism a figure of 50,000 pounds was studied as the probable maximum requirement at the end of each hook for this purpose. This lock design virtually duplicates, as a matter of fact, the lower half of a lock developed for use on the leaf of a double bascule span at Sorel, Quebec, where two halves moving in a vertical plane came together to meet a tongue protruding from the opposite bascule leaf. The same contractors, the Dominion Bridge Company, were engaged on this bascule bridge, for which the author's firm were consulting engineers, and the experience in this earlier work suggested the adaptation referred to. The lock motors at the Second Narrows Bridge are of 1-h.p. Lancashire Dynamo and Motor, geared-down type, with limit switches of the Norwood-Noonan make, and the necessary gearing to reduce from 15.9 r.p.m. at the motor to 2.81 r.p.m. at the lock end of the shaft. This shaft is of $2\frac{5}{8}$-inch diameter as indicated on Fig. 6 where the dimensions of the lock are also detailed. The mechanism is assembled in a welded plate frame, using $\frac{5}{8}$-inch metal and $\frac{5}{16}$-inch fillet welds, the bearing blocks of the main shaft being 4-inch slabs $3\frac{3}{4}$ inches deep welded into the frame. The levers, hooks, arms, etc., of the lock itself are of heavy welded plate construction, and for all bearings of the main shaft welded construction has been used in preference to castings.

On the same cross struts are built various platforms and railings which give access to these locks, to the upper span guides, to the deflector sheaves, and tower ladders, and at the south end of the span where the power pick-up is located, these walkways also lead to the electrical contactor system.

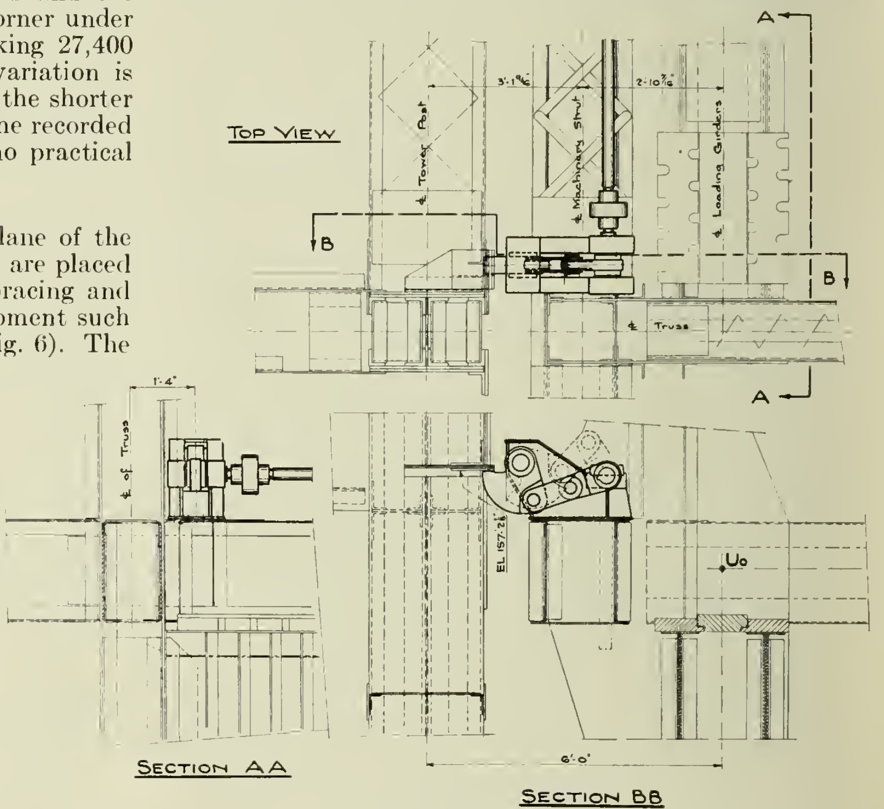


Fig. 6—Locking Device.

Guides

The system of guides adopted for this lifting span consists of shoes instead of rollers, the general reason being the removal of point loads and the substitution therefor of plates which would spread the load over a more reasonable distance and so tend to avoid high intensities of pressure. At the south end the lower span guides limit the movement between span and tower both laterally and longitudinally, but all other guides simply restrict the lateral sway of the lifting span. Figure 7 shows diagrammatically the principles involved, the general design, main dimensions and clearances. It was noted in discussing the distribution of wind stress that a total of 8 guides was adopted, 4 at the top corners U0, and 4 at the bottom corners L0, and the diagram shows the provisions made on the tower to pick up the bearing from each of these devices. Into the guide system there was incorporated a centring device, this being a modification of the engineers' design suggested by the contractors and accepted upon examination as advantageous in many respects. The device consisted in the gradual swelling of the guide bearing elements situated on the towers in the lower 3 feet of their effective length for both upper and lower guides. This swelling of the tower elements was designed to reduce the normal swaying clearance of ½ inch to ⅛ inch as the span in its downward travel approached within 3 feet of its locked position. This device served to eliminate the need of any independent latch or tapered seating detail on the floorbeams of the span or on the piers and, while it demanded very careful shop work, was very successfully dealt with and has been found to work very satisfactorily.

The bottom span guides are made of heavy plate slabs machined to the shape indicated and finished with a vertical dimension of $15\frac{15}{16}$ inches. These are bolted to brackets which are supported from the cantilevered roadway cross-beams and they bear against the planed edges of the guide angle and guide plate forming part of the tower leg and, as the span approaches its down position, against the machined surfaces of the tower elements already alluded to. The upper span guides consist of 2⅜-inch plates 16 inches deep by 22½ inches long to each of which is welded a tongue 3 inches by 3½ inches by 17 inches which tongue bears on its 3-inch planed face against a special thick plate on the tower leg which constitutes the swelling device for these upper guides. This special bearing takes place, also, for a limited distance only, whereas the plate portion of the span guide runs up the edge of the guide angle and guide plate which form part of the tower leg for the greater portion of its height. The special tongue plate just referred to is part of the centring device and is planed to such a shape as to swell the tower element in the guiding system and gradually reduce the clearance as the span settles down. The guide angle and plate on the tower leg against which the plate portion of the upper span guide bears, are themselves swelled out at the bottom of their reach to serve as the means of similarly decreasing the clearance for the lower span guides. Manifestly this guide angle and plate could not be so treated at the elevation of the upper guides as this would have interfered in the free travel of the lower span guides, seeing that the latter move down the span some 33 feet ahead of and below the upper span guides. The short thick tongue is thus quite independent of the plate and angle guide and serves to engage the upper guides at the same moment as the main angle and plate element on the towers begins to grow wider and to engage the lower span guides.

Power

Mention has been made of the contactor system of power transmission. Main power is brought from the British Columbia Electric Power Company's line on the south shore at 11,000 volts. It is stepped down to 2,200 and again to 440 volts and carried in conduit along the approach spans and up the tower to three strips of copper fastened to three steel angles which are in turn suspended in front of the cross-bracing of the south tower but insulated therefrom. On the span, spring-controlled contactors press up against these straps, sliding up and down them as the span travels. The current thus collected is carried by cables in conduit to the operating cabin for distribution to the main motors. Auxiliary electric power for lighting, for lock motors, for warning bells, for navigation and signal lamps, is brought from the same British Columbia Electric line but transformed at the southern entrance of the bridge down to 110/220-volts, 3-phase, 60-cycle, and then carried approximately half way up the tower whence a flexible "cabtire" cable is slung to the span, making connection at the platform level on top of the end upper chords. With the span down this "cabtire" cable hangs loosely down to the span; with the span up it hangs loosely down to the tower. It is suspended from special framing which leads it well outside the tower legs so that even under adverse winds it will not scrape against steel to its own destruction or to the breakdown of its insulation. In this "cabtire" cable are also laid the conductors leading back from the cabin for control purposes to the gates and bells, to the lamps on the south approach span and piers; and in a similar cable a corresponding set of control wires are led to the north side approaches via the north tower, both "cabtire" cables being hung on the upstream or east side of the bridge in the lee of prevailing winds.

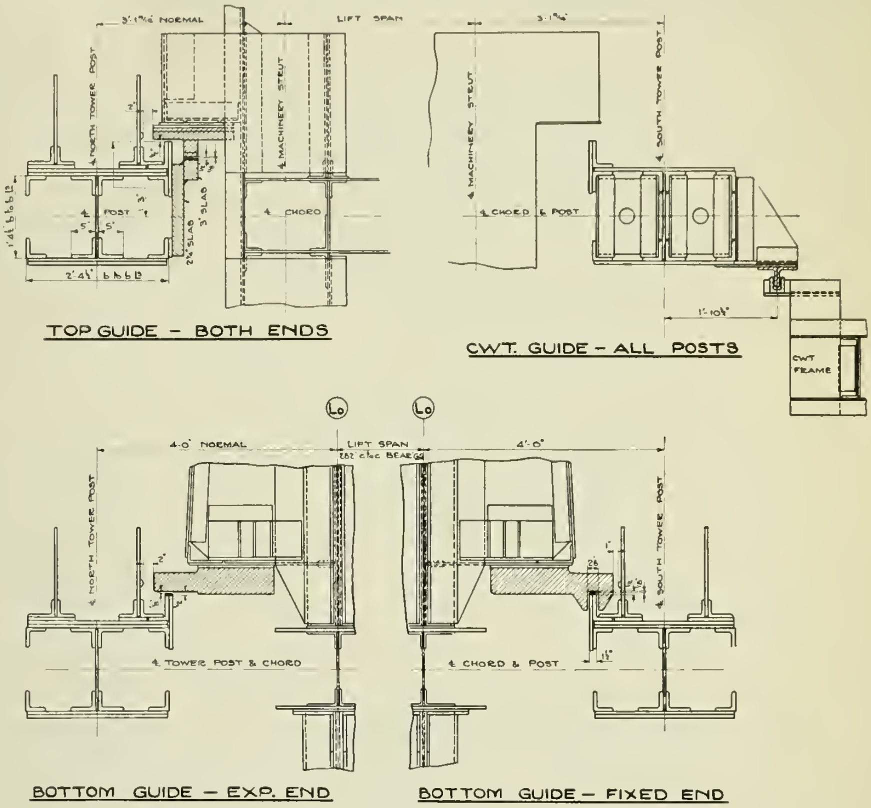


Fig. 7—Guide System.

Operating

The moving span is lifted by hoisting ropes wound up on drums situated in the cabin. The hoisting ropes are sixteen in number and are installed in pairs, four pairs of uphaul and four pairs of downhaul ropes being required. At each corner of the span there is thus one pair of each. The uphaul ropes are fastened high up on the tower by means of devices known as "take-up" drums which will be described later and are led via idlers to the top side of the drums; and the downhaul ropes are fastened low down on the tower to other "take-up" drums and are led by idler sheaves to the underside of the drums (see sketch, Fig. 8). A glance at this diagram will make clear the fact that by rotating the hoisting drums clockwise the span is hauled up and by reversing them the span is lowered. Manifestly, the position of the idlers has to be chosen to minimize "fleet" in the hoisting ropes and to obviate any fouling as between these ropes and the structural or mechanical parts. The idlers on the tower legs are 24-inch diameter sheaves while the deflector sheaves on the span over the panel points U0 are 67 inches in diameter. The smaller sheaves are of cast steel, each for a single rope and each with 4-inch hub although two are set together on a common pin $5\frac{15}{16}$ inches in diameter bushed to suit a $6\frac{11}{16}$-inch bore. The larger deflector sheaves are made for double ropes and are built up from independent parts welded together. The rim for example is a $6\frac{1}{4}$-inch by $3\frac{7}{8}$-inch slab rolled to circular form and then butt welded. The hub is a forging 16 inches in outside diameter, 7 inches in length and bored to $10\frac{3}{4}$ inches for a bronze bushing. The web of these

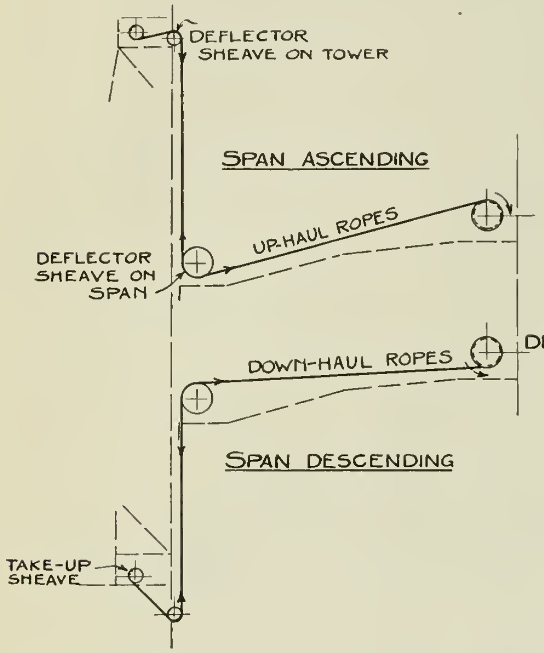


Fig. 8—Diagrammatic Sketch of Operating Ropes.

sheaves is a $\frac{5}{8}$-inch plate and the six spokes are pairs of 3 inches by 3 inches by $\frac{5}{16}$-inch angles set with all their toes on the web plate and there welded. Two such sheaves bear side by side on a $9\frac{1}{4}$-inch pin which is supported on shelf angles attached to gusset plates at U0. The pin is tapped for lubricator-gun fittings and the bushings are suitably grooved.

The operating ropes are of $1\frac{3}{8}$-inch diameter improved plough steel wire with a 6 by 19 construction around a hemp centre. They were designed for starting the motion against the combined resistances offered by inertia, sliding frictions, counterweight rope bending, and the unbalanced snow or ice load. The governing condition suggested about 112,000 pounds as the total load in the operating ropes, which, distributed equally to four corners, called for 28,000 pounds per corner. The specification C.E.S.A. A-20, 1927, calls for a capacity in such parts up to $1\frac{2}{3}$rds times the figured amounts so that using two ropes at each corner the design stress per rope became $\frac{28{,}000 \times 5}{2 \times 3}$ or 23,333 pounds. To meet this demand the wire was required to show an ultimate strength of 220,000 pounds per square inch and the breaking strength of the rope when tested to destruction was specified as at least 148,000 pounds. The anticipated metal area was .756 square inch which is slightly exceeded in the ropes provided when filler wires are included. The actual ropes are made up of six strands, each of 1-6-6-12 construction with wire diameters as follows: Core .102 inch, fillers .038 inch, inner wire .093 inch, outer wires .088 inch. The area calculated from these nominal dimensions is .7315 square inch exclusive of fillers or .7723 square inch inclusive and the breaking strengths on four test specimens 6 feet long pulled at the University of British Columbia were:—

No. 1 April 28th 168,750
No. 2 April 30th 160,520
No. 3 April 30th 162,480
No. 4 May 1st 159,600

651,350 pounds = 162,828 pounds as an average.

This average figure is equivalent to 210,850 pounds per square inch on the finished rope.

The main wires, as tested at the English mills, averaged from 108 to 112 long tons per square inch and when retested in Vancouver showed values of 246,000 to 252,000 pounds per square inch. The filler wires being of much smaller diameter were drawn to a lighter specification and showed, on tests at the English mills, values between 90 and 92 long tons per square inch but the check tests in Vancouver showed slightly wider variation. Using average values of 110 tons for the main wires and 90 tons for the filler wires the metal strength of the rope would be 188,467 pounds so that the efficiency of rope to wire is about 86.4 per cent. Using again the formula $E \times \frac{d}{D}$ for the calculated bending stress, and remembering that the rope only runs over the 67-inch diameter sheaves or drums, the total fibre stress on the final area aggregates 50,700 pounds per square inch of which bending produces 20,500 and the direct tension 30,200. Comparing this aggregate figure with the 110 tons minimum breaking strength shown on the test reports for the wires, the factor of safety is 4.84, while for direct tension the factor is expressed as $\frac{188{,}467}{23{,}330}$ or 8.08, a very ample provision, actually rather better than first anticipated. The lay of the operating ropes as established by the subcontractors, Wright's Canadian Ropes, was $9\frac{3}{8}$ inches for the rope and $4\frac{3}{8}$ inches for each strand. "True-lay" rope was favourably considered but the extra expense was not felt to be justified for such slow and infrequent operation. The speed of movement of the span and, therefore, of the operating ropes is little over 1 foot per second for the worst case, counting acceleration and deceleration as occupying each twelve seconds and the total time limit as two minutes for lifting the span 117 feet. This was the time specified for opening under normal balance conditions exclusive of closing safety gates and withdrawing locks. For the case of operating under maximum snow or ice load another minute was allowed. The speed of the existing motors being 570 r.p.m. and the speed of the hoisting ropes over the 67-inch drum being about 65.2 feet per minute the gear ratio became $\frac{570 \times \pi \times 67}{65.2 \times 12} = 153$. The torque for starting under unbalanced ice or snow load is the pull in the ropes, already referred to as totalling 112,000 pounds, applied at the drum circumference and reduced by the gear ratio and the mechanical efficiency. Thus:— $\frac{112{,}000 \times 2.79 \text{ feet}}{153 \times 0.59} = 3{,}460$ foot pounds torque. The specification calls for motive power equal to $1\frac{1}{4}$ times this bridge torque, or 4,320 foot pounds. Other conditions to be considered in examining the motive power are those arising from the running condition at full speed with the bridge balanced and the running condition at $\frac{2}{3}$rds speed with the bridge carrying an unbalanced ice or snow load. The torques required by these two conditions are respectively 1,700 foot pounds and 2,580 foot pounds. Using the two existing motors from the old bascule span the available starting torque is 4,500 foot pounds, this figure being obtained from the torque-speed curves which suggest a capacity of 2.45 times the normal, 200 h.p. at 570 revolutions, for the starting torque. Similarly, the available torque when running at full speed is 1,840 foot pounds and when running at ⅔rds speed is 2,670 foot pounds. It thus became evident that the two motors from the bascule span would be quite capable of doing the work required in the main lifting operation of the new span at the speeds specified.

In tests after completion the performance was very much as expected, the lifting time being between 105 and 110 seconds including acceleration and deceleration with the span virtually balanced. It was also demonstrated in tests that one motor could lift the span under emergency conditions although the rise in current was such as to suggest that this should only be attempted infrequently and at sufficiently long intervals.

To obtain the gear ratio required, namely about 153, it became necessary to include some new items, both shafts and wheels in the gear train in addition to the existing machinery practically all of which could be re-used. The drums, the drum gears, and drum pinions were necessarily new and the first pair of gears in the train from the drum pinion and the shaft were made new. Further, one new pair of gears was introduced into the auxiliary power train as indicated on Fig. 9.

The auxiliary power on the old bascule span was a 70-h.p. Buffalo gas engine with four cylinders of 5½-inch bore and 7-inch stroke, whose normal speed was 1,000 r.p.m. At full efficiency this machine would provide torque equal to $\frac{70 \times 33,000}{2 \times \pi \times 1,000} = 368$ foot pounds. In order to use it again it became necessary to determine a "time" and a corresponding gear ratio. Adopting suitable tentative figures for teeth on the new gears above mentioned a reduction of 1,860 between gas engine and drum was obtained, which, retaining the 1,000 r.p.m., meant a uniform rope speed of 0.157 foot per second. An acceleration curve was drawn which suggested a lifting time of 20 + 725 + 20 seconds, the middle figure being the time occupied at normal uniform running speed. This seven hundred and sixty-five seconds, nearly thirteen minutes, was considered satisfactory under the circumstances and the power requirements were figured therefor. Speed and acceleration being thus reduced, the maximum rope pull for unbalanced snow or ice load became about 108,000 pounds under the auxiliary power conditions instead of 112,000 pounds for main power and high speed. The gear train being longer, the efficiency at starting could only be reckoned at $.90^7$ or 47.7 per cent and the torque required at the engine was consequently $\frac{108,000 \times 2.97}{1,860 \times .477} = 340$ foot pounds, just under the amount available. These relations were, therefore, indicated on the power stress sheet as issued.

This gas engine had not been used a great deal during the chequered life of the old bascule bridge and it was expected to show, upon detail examination, a very fair efficiency. The problem of auxiliary power supply to the lock motors, safety gate motors, bells and lights, required at night time, was a little more difficult to solve but was finally met by the provision of a new independent gas-engine generator-set of 15 kv.a. capacity. The description accompanying the tender for this additional unit and its attachments was as follows:—

> "One 15 kv.a., 1,800 r.p.m., gasoline engine driven alternator, direct connected exciter, automatic voltage regulator, switchboard with ammeter, voltmeter, 3-pole knife switch and fuses, radiator and fan, electric starting equipment, storage battery, and gasoline tank, semi-automatic control equipment to enable the operator to start the engine from the operator's house, with necessary cut-out and thermostatic control, together with push button station for installation in the operator's house."

This installation involved in addition, the usual array of wiring and switches by which the auxiliary current could be led to the various transformers, motors, light circuits, etc., which it had to serve.

The general layout of equipment in the machinery cabin is illustrated in Fig. 9. The cabin itself is a commodious room situated above the top chord of the centre

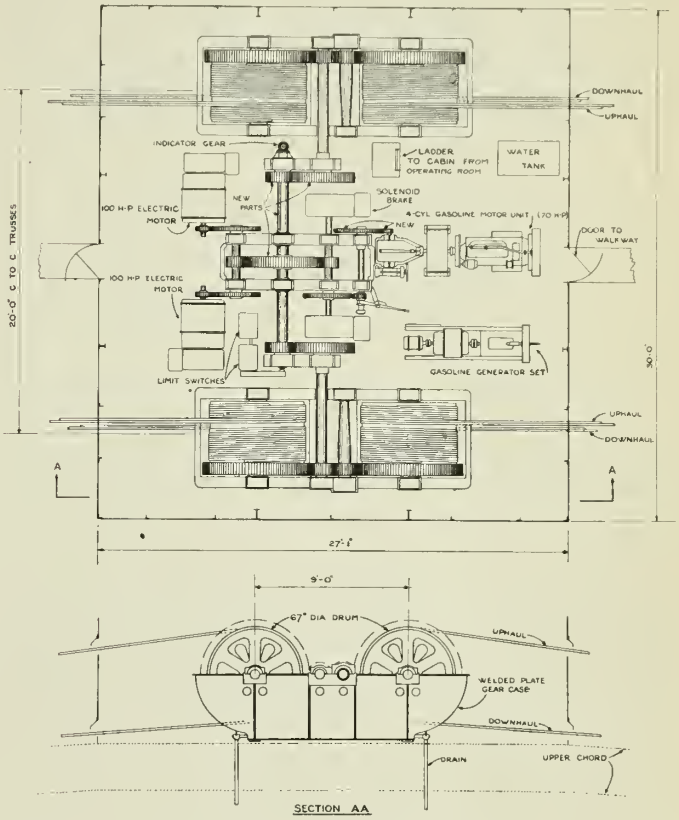


Fig. 9—Cabin Machinery.

panel of the lift span and is reached from the operator's house below by a ladder. Doors from the machinery cabin give access to railed walkways which lead to the signal equipment and to platforms situated at each end of the span. As mentioned before, these platforms provide safe and easy access to all the equipment mounted at the ends of the span and also to the ladders which run up the main tower legs from deck level to top. The cabin is of structural steel frame, sheet steel floors, walls, and roof, and is provided with a trolley beam under the ridge together with swing doors which open out over the roadways. The beam passes out of these doors and so provides means of hoisting the machinery parts from trucks and swinging them into place in the cabin, if required, during periods of repair.

In the operator's house are located all the controls, ammeters, volt meters, switches, indicators, etc., together with the hoisting gear for the navigation signal systems, the operator's desks, lockers, etc., and access to this house is obtained from the deck by ladders running up the truss members.

The operating ropes enter and leave the machinery cabin through louvred openings directly over the truss chords. The main drums are set symmetrically about the axis of the span and are housed in a special welded framework familiarly referred to as a "bath tub" on account of its shape. The drums are themselves partly of welded construction, each unit consisting of a grooved cylinder

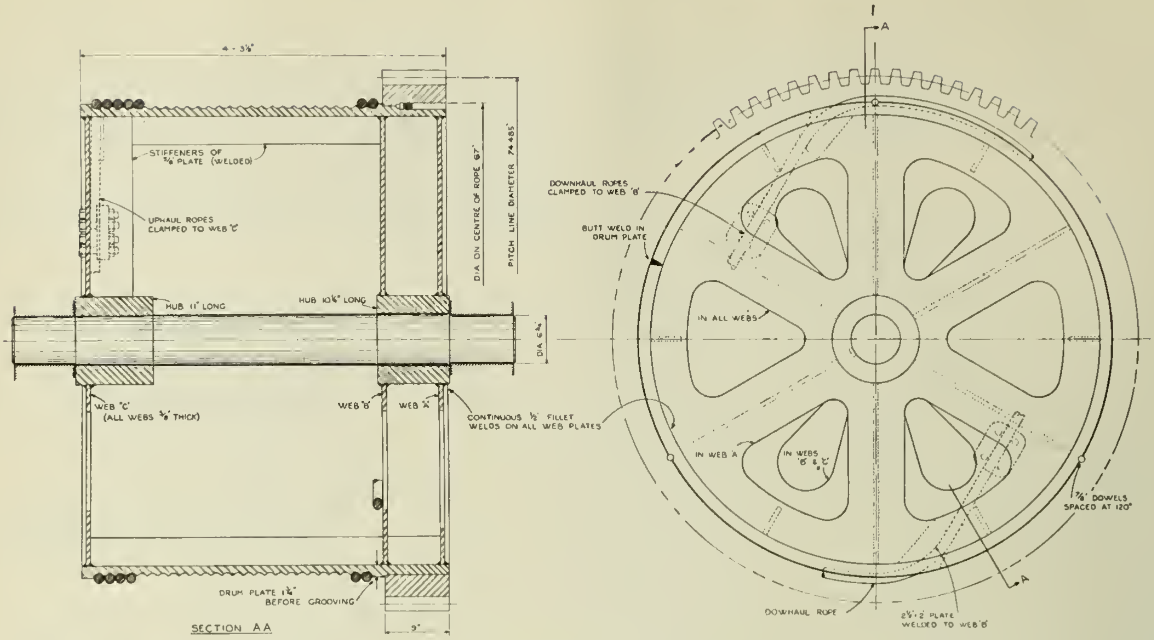


Fig. 10—Welded Drum Assembly.

supported on three web plates, with a driving gear to one end, and the whole mounted on an axle bearing on the walls of the "bath tub." By reference to Fig. 10, which presents a detailed sketch of the drum combination, the grooved cylinder will be seen to consist of a 1¾-inch plate, 4 feet 3½ inches in width and long enough to roll up to 67 inches outside diameter. This plate was ordered to a special specification, namely 70,000 pounds per square inch tensile strength and 150 Brinell hardness and suitable for welding. The four plates were rolled in Fort Erie, Ontario, as they needed some special rolling equipment not available at Lachine. The webs are all of ⅝-inch plate burned out to simulate spokes and stiffened along these spokes by other welded ⅝-inch plates. These stiffening plates were also welded to the cylinder plate and to the hubs. The latter are short pieces of forged shaft 12½ inches in outside diameter and bored to 7⅜ inches and 7 inches to take the axle. The axle was a forged shaft 5 feet 11¾ inches long, turned down to 7 inches for the rear hub which was 11 inches long and to 7⅜ inches for the forward hub or gear end hub 10¼ inches long and also turned to 6¾ inches for the 9-inch long bearings on the walls of the tubs. The whole welded assembly was stress-relieved before any machining was done. After planing the edges of the cylinder and before the grooving was started, shop inspectors discovered one of the four drums to be distinctly laminated. Etching and exploratory drilling were used under the author's personal direction, to determine the extent of this lamination, as it was felt that this defect might be of prime consequence and the time required for replacement, if found necessary, would constitute a serious delay in the whole programme. As a result, chipping, edge welding, and plug welding, were resorted to in order to localize the laminated section and prevent the split from spreading. The principal split seemed to be about 45 inches long, almost a quarter of the whole circumference. The maximum depth into the edge of the plate was found, by etching the test holes, to be about 2½ inches, which meant that the lamination might reach as far as the site of the first groove. The split was almost in the middle of the thickness at the exposed edge but rose slightly toward the extrados as it entered into the plate, and for this reason would all the more likely show itself in the first rope groove when the latter came to be cut. Small holes of ½-inch diameter were drilled into the edge of the plate at the apparent ends of the split and at intermediate points. These were tapped and screw-plugged. Further, nine ¾-inch diameter holes 1¼ inches deep were drilled from the extrados through the laminated area at edge distances varying from 1 inch minimum to 1¾ inches maximum. These were reamed to a counter sunk finish. The split itself, as it appeared on the edge of the plate, was chipped out about ¼ inch wide and ¼ inch deep for its full length and completely filled with weld metal deposited in stretches so as to avoid any further opening up. The nine holes were then also filled with weld metal, as were the exploratory test holes which had been used to determine the depth of the lamination. After grooving, the outcrop of the split was found as expected in the first groove for a short stretch and this also was cut out, filled with weld metal, and ground. The greatest of care was given to this repair job, as the engineers considered it merely as an experiment until it had been completed. However, on examination the results appeared to be perfectly satisfactory and the drum was accepted. Subsequently, after some months of operation, a careful search was made by the author for signs of the split but not even a sign of the repair work could be found with any degree of definiteness.

The gear of the drum was specially forged, rolled and cut. As forged it consisted of a 9¼-inch by 5½-inch ring section and the 78 teeth of 20-degree involute shape were cut on a pitch diameter of 74.485 inches which gave a finished pitch of 3 inches, a finished face of 9 inches and a depth of 2.09 inches. These gear rings were press-fitted on to the turned drum cylinder and were further secured by three ⅞-inch dowels 6 inches long at 120-degree spacing. The drum hubs were also press-fitted on to the shaft which, by reason of the variation in hub internal diameters, could be entered from the gear side so that both hubs fitted at the same moment. The cylinder surface was then grooved for the operating ropes in the manner shown on Fig. 10, the lead being 3 inches to accommodate one pair of 1⅜-inch operating ropes.

The two tubs, as they were styled, are themselves rather interesting features, being good examples of the convenience of welded construction. They consist generally of ⅝-inch plate walls and ⅝-inch plate bottoms. In the walls are assembled blocks which serve as bearings for the various shafts. On the top and bottom of the walls are assembled ⅝-inch flange plates which serve to stiffen the construction vertically and laterally. The various bearings are supported by ⅝-inch stiffening plates also welded to the main wall plates. Drainage is provided in each tub for the evacuation of water brought in on the operating ropes during rain or snow storms. The tubs are 16 feet 2 inches overall in length and nearly 6 feet wide over the bearing blocks. They are seated on four bearing plates, 8 inches by 11 inches by 1½ inches welded to the bottom flange plates at about 9-foot centres, directly under the

Fig. 11—Lifting "Bathtub" into Place.

main drum shaft centres. These seats are then bolted down to the beams and brackets of the cabin floor. Each tub was shipped from Montreal to Vancouver with all bearings, drums, and gears assembled, and was lifted directly off the flat cars at the site to its final location on top of the span (see Fig. 11), the lifts taking place on March 12th and 13th, 1934, respectively, and each lift involving 14 tons.

The "take-up" devices for adjusting the length of the operating ropes, already referred to in the text, are in accord with common practice both as to location on the tower and as to design. Each hoisting rope is wrapped over a drum and anchored thereto by U-bolt clips. This drum is cast solid with, and rotated by, a worm gear, the shaft of which is made accessible at its upper end for the application of a hand turning-key or lever. The bearings for the worm shaft are mounted on small channel struts which span between the webs of supporting girders built into the tower framing. The same webs carry pipe bearings 13⅜ inches apart face to face, for the ends of the 4-inch diameter drum shafts and the drum hubs are in two parts, each 4 inches long, faced to an overall dimension of $13\frac{5}{16}$ inches. The same detail exactly is used for the take-up devices on the up-haul and down-haul ropes and working platforms are provided to give access to the worm shafts for adjustment purposes.

The counterweight sheaves, four in number, were steel castings poured by the Canadian Steel Foundries of Montreal. They were cast flat with risers at four points in the outer circumference and also at the hub. The first cast was somewhat experimental as to cores, quantity of metal, etc., and on coming out of the sand was very thoroughly examined and measured up. A little building-up by welding on a few of the spokes and at one or two spots on the rim circumference was found necessary after which the preparation of the cores of the succeeding sheaves was undertaken with greater certainty. The next three castings were very satisfactory, a little more metal being used than for the first sheave. The shipping weights from the foundries, after cleaning and annealing, were 33,105 pounds, 33,995 pounds, 33,715 pounds, and 33,815 pounds, respectively, whereas, after machining in the shops of the Dominion Engineering Works at Rockfield, the net weight of the sheaves averaged 28,365 pounds. Typical test reports on the metal for these sheaves showed carbon contents approximating .28 per cent, manganese .82 per cent, and silicon .46 per cent, with tensile strengths of about 77,000, yield points of 40,000, elongations around 30 per cent, and reductions of area 46 per cent.

The rope grooves were spaced at $1\frac{15}{16}$-inch centres so that the overall finished width of the rim became 2 feet $8\frac{7}{16}$ inches, see Fig. 12, the metal thickness in the eight I-shaped spokes is generally 1½ inches and in the barrel of the hub 5 inches. A new feature, it is thought, is the provision of a 12-inch by ¼-inch cover plate welded to the inner flanges of the rim continuously between spokes in order to prevent water or debris of any kind entering and lodging in the chambers of the rim girder from which, during the revolution of the sheave, it might otherwise be emptied, to the probable discomfiture of passengers on the deck below. With this provision it was felt quite unnecessary to add hoods over the sheaves, which is sometimes done.

The shafts are forgings, finished to 19-inch diameter in the sheave and 17-inch diameter in the bearings, their overall length being 6 feet 10½ inches and their net weight about 5,715 pounds each. The sheaves were heated to 400 degrees F. to be shrink-fitted on to these shafts, after which four set-screw holes drilled and tapped in the hubs of the

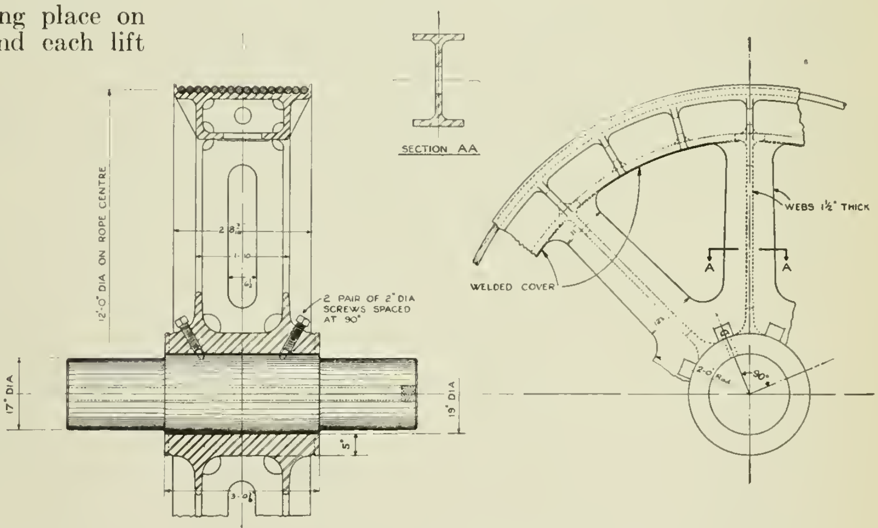


Fig. 12—Counterweight Sheave and Shaft.

sheaves were continued to penetrate slightly the surface of the shaft as shown on Fig. 14.

Steel cast bearings, heavily bushed with phosphor bronze, were seated on the structural members of the tower and covered by welded sheet steel caps in which the lubricating grease is stored under wooden covers. In addition, the usual arrangements for gun-lubrication of the bushing surface are provided. Figure 13 shows one of these sheaves being hoisted up the north tower.

Counterweights

The counterweights for the span were shown by the designing engineers as concrete blocks cast around suitable steel skeletons and furnished with adjustment chambers, with connections for the lifting ropes, connections for the balance chains as well as with the negative members of a system of guides. The steel skeletons were further furnished with ample rod reinforcing and wrappings of wire-mesh in order to assure a satisfactory bond between the concrete and the steel. The blocks were shaped so as to deliver to each set of counterweight ropes a weight that would balance the weight applied to these ropes by the lifted span. The heavy side of the span being to the east, the centre of gravity of the counterweight block was offset 0.27 foot on this side of the railway axis. When in their lowest emergency position the counterweight blocks just clear the rails on the flanking spans, but longitudinal 6 by 6 timber bumpers are inserted in the concrete at 5-foot centres to lie over these rails in case contact should ever be established. The balance chains for counterweighting the lifting ropes were slung two under each counterweight block and were made of cast iron links built in the Ross and Howard Foundry at Vancouver. These chains serve to balance the rope weight as the ropes move over the sheaves from the span side to the tower side, or vice-versa. When the span is down there is a weight of some 146½ feet of sixty-four 1¾-inch steel ropes added to the span load, while only some 16¼ feet of the same ropes add weight to the counterweight load. At some point in the travel, these lengths are evenly divided and when the span is up at its normal high position some 133½ feet of counterweight rope are found on the counterweight side of the sheaves and only 29½ feet on the span side. The object in supplying the balance chains, which hang in a catenary under the counterweight blocks, is to so dispose them that a portion of their weight, which is suspended from the counterweight, that is to say the portion which lies on the counterweight side of the low point of the catenary, will change from a minimum to a maximum as the counterweight rises and contrary-wise as it descends. In addition, the rate of change of this portion of the weight, both as to time and space, is required to approximate the rate of change of the difference between the weight of ropes suspended on the counterweight and span sides respectively of the sheaves. Referring to the sketch, Fig. 14, the length t is the travel of the span from the "up" toward the "down" position, the maximum value T being reached when the span is completely "down." The total change in the difference between the lengths of the counterweight ropes on the span and counterweight sides is $2T$ as the difference changes twice as rapidly as the travel. The corresponding maximum change in balance is $2wT$ where w equals the weight of ropes per unit length. Actually w equals 16 by 4.80 pounds per foot or 6.40 pounds per inch.

Fig. 13—Hoisting Sheave on North Tower.

The counterweight carries a length of balance chain s_2 varying from a minimum to a maximum, the remaining portion of the length of the chain s_1 being supported on the tower. The variation of this length s_2 can be established mathematically as the counterweight moves and the computations serve to show that this length s_2 bears substantially a straight line relationship to the travel of the span. Thus, if the catenary at any time is expressed by the equations: $y = c \cosh \frac{x}{c}$, and $s = c \sinh \frac{x}{c}$, the simultaneous values of x_1 and x_2 add up to the constant figure 243 inches, and the simultaneous values of s_1 and s_2 add up to the constant figure of 844 inches, the length of the balance chain between points of suspension. The parameter c and the values y_1, y_2, s_1, s_2, can be obtained for every position, and as $y_2 - y_1$ is a direct measure of the travel of the span, a relationship between s_2 and t emerges.

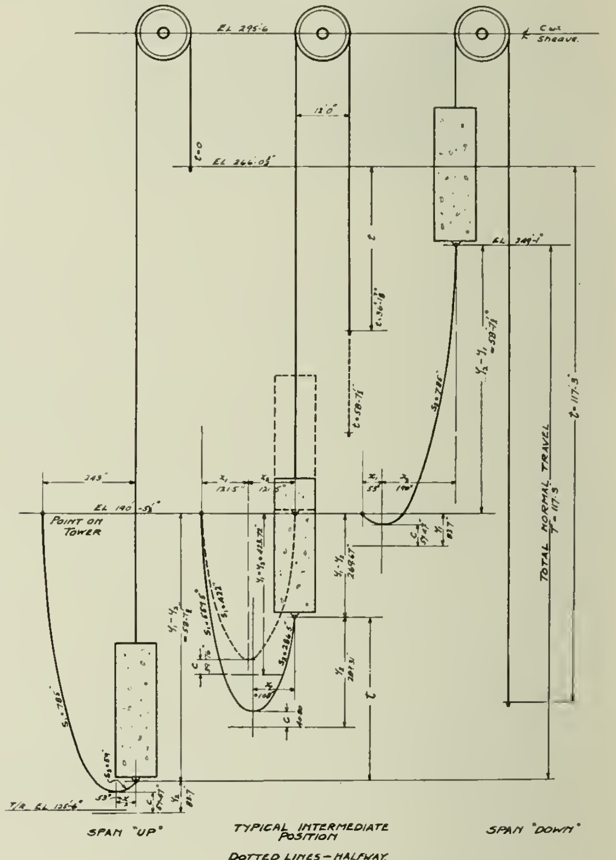


Fig. 14—Balance-Chain Theory.

The steps are as follows:—

Choose any x_1: then $x_2 = (243 - x_1)$

Obtain a corresponding c by: $\sinh \frac{x_1}{c} + \sinh \frac{x_2}{c} = \frac{844}{c}$

Evaluate $y_1 = c \cosh \frac{x_1}{c}$; $y_2 = c \cosh \frac{x_2}{c}$, and $s_1 = c \sinh \frac{x_1}{c}$

Then $t = \frac{T}{2} \pm (y_1 - y_2)$ where T is 117 feet 3 inches, the total normal lift.

The resulting graph showing s_2 against t is plotted as Fig. 15, from which it will be seen that the chosen balance situation is virtually maintained without change throughout the travel. Incidentally, "b," the weight per unit length of the balance chains, is given by:—

$$b \times (s_{2\,max} - s_{2\,min}) = 2\,wT$$

or $$b = \frac{6.4 \times 2{,}814}{726} = 24.8 \text{ pounds per inch}$$

Other methods of balancing the counterweight ropes of a movable lifting span have been used but this method is considered to be both simple and sure and usually inexpensive.

The counterweight frames were erected slightly above their "up" position, on temporary steel floors carried on the tower framing. Formwork, bond and reinforcing rods were placed and the concrete poured, under a sub-contract. Sample cubes of the concrete were cast during the pouring to enable the unit weight to be established and to assist in the determination of the number of adjustment blocks to be manufactured. The weight used in calculations for balance was in the first place 147 pounds, this figure arising from some preliminary tests made at the site using the same concrete as was furnished for the piers. On the sub-contractors, Messrs. Smith Brothers and Wilson, informing the engineers and general contractors that they would be using a granitic gravel aggregate, further test blocks were made and it was decided to use exactly 150 pounds per cubic foot for the computations. From the numerous sample cubes made during the pouring of the counterweight blocks, it was found that the concrete actually weighed from 150½ to 153½ pounds after two weeks of ordinary exposure.

Towers

The principal dimensions of the towers are governed by the required lift, the spacing of the existing trusses, and the panel lengths in the old bascule span. These latter were 28 feet 0 inch so that in order to use two such panels as a longitudinal base the tower was sketched as being 56 feet long at the level of the upper chords of the bascule span. To preserve identity above this elevation the new approach span on the north end was given two similar panels of 28-foot length and also a depth equal to that of the existing bascule span which permitted, in addition, the re-use of numerous parts of the truss and the floor system originally built for the two panels of the bascule which were now to be dismantled. Thus, all stringers, floor beams, brackets, lateral bracing, chord and web members belonging to these two 28-foot panels of the new span were taken from the old, leaving only the parts belonging to the new 14-foot panel to be fabricated from new material.

The 20-foot spacing of the existing trusses was considered too narrow for stability of the tower legs under the lateral loads anticipated, so that auxiliary legs were provided at 46 feet 2½-inch centres, that is to say outside the highway lane on each side. The addition of these outer legs rendered indeterminate the framework below elevation 163 feet 11 inches where they diverged from the main legs, so that methods of computation involving geometric and elastic properties were required for the determination of the loads in the individual members of this lower portion. The stress sheet, Fig. 16, indicates the general dimensions and appearance and no unusual features are involved. Means of adjustment was provided at the heel of each tower where the back leg connects to the supporting truss in order that plumbing of the front legs could be accomplished during erection. The main leg section was reasonably orthodox, the only features of particular interest perhaps, being the detail of the diaphragms and the computations for the numerous co-existing stresses. A very neat, simple, and effective diaphragm, providing definite value against distortion from any cause, was suggested by the engineers of the Dominion Bridge Company and was adopted as an improvement on the original type proposed. These diaphragms consisted of four pairs of angles 7 inches by 3½ inches by $\frac{7}{16}$ inch enclosing two $\frac{11}{16}$-inch plates, and were inserted at about 4-foot intervals up the main legs. The angles were placed with their 7-inch legs vertical against the central web plate and the outer flange angles of the main post, and their 3½-inch legs enclosing the horizontal plates referred to. Where necessary these plates were furnished with holes for the passage of ropes.

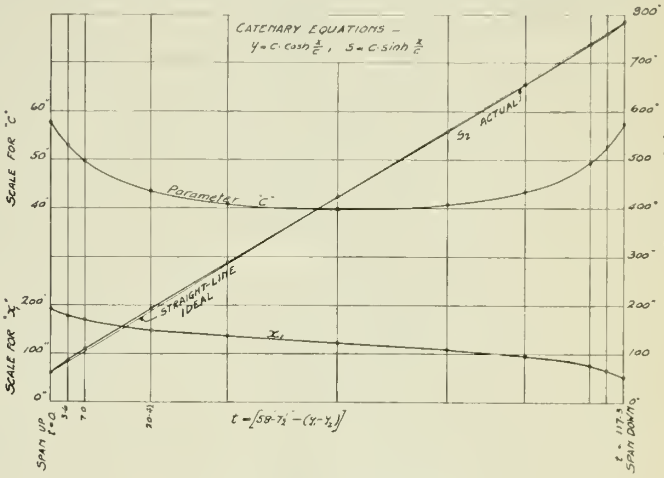


Fig. 15—Curve of S_2/t.

The lateral pressure from the span guides, being applied very eccentrically to the main tower legs, rendered it necessary to accord special consideration to secondary bendings and torsion when seeking for the maximum probable unit stresses in the component parts of the post section. The concentrations from wind on the lifting span move up and down with the span and are, therefore, applied at any point in the 120-foot length of the tower leg. Further, the position of the lifting span naturally governed the axial stresses induced in the main post as parts of the transverse sway bracing system. Thus, numerous considerations were necessary for the various sections in order to secure the critical combination resulting from main axial wind stress, bending in the 20-foot panel of the tower leg from the span guide concentration, bending again in the particular flange on which the guide runway detail was connected, this occurring at or between the diaphragms, and also torsion on the tower leg between diaphragms from the same cause.

A typical computation is outlined in the following paragraph:—

1. Direct stress in post uniformly distributed over main effective section.
2. Bending in 20-foot panel from concentration of 45,600 pounds applied to main effective section.
3. Bending in 4-foot panel between diaphragms from same concentration applied to one flange only consisting of main angle, part of main plate, guide angle and guide plate.
4. Torsion from same concentration applied to main effective section via diaphragms.

1. Shown on stress sheet as w_t.
2. Produces 1,085 pounds per square inch compression on inside edge of main angle as per diagram attached (Fig. 17).
3. Produces 4,800 pounds per square inch compression on inside edge of main angle as per diagram attached (Fig. 17).
4. Produces a torsion moment of 45,600 by 14 inches by ½ which allows for the distribution of the moment equally between the portions of the post

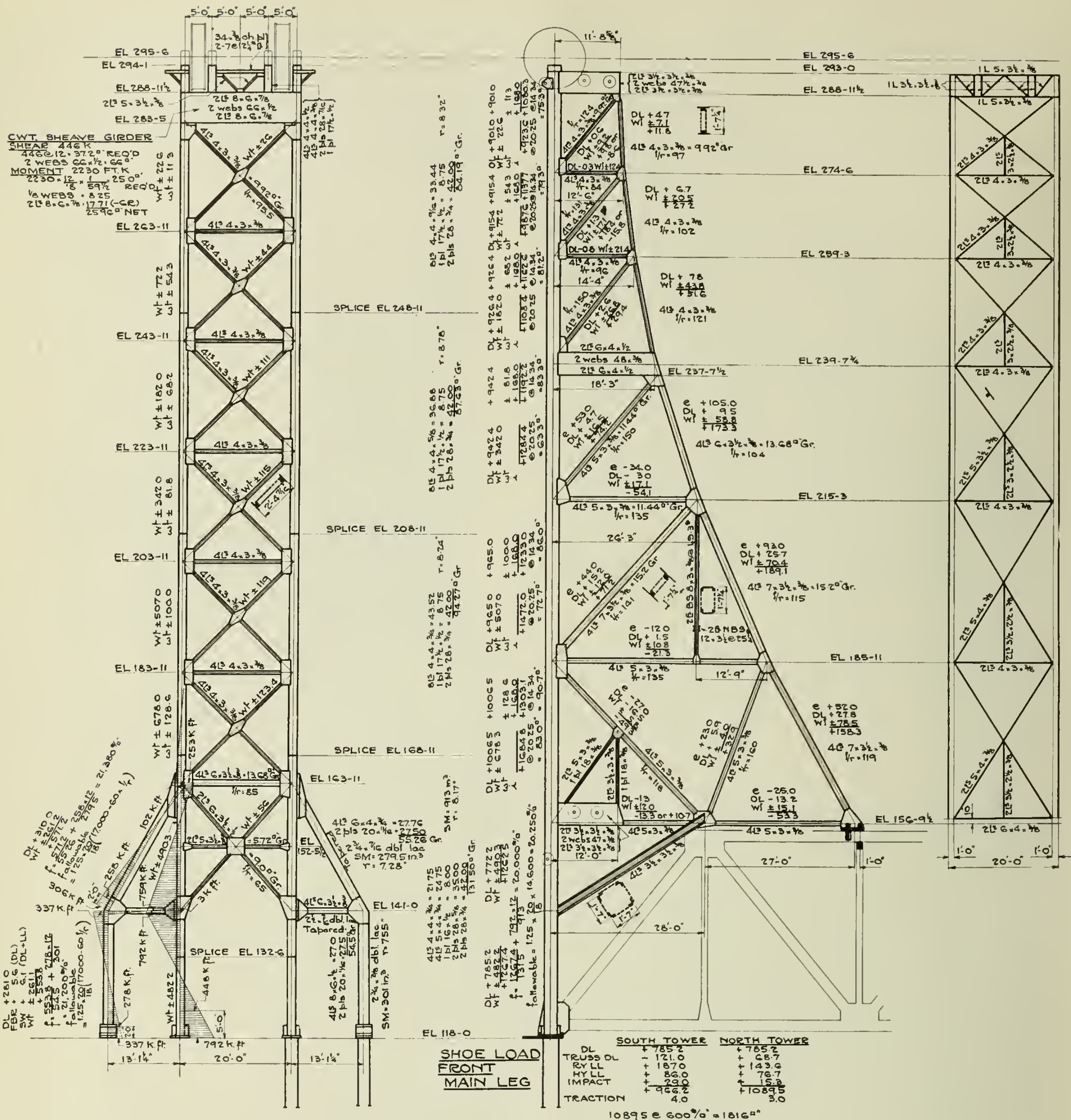


Fig. 16—Stress and Material Sheet for Tower.

in the panel above and below the point of application of the load. The torsion modulus is established as 466 in.³ for the main effective section with a resulting shear unit stress of 700 pounds per square inch maximum. To appraise the effect of this on the principal stresses, $q = 700$ and $p_{\max} = 14,000$ are entered into the following expression:

$$p_{\max} = \frac{p}{2} + \sqrt{\frac{p^2}{4} + q^2}$$

which yields $p = 13,950$ approximately, indicating that the effect of torsion is to reduce the allowable compression unit by 50 pounds per square inch.

On the main material, therefore, with l/r less than 40, the permissible unit stress in compression for combination 3 is $(1.25 \times \frac{20}{18} \times 14,600) - 4,800 - 1,085 - 50 = 14,343$. This makes the assumption that the maximum unit stresses from the two bendings and the torsion may occur at the same point vertically and on the inside toe of the inner angle which, while not strictly true, is reasonable in view of the approximate figures and methods adopted. On the guide angle outside toe the two bendings and the torsion produce units of $(11,000 + 3,550 + 50)$ approximately, which total 14,600 pounds per square inch, this metal not being calculated as carrying direct stresses.

The governing combinations of loading for the various parts of the tower are stated on the stress sheet together with the permissible unit stresses for these combinations. The group which includes the various dead loads, wind loads and impact allowances, was the critical consideration in most cases. Bracing members were computed to resist stress induced by longitudinal as well as lateral wind and by considerations occurring during erection where these were more serious than those incident to the final conditions. Heavy anchor bolts were provided at the bases of the legs to resist bending moments induced by wind and these bolts were of prime service during erection. Guides for the passage of the counterweight were provided on a rearward extension of the inner face of each tower leg between the elevations required by considerations of abnormal lift. These guides were simply pairs of angles 4 inches by 4 inches by ½ inch, stiffened horizontally at suitable intervals by brackets built out from the main post and set so that their outstanding legs, which are riveted back to back with countersunk head rivets, are centred at 1 foot 10½ inches from the centreline of the main leg (Fig. 7). The corresponding member on the counterweight consists simply of a slotted slab which is welded to a 12-inch channel bracket riveted to the steel skeleton framework and protruding the required amount beyond the lines of the concrete block.

The towers are provided with ladders which lead up the wind legs to the main legs, and by means of these up to the system of platforms and walkways which give access to the main sheaves and take-up devices. These ladders have rest cages at 20-foot intervals and are accessible from the walkways on the top chords of the lifting span at any position as well as from the roadway decks.

On the outside face of each main tower leg, that is to say on the east face of the eastern legs and the west face of the western legs, a continuous series of markings have been painted which serve as scales on which a pointer, fixed to the lifting span, indicates the clearance available above standard high water level, elevation 97.77, at any position of the span during the important range of its travel. The scale is painted in white on the black finishing coat, and each foot is indicated by a horizontal line. Every fifth foot is shown by figures 18 inches high and the scale reaches from 90-foot clearance to 145 feet, the former being the lowest point marked and occurring when the pointer, or low steel on the lift span, is at elevation 187.77 referred to the harbour datum.

Fabrication

The fabrication of the steelwork was divided by the Dominion Bridge Company between its local Vancouver shop and its principal works at Lachine, Quebec. The mechanical parts that were new for the work were made in Lachine where foundries and machine shops of sufficient capacity were available while the structural parts were all allotted to Vancouver where a well equipped shop had been recently built and put into operation. Consequently, all the lift span, the towers, the north approach span, and the counterweight frames were fabricated locally. In addition, all dismantling of existing members and machinery was carried out by the Vancouver forces of the steelwork contractor. The approximate weight of material fabricated in Vancouver amounted to 1,117 tons of which small items were sublet as follows: namely, 136 tons of floor girders to the Western Bridge Company and 43 tons of cast iron balance chains to the Ross and Howard Foundries.

From Lachine were shipped 171 tons of heavy and complicated mechanical parts, including the pre-stressed counterweight ropes. Shop inspection at Vancouver was carried out by Macdonald and Macdonald of that city under the direction of the engineers and, in the later stages, under the supervision of Mr. G. R. Hamilton, field inspector for the engineers.

Erection

The erection programme consisted of five parts:—

(*a*) The dismantling of the old bascule span,

(*b*) the assembly of the towers, the north tower span, and the counterweight frames,

(*c*) the assembly of the lift span at an independent though neighbouring site,

(*d*) the floating of the lift span into position on the new piers and the connection of same to the counterweight ropes,

(*e*) the subsequent items such as electrical installations, signal equipment, adjustments, and tests.

To hold the moving leaf of the old bascule down after the removal of the two forward panels naturally meant one of two things, either the propping up of the counterweight or some positive anchoring of the span to the new

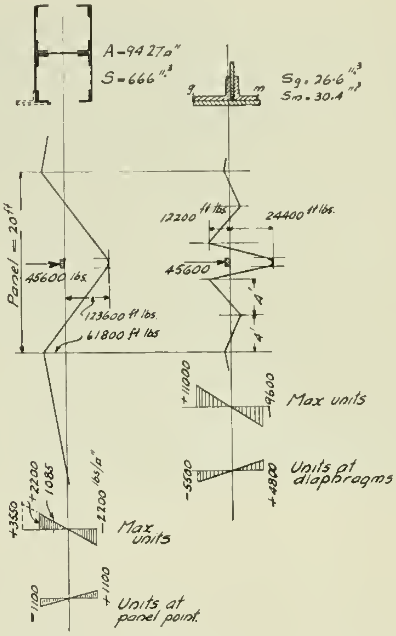


Fig. 17—Stress Combinations on Tower Post.

pier. The former method was in many respects unsatisfactory and difficult of accomplishment so that the latter method was adopted and special details developed for the purpose. The fact that the axis of the main front legs of the tower on pier 2-B was to coincide with the existing panel point number 4 of the bascule span meant that the bascule itself could be lowered and used to locate the main anchor bolts previously mentioned as being an essential part of the base of the tower legs. These bolts are 3½ inches in diameter and 15 feet long for the main legs, 15 feet 6 inches long for the wind legs. Upon the pier being finished and the bed plates placed over the anchor bolts which were built into the concrete, the span was

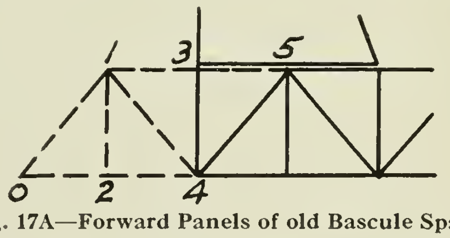


Fig. 17A—Forward Panels of old Bascule Span.

again lowered and suitable holes which had been previously burned in the lateral connection plates fitted over the top of these main anchor bolts permitting the old truss to be brought to its final position as part of the new structure. Yokes of 12-inch channel members were then assembled over the top flanges of the railway floor beam at this particular panel point No. 4, close enough to the truss to be directly in line with the axes of the inner pair of anchor bolts. These yokes carried 1¾-inch bolts which were connected by long sleeve nuts to the 3½-inch bolts below and so completed a temporary anchor system ample to hold down the remaining portion of the bascule span during the period when all the necessary dismantling was being carried out.

The stress sheets indicate that some 121,000 pounds of uplift would occur at each anchorage due to the removal of the two forward panels 0-2-4 and the upper chord 3-5 of the original bascule. Temporarily this tension would travel eccentrically from the main anchor bolts through

Fig. 18—Bed Plates and Anchor-Bolts on Pier 2B after Vibration.

the yokes by shear in the floor beam into the truss members, but all details were found on examination to be perfectly safe for this condition. The use and arrangement of the yoke, as above described, permitted the outside gusset plate at the panel point to be disconnected and removed, and the new gusset plate detailed to connect to the foot of the tower leg, as well as to accommodate the existing truss members, was then introduced, bolted up to the said truss members and attached by means of shelf and stiffener angles to the two hitherto unused outer main anchor bolts. This procedure enabled the uplift to be transferred to the old span by means of these outer bolts, the new gusset, and the outer half of the connected members and so made it possible to remove the temporary yoke and to dismantle the railway floor beam, after which the inside gusset plate was similarly replaced by a new one to which in due time the new railway floor beam at this point could be connected. The old railway floor beam was re-used on the north span as mentioned earlier in this paragraph.

Before this new floor beam was placed or the bottom section of the tower legs erected on pier 2-B, the blasting of the old pier took place, on March 1st, 1934, as described in the author's earlier paper on the substructure. The steel actually in place at this time consisted of the main and wind leg anchor bolts, the four bed plates, the four new gusset plates with their shelf and stiffener angles upon which the nuts of the anchor bolts bore, and the numerous ⅞-inch diameter erection bolts which temporarily connected these new gusset plates to the bottom chords and web diagonals of the retained portions of the bascule span trusses. Upon the occasion of the blast certain slight distortions were introduced into some of this steel by the vibration of the pier. The main anchor bolts naturally swayed with the pier while the bed plates through which they passed were, by reason of their connection to the steel span above, not able to share totally in these swaying movements, so that a relative displacement took place longitudinally with the bridge axis, as between the bed plates and the top of the pier. The maximum total amplitude appears, from measurements, to have been 5 inches and undoubtedly it was held down to this limit by the fact that the bascule span was directly connected to the anchorage bolts built into the pier. The grouting spaces left in the concrete around the anchor bolts for a depth of 15 inches had not been filled up but the pier in swaying this 5 inches took these holes far enough to the south to bring the north edges of the holes into contact with the 3½-inch anchor bolts, which contact indented the concrete distinctly. The oversize holes in the steel bed plates were elongated by the bolts pressing into the metal and the bolts themselves were bent in two planes, longitudinally convex to the south and laterally convex toward the gusset plates. From an examination of the situation on the morning after the blast it was evident that the metal between the point of contact of the bed plate with the pier, and the point of connection of the new gusset plates to the truss members had been alternately in compression and tension as the pier swayed. The gusset plates had buckled so that they were no longer in parallel planes, but were 3 inches or 4 inches further apart where free than where connected to the restraining members of the old truss. Correspondingly, the base angles had ceased to bear except at isolated points along their toe edges. Figure 18 shows the bent bolts and the marks left on the pier tops by the bed plates as the concrete moved to and fro underneath them. The edge to the left of the photograph is to the north and measurements indicated that the initial movement of the pier toward the south was at least 2¾ inches while the maximum to the north, which undoubtedly followed, was damped down to 2¼ inches and the supposition is that this damping was very rapid and that the actual time during which sway took place could be measured by a very few seconds. It might be considered fortunate that the connection of the old span to the new pier was ample to maintain itself and yet not too stiff to offer serious resistance to the vibration of the pier. The damage suffered by the pier might possibly have been less had there been no connection whatever, but even this cannot be stated with any degree of certainty. Had there been more steel in place on the pier, such as the new railway cross beam and the tower leg bottom sections, it is readily conceivable that more local damage would have been done to the steel structure and that the pier, by being more rigidly held at its upper extremity might have suffered more seriously at some lower elevation, possibly at construction joints or where the moment of inertia in the north and south direction materially changes.

Careful inspection, under the author's personal direction and supervision, disclosed no defects in the steelwork that could not be simply and completely remedied without calling for new parts. Virtually, therefore, no delay was necessitated in the steel erection. The stress in the outer bolts was relieved by loading cars of gravel on the span and hanging tanks of water underneath it, these weights serving to replace the uplift as a means of balancing the counterweight. These extra weights were kept in place until sufficient tower steel had been placed to overcome all tension in the anchor bolts. The metal in the anchor bolts was thus enabled to rest for several weeks as it would not be subjected to tension again until the lift span was raised under fairly heavy wind. The use of jacks and heating torches was sufficient to restraighten the anchor bolts and all other structural members; a few rivets being cut out from the tie plates of the truss members in order to make sure that no remaining material was overstrained. The placing of the new steel then proceeded without further trouble.

The erection of the north flanking span was commenced on February 27th, the full length of each bottom chord, namely 70 feet, being shop connected and handled in the field as one piece. They were trussed by struts and rods to enable them to carry the verticals, diagonals, floor members, and erection track until the upper chords could be placed and the main frame thus completed.

The locomotive derrick moved out on the span to place the lower sections of the tower legs and then build the creeper traveller. The latter was designed to climb up the tower, which it did in five stages, erecting all accessible parts as it went, according to a prearranged schedule. (Figures 19 and 20.) The creeper traveller was dismantled on April 5th and removed to the south tower where the lower sections were erected from a floating derrick in view of the fact that the tracks on the bascule span were still loaded with the gravel cars for anchorage purposes. This floating derrick also built up the creeper again which then proceeded with the remainder of the south tower erection. The last counterweight sheaves were raised on April 23rd by which time also much of the riveting had been done and much of the preliminary work in connection with electrical installations. Formwork for the concrete counterweight blocks on the north tower was also completed in April and at 4 a.m. on May 1st pouring was begun, continuing without break until 10.30 p.m. and again on May 2nd from 4 a.m. to 7 p.m., and a small finishing pour on the 3rd. Similarly, on May 16th, beginning at 4 a.m., the concrete for the south counterweight was begun. This was

Fig. 19—Erecting Lower Sections of North Tower.

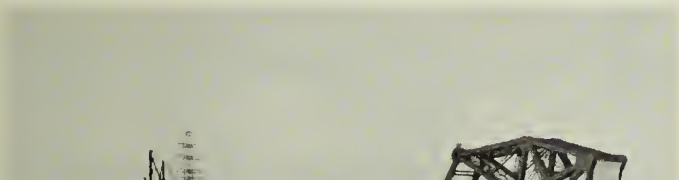


Fig. 20—Erecting North Tower by "Creeper."

completed at 8 p.m. on the 17th at which time also the whole 64 counterweight ropes were slung and attached to the counterweight frames. The span ends of these ropes were bridled together and left hanging to be suitably looped-up out of the way of the floating operations, but immediately accessible for connecting to the lifting girders when the span had been landed. The counterweight was erected high enough to permit of it being lowered on jacks in order to stress the counterweight ropes after they had been connected to the span and the span in turn had been lowered to its proper position on the piers. Arrangements were also made so that when the ropes had been stressed in this manner, sufficient room remained for the removal of the jacks and of the supporting floor which had been connected to the tower frames during the construction of the counterweight frames.

Attention was next centred on the lifting span and the preparation of the floating and landing equipment. Im-

Fig. 21—Runways and Falsework for Erection of Lifting Span.

mediately to the east of the existing bridge, alongside the Canadian Pacific Railway main line on the south shore of the inlet, falsework runways had been built during the early part of February, leading out normally from the tracks toward the deep water. The proposed scheme involved the erection of the span on a site convenient to the railway and the moving of it outwards on rollers until it could be picked up by a series of scows brought in at something less than high tide. Inshore, parallel to the tracks, a further series of falsework bents and platforms was constructed (Fig. 21) upon which the 286-foot lift span was assembled. There are no unusual items to record about this part of the work. The inner highway brackets were temporarily omitted to give better access to the trusses and the span was moved slightly northward before they were added. Camber was introduced as directed. Riveting was completed on this staging and the cabin machinery was assembled and turned over. In short, everything possible was done to ensure that after being floated out and landed on the new piers the briefest time possible would elapse before the span could be lifted and the navigation channel restored to service. The contractor had estimated on his tender form some forty-eight hours as the period during which the channel would be occupied by floating equipment and thus closed to shipping. This period actually commenced at about 5.30 p.m. on May 29th and at 5.15 a.m. on June 1st the span was raised by the auxiliary engine and the waterway thus re-opened. The restriction period was thus barely sixty hours. Studies of the tide time tables were of course essentially important in connection with this scheme inasmuch as the span was lifted off the runways by the tide and was also lowered by the tide on to its permanent seatings on the new piers. Tidal conditions had to be chosen which would permit of the scows being floated under the span, already rolled out to the extreme northern position on the runways, all necessary blocking placed between the underside of the steel and the timber towers carried on the scows, all tugs assembled and in position with their tow-lines attached and all guide cables arranged so that when the load came to be taken off the runways it would be under complete control for the lifting operation. Further, the movement under tug-power from the falsework to the permanent position of the span between the towers had of necessity to be completed before high tide so that the span could either be landed on blocking supported on sand boxes or else directly attached to the cables before the water fell low enough to prevent these operations, bearing in mind always that jacking-up was not to be undertaken if it could be possibly avoided. It was finally decided to let the span come to rest on a series of 12-inch by 12-inch timbers placed across sand jacks on the piers. These sand jacks consisted simply of boxes filled with sand and furnished with outlets at the bottom of the walls of the box through which the sand could be evacuated under control. The adoption of this method meant that the span as it came into place had to be moored by a system of wire ropes at each end to the corresponding piers and towers and allowed to merely lower itself onto the said blocking as the tide fell, after which the scows could either be freed by the addition of water, as was actually done, or could be allowed to release themselves on the falling tide. Whether connected up to the counterweight ropes or not, the lifting span would thus be safely supported in virtually its exact position in the horizontal plane, and sufficiently high to permit of the rope connections being made at the earliest convenient moment. Suitable tides were available on May 29th and 30th so that the programme was laid out to make the transfer on the earlier date. High tide on this day was officially scheduled to be at elevation 97.87 in the harbour, but at the site of operations it reached 98.77 at approximately 7.49 p.m.

Fig. 22—Scows in Place under Lifting Span.

The three scows with their timber towers and connecting struts were floated in under the span at noon, the span having been rolled out earlier in the day. As the tide rose, they began to take load at approximately 3 p.m. and by 5.30 p.m. the span was clear of the runway supports and all the temporary shoe plates could be freed. Unfortunately, rain began to fall at 6.30 p.m. but at 6.50 the tugs were ordered to pull out. Immediately a severe east wind arose which quickly developed into a gale. The span was caught by this pressure and rushed downstream against the weak remaining flood tide, the tugs being to leeward and thus of little use in manœuvring the scows. The south end of the span failed to clear the south pier, and the north end having thus ample clearance swung very rapidly into the opening and, to some extent, over-ran its place. By this time the tugs were able to readjust themselves and to push back the north end so that the mooring ropes could be seized and connected and by this means the span was hauled back into line. The tugs were then able to enter between the southernmost scow and the south pier 2-B, and the squeeze the span northwards until mooring tackle at this south end could also be engaged and the span warped into its correct position. As soon as the span was thus tied up at both ends, gangs of men were put to work on entering the counterweight ropes into the slots located on the lifting girders and making what little adjustment was necessary to set the span laterally and longitudinally over the blocking. The gale and the rain persisted throughout all these operations but the bridge-men were enthusiastic and gave a splendid response to the leadership of Mr. E. E. Davies, the erection superintendent. By 8.10 p.m. all the cross-mooring tackles were in place and the span accurately centred for lowering. By 9.00 p.m. the sand boxes were taking load and the counterweight ropes had all been engaged and locked in. The span at this time was about 6 feet higher than its final position, this arrangement having been agreed upon to simplify the various operations. Due to the lateness of the evening, water was now let into the scows to aid in sinking them and the resulting acceleration in the lowering of the span on the sand boxes was quite visible. By 10.15 p.m. the scows were disconnected and cleared away on the falling tide and ebbing current—and so to bed, everybody soaked through but satisfied with a real job well done.

Fig. 23—Lifting Span Approaching Final Position.

Fig. 24—Span Lifted for First Time.

The fouling between the lift span and the south span was limited to a contact between the outer highway stringer beam at the south west corner of the former and the upper handrail pipe at the extreme north eastern edge of the latter. Incidentally, pier 2-B, which had suffered temporary damage some three months previous, stood up splendidly to this unexpected and heavy horizontal pressure to which it was subjected, as the tugs nosed in between it and the scows to push the latter away against the wind.

The attaching of guide details and other omitted parts together with completion of electrical and mechanical features was proceeded with directly during the following three weeks, the span being raised and lowered for shipping requirements by the gasoline auxiliary power. The harbour master's signalling devices were re-designed about this time and their installation followed in due course. A yard arm for day signalling was erected to which coloured discs and cones could be hoisted in accordance with pre-arranged and published codes whilst for night use the system of red and green electric lamps originally specified was retained. Signal lamps for the control of railway traffic were also installed at convenient sites in collaboration with the proper operating authorities. (Figures 22, 23, 24.)

The navigation lighting system, as distinct from the signalling system, is such as to furnish flood lighting on each pier, making them readily visible to on-coming mariners, except of course in case of fog, white lights indicating the chords of the fixed spans at points closely adjacent to the new piers, and white lights indicating the clearance line on the lower chords of the lifting span also quite close to the main piers.

The contract called for competent operators being supplied by the contractors to move the span between the period of floating and the date of official acceptance, or some subsequent date to be agreed upon, and to train the Commissioners' own appointees until, in the opinion of the engineers, the latter were sufficiently well acquainted with the machinery and its control to carry out the duties independently. The span was delivered to the Vancouver Harbour Commissioners on June 15th, 1934, after detailed inspection by the author, assisted by his field inspector and the representatives of the contractor. The sequence of operations is electrically controlled and interlocked so that they can only be performed in the proper order. The specification making reference to this demand also called upon the contractor to furnish printed instructions regarding the machinery and its proper use for the assistance and advantage of the operators as they were being trained, and for their future reference. Special tests of the auxiliary gas engine were run during the night of the 24th-25th of September, under the author's direction, to confirm and demonstrate the adequacy of this equipment and to generally verify the working conditions, check-up clearances, needs of lubrication and all other points that might have come into question after three months of operation. A report was made by the author, after this test, which included a recommendation that in view of the chief operator responsible for control of the bridge having had impressed upon him other duties in connection with the Harbour Master's Department, such as signalling to ship masters and directing their movements, it would be a wise precautionary measure to provide at all times an assistant operator who was capable of handling the machinery in case the chief operator should be otherwise engaged when this became necessary.

All the erection work at the site, including steel, timber, machinery, electrical and mechanical installations, and painting was inspected directly by the engineers' field inspector assisted, when necessary, by a local staff.

The author is indebted to the Dominion Bridge Company for photographs used to make Figs. 21, 22, 23, and 24, and to the very willing co-operation always provided by their Vancouver engineer, Mr. James Robertson, M.E.I.C.

The Manufacture of High Voltage Porcelain Insulators

J. M. Somerville,
Canadian Porcelain Company Limited, Hamilton, Ontario.

Paper to be presented before the General Professional Meeting of The Engineering Institute of Canada, at Hamilton, Ontario, on February 6th and 7th, 1936.

SUMMARY.—The methods of scientific control of the materials and processes employed in the manufacture of porcelain insulators are described in some detail, together with the technique and equipment used. Particulars are given as to the physical and electrical properties of the finished material and the tests applied.

The transmission and distribution of electric power today demands reliable insulation capable of withstanding potentials ranging from 550 to 260,000 volts for indefinite periods.

Wet process porcelain, first used for the fabrication of insulators on this continent by Fred M. Locke in 1893, is the most satisfactory material developed for this service to the present time. It is impervious to moisture, resists the corrosive action of industrial fumes and remains unaffected by sunlight. It develops sufficient mechanical strength to carry the load of heavy cables and withstand the thermal stress arising from rapid temperature variation. When incorporated in insulators of proper design porcelain shows no deterioration under the dielectric stress created by high voltage.

Wet process porcelain is a homogeneous mechanical mixture of ball clay, china clay, feldspar and flint. Chemically these materials consist of silica and intricate combinations of silica, alumina, potash and soda.

Flint, commonly known as quartz, is silicon oxide SiO_2. In some localities it occurs in pure form in extensive veins and may be found surrounded by igneous rock. Where the action of glacial streams has broken down these veins, deposits of quartz sandstone can be found. Such deposits occur in Pennsylvania, Michigan and Quebec, and if at least 98 per cent pure they form ideal sources of flint. For ceramic consumption the sandstone is washed free of earthy matter, dried, ground, passed over a magnetic separator for the removal of iron, and then subjected to a final grinding process until 100 per cent of the material will pass through a 200-mesh screen.

Feldspar is a complex mixture of silica, alumina and potash or soda. Potash spar is of chief interest for the production of electrical porcelain, in the pure form it is represented by the formula $K_2O\ Al_2O_3\ 6SiO_2$. Feldspar is very plentiful but unfortunately in the majority of cases it is mixed with quartz, mica, iron, tourmaline and other impurities rendering it unfit for ceramic purposes. Occasionally it is found in a reasonably pure form in veins or dykes which fill large cracks in granite. Such deposits at Buckingham, Quebec, and Verona, Ontario, furnish the industry with a high grade potash feldspar. The broken lumps are sorted for first class material and then subjected to a process or preparation very similar to flint. A 200-

mesh screen will pass 80 per cent of the final grind usually selected for the ceramic industry.

Ball clay is a hydrated aluminum silicate, generally the product from the weathering of feldspar dykes. The weathering action leached the potash and soda from the feldspar, leaving alumina and silica in a form which combined with available water to form a colloidal aluminum silicate, the colloidal properties imparting plasticity and adhesive powers to the mixture. Rain carried this product to swollen streams where it mixed with organic matter which further enhanced its plastic qualities. Where such streams entered quiet ponds or marshes the water slowed sufficiently to allow the clay to drop out, forming large deposits which finally filled these ponds with clay. As time passed on the river beds shifted, leaving the clay deposits covered with debris and earthy matter, where they are now found at depths from ten to one hundred feet below the surface of the earth. Ball clay, which fundamentally is an amorphous form of kaolinite, Al_2O_3 $2SiO_2$ $2H_2O$, is never found in pure form but intermixed with small proportions of calcite, limonite, pyrite, gypsum and organic matter. The quantities of impurities present largely determine the characteristics of each clay deposit and allot it to some particular sphere of usefulness in the ceramic industry. Ball clay deposits found in England and the State of Kentucky are particularly well adapted to the manufacture of electrical porcelain.

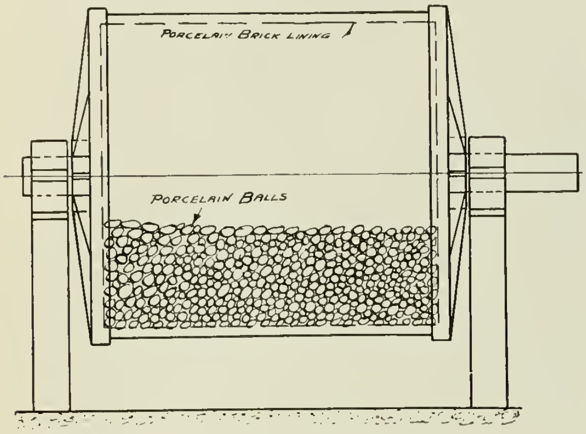


Fig. 1—Ball Mill.

Fig. 2—Electric Slip Lawns.

China clay is also an amorphous form of kaolinite but less plastic than ball clay and comparatively free from organic and mineral impurities. In preparation for industry it is washed free of mineral and organic impurities and then classified in large settling basins. England provides the chief source of china clay although deposits recently discovered in northern Ontario offer future possibilities.

The component materials of porcelain bear a striking chemical resemblance to each other, however their physical nature gives each an essential part in the complete mixture. Feldspar acts as a vitreous bond in the fired ware, beside supplying elements necessary for the transformation which occurs during firing. Flint acts as a backbone to the porcelain body, lending strength which helps to prevent deformation at elevated firing temperatures. It also lowers the vitrifying temperature of the feldspar and enters to some extent into a complex reaction with it during firing. Ball clay forms the plastic bond which binds the other materials together, making it possible to form and machine intricate shapes before firing. It, and the china clay also provide alumina which aids vitrification and enters into the crystal structure resulting from firing at high temperature. The quality of the ball clay and its colloidal nature not only determine the strength of the body before firing, but also contribute greatly to its mechanical strength, dielectric characteristics and resistance to thermal stress after firing.

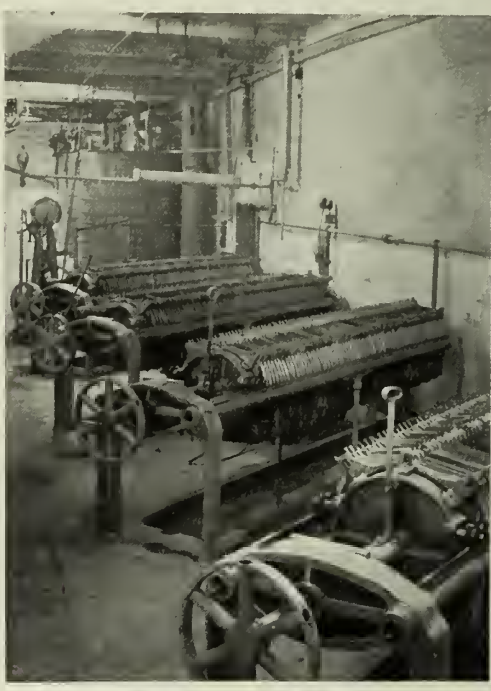


Fig. 3—Filter Presses.

Wet process electrical porcelain may be made from the following proportions of raw materials: ball clay 25 per cent, flint 25 per cent, feldspar 25 per cent, china clay 25 per cent. The clay is treated several days before mixing to develop its plastic qualities. It, and the remaining raw materials are then weighed out with sufficient water for mixing and placed in a ball mill, where they are subjected to a grinding and mixing operation lasting from two to eight hours, depending upon the degree of fineness desired. (See Fig. 1.) The mixture emerges from the ball mills in a liquid form termed clay slip. A careful check of the *Ph* value of the mixing water and variations of mineral content is necessary to hold the slip characteristics constant from day to day.

The slip is next passed through vibrating wire screens or lawns which remove large particles of lignite and other lumpy substances originating in the ball clay. It is then exposed to powerful magnets which remove any magnetic materials present in the liquid. Quart samples of the slip are selected at this stage and weighed to 1/100 of an ounce for density determinations. The density and viscosity of the slip has a marked effect on the characteristics of the plastic clay formed from the slip in the filter presses, for this reason variations in density and viscosity must be avoided.

If the slip is satisfactory it is next pumped to the filter presses. Here the clay is retained by cotton duck filtering or press bags while the water is allowed to pass on. As pumping continues the clay gradually builds up into slabs termed filter cakes. To avoid segregation of the component materials and insure proper plasticity of the clay in the filter cakes a strict pumping schedule of pressure in relation to time must be adhered to. When the press fills with clay the pressure is removed and the clay slabs taken from the press. (See Figs. 3 and 4.) Each slab is checked for plasticity and density, if satisfactory it passes to the clay cellar where it undergoes an ageing process, which improves the plasticity and tenacious characteristics of the clay besides allowing it to acquire uniformity throughout. During the ageing process the humidity in the clay cellar is maintained near saturation to prevent the clay from drying.

In the next stage of production, clay from the cellar is cut and placed in a pug mill consisting of a vertical set of blades or cutters pitched similar to a worm. These cut the clay and force it downward into a horizontal worm which in turn extrudes it at high pressure through the nozzle of the mill. The blades on the vertical feed are maintained at an irregular pitch to eliminate any tendency to produce spiral laminations in the clay. As the clay leaves the mill nozzle in cylindrical form it is cut off in

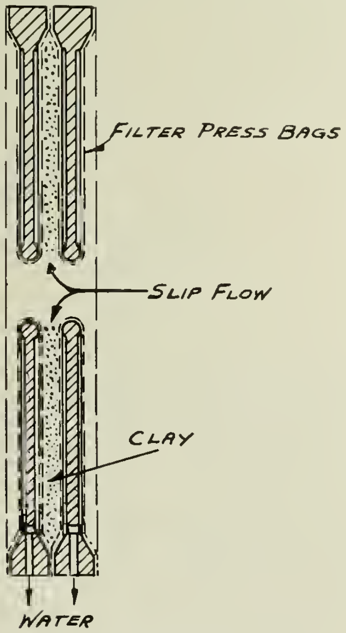


Fig. 4—Arrangement of Bags in Filter Presses.

convenient lengths for the production of various size insulators. Clay tubes and strain insulator blanks may also be extruded from the pug mill by fitting it with nozzles adapted to the purpose. (See Fig. 5.)

The pieces from the pug mill are next rolled and shaped by hand to eliminate the possible presence of folds or laminations. They are then packed tightly into plaster of paris moulds ready for pressing or jolleying into insulator parts. The fit of the hand shaped clay slug in the mould is very important as a loose fit may allow entrapped air pockets or folds to exist in the finished insulator part. Plaster of paris moulds used for this operation are carefully cleaned and brought to the proper moisture content before the filling operation. The absorbent properties of the dry plaster are used to assist in drying the clay pieces when first formed; however, if the plaster is too dry, the resulting rapid absorption is likely to damage the clay piece.

Suspension insulators and small pin type insulator shells are formed in a hot press. The mould containing

Fig. 5—Pug Mills.

the clay is placed in the press which is semi-automatic in operation. A hot metal plunger or die then descends into the clay with a revolving motion, subjecting the clay to a high pressure, which causes it to assume the form of the mould and plunger. At the point of maximum downward travel the plunger reverses rotation and withdraws from the mould leaving a formed insulator or shell. The metal plunger is heated and provided with an elaborate set of air valves to allow it to release from the clay upon reversal. The heated metal surfaces create a thin wall of steam between the plunger and the wet clay which overcomes the tendency of the plastic clay to adhere to the plunger surface. Simple types of thread can be produced in pin type insulator centres or shells by incorporating a metal master thread in the plunger centre. The two main essentials of the plunging operation are to obtain an evenly pressed piece, in which the clay is distributed with even density at high pressure without the creation of folds, and then to allow the plunger to release from the surface of the piece without sucking. Many rather obscure faults in the finished insulators which cause low mechanical strength, poor thermal resistance and low dielectric strength can now be traced to plunger sucking. For this reason careful attention must be given to the contour of plunger surfaces and the location of air release valves. Sufficient heat during operation must be applied to the plunger for the production of steam for release purposes, but overheating which will readily damage the clay surface is to be avoided.

Larger pin type insulator shells are made on a jolley which resembles a potter's wheel. The clay in the mould is placed in a rotating cup, a male template designed to the shape of the finished piece is then slowly lowered into the rotating clay, where with the assistance of the operator's hand it spreads the clay and finally imparts the desired shape to it. The jolleying operation requires a skilled operator, as suitable compression of the clay in the finished piece is only obtained by the skilful use of his hand in feeding it under the template. (Fig. 7.)

Jolleyed and pressed insulator parts remain in the moulds under the influence of a moderately warm dry atmosphere for periods from eight to twenty-four hours. During this time the clay dries to a state termed leather dry, shrinking sufficiently for easy removal from the mould. As regards shrinkage it may be noted that the shrinkage from the wet stage of the formed pieces to the dry stage just before glazing is 9/16 inch to the foot. From the dry stage to the fired stage when the porcelain is finished there is a further shrinkage of 1⅛ inch to the foot, giving a total from the wet stage to the finished piece of 1-11/16

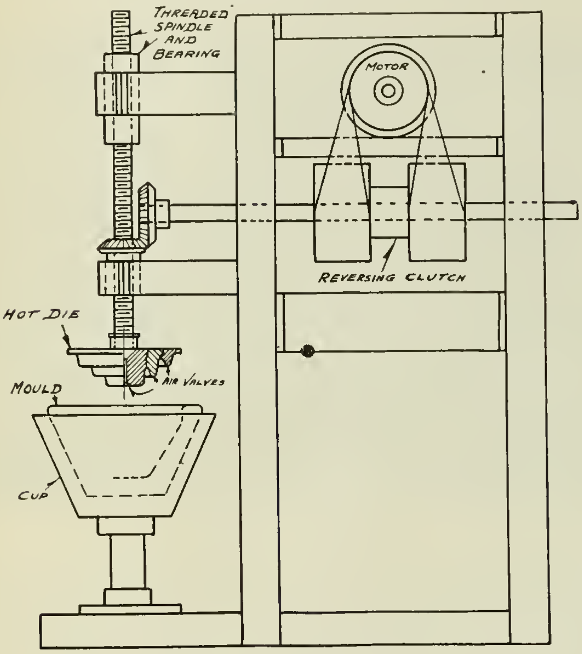


Fig. 6—Hot Press.

inch to the foot. Leather dry pieces must be carefully handled to avoid distortion with its tendency to develop internal strains.

Following removal from the moulds the insulator parts are placed on rotating forms where rough edges and other

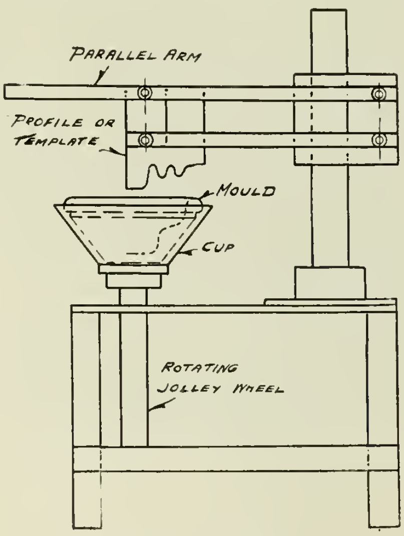


Fig. 7—Jolley.

superfluous portions are removed. A moist sponge is then used to impart a finished surface to all the trimmed parts. Trimmed parts are next placed on racks for storage in the humidity dryers.

Large entrance bushing parts, potheads, cutout boxes and other intricate porcelain pieces are cast from liquid clay slip. This process so differs from ordinary methods of production that it justifies further consideration before continuing with the manufacturing process as a whole. Ordinary clay slip as used for the production of clay in the filtering operation has too great a water content for casting thick sections, due to its excessive shrinkage upon solidification. Casting slip is made from a milled mixture similar to the regular mix but having a higher flint content and its density raised to 72 ounces to the imperial quart. At this density the mixture would not remain liquid but for the addition of the deflocculating agents, silicate of soda and sodium carbonate, in small quantities. These deflocculants react with the colloids of the clay in a manner which increases their mobility to the point where a mixture which would ordinarily be solid is kept liquid with such a small water content that shrinkage upon solidification is reduced to a minimum. The casting slip is forced into sealed plaster of paris moulds under pressure, where precipitation of the slip occurs as the mould absorbs the water. Two methods of casting are employed, core casting and drain casting. In core casting a plaster of paris core having a perforated pipe imbedded in its centre is placed in the mould. The clay forms between the core and mould walls as the slip is pumped in. When precipitation is complete, compressed air is applied to the pipe in the core, from which it passes through the plaster and releases the clay from the core surface, thus making it possible to withdraw

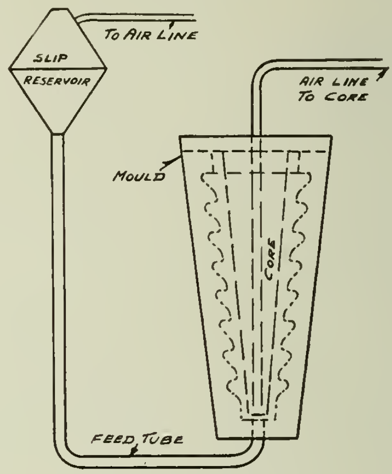


Fig. 8—Casting.

the core. (Fig. 8.) In drain casting no core is used, and the complete mould is filled with slip under pressure; then when sufficient time has elapsed to allow precipitation of the clay to the desired thickness the pressure is removed and the surplus slip drained out of the mould. Cast pieces are allowed to remain in the moulds until they dry enough to support their own weight. They are then removed, trimmed, and allowed to continue drying under canvas covers to protect them from direct draft.

All pieces regardless of the method of firing must be given a final drying in the humidity dryer. The moist ware is closely stacked in large drying rooms which are then closed tightly to prevent the escape of moisture and the temperature raised by means of steam heating coils. As the temperature increases the humidity in the dryer rises to a point approaching saturation, which retards drying until the clay pieces are evenly heated throughout. Ventilators are then opened and the moisture allowed to slowly escape until the clay ware is completely dried. The drying operation requires approximately one hundred and twenty hours at a maximum temperature of 160 degrees F.

After drying each piece is inspected for cracks, warping or improper dimensions before passing to the glaze table.

Small transformer bushings and busbar insulators are turned and drilled from dried clay blanks. Clay turning is done in the manner of wood turning with the clay revolving at high speed. Cutting is accomplished by means of carbaloy-tipped tools guided by hand in some cases and by metallic templates in others. It is important that the clay pieces be driven at the highest possible speed in order to attain a smooth surface free from incipient cracks.

Fig. 9—Operator Turning Transformer Bushing.

Before glazing all adhering dust is removed from each piece by means of powerful air jets and the surfaces wiped with a moist sponge to prevent the formation of pinholes in the glazed surface before and during firing. Surfaces which must be kept free from glaze are covered with molten paraffin. Each piece is then quickly immersed in liquid glaze and then placed on drying pins to await the sanding

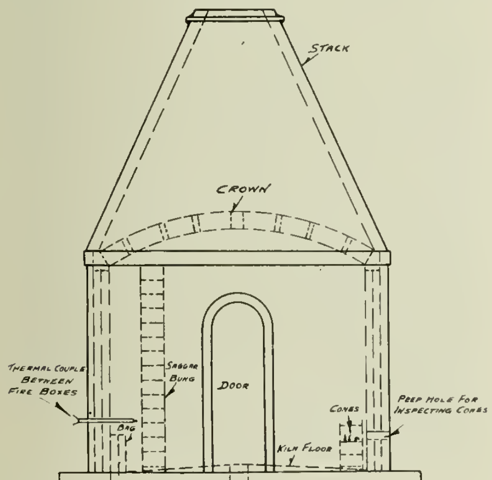


Fig. 10—Kiln.

operation. Large pieces too cumbersome to dip are glazed by means of a spray gun.

Insulator glazes mature at the top temperature at which the porcelain is fired, they must be hard, resist rapid thermal changes without crazing or chipping and withstand the action of corrosive industrial fumes. They are composed of the following materials: feldspar, ball clay, china clay, calcium carbonate, and manganese, with the addition of various colouring agents, dictated by the final colour of each particular glaze. Lead or other poisonous substances are not used in insulator glazes.

When the glazed pieces are dry the surfaces which require sanding are covered with an adhesive material which holds the sand in the desired place. The sand is then applied while this material is wet. This sand, which later provides the means of gripping the porcelain with Portland cement for the attachment of hardware, securely bonds itself to the porcelain surface during firing by fusion of the undercoat. It is made from screened porcelain, fired, crushed and graded, it will pass through a 14-mesh screen but will remain on a 20-mesh screen. A close inspection under intense light for glaze or sand faults follows the sanding operation. Accepted insulator parts are then placed on padded trucks for removal to the kilns.

The best established method of firing electrical porcelain employs the periodic kiln fired with coal, oil or gas. Each piece placed in the kiln is set inside a sagger pot composed of refractory fire clay, which removes all weight from the insulator parts during firing, other than the weight of the individual piece. The sagger pot also protects the glaze from the erosive action of the kiln fire. The pots are stacked in vertical piles termed bungs, the joints between the pots are sealed with strips of wad clay. Bungs are arranged at fixed distances apart so that the hot gases from the kiln fire will have ready access to each sagger. To overcome the friction between the base of heavy insulators and the sagger bottoms set up by the shrinkage of the porcelain during firing, large insulators are set on shrink plates of unfired clay which in turn rest on a layer of flint sand in the sagger bottom, thus avoiding internal strains which tend to crack the shrinking insulator during firing. (Figs. 10 and 11.)

Fig. 11—Interior of Kiln During Loading.

When kiln loading is completed the door is carefully sealed and the fires started. The majority of circular periodic kilns have ten fireboxes spread equally around the circumference of the base or kiln hob. Fuel is supplied to each firebox in measured quantities to insure even heating and temperature progression at a pre-determined rate. Each kiln is equipped with seven thermocouples, five of which are located around the kiln wall at points between the fireboxes at a height of thirty inches above the kiln floor. The sixth thermocouple is located in the kiln wall about eight feet above the floor. The seventh couple is placed at the kiln top in a hole in the centre of the kiln crown. Thermocouple leads are carried to a pyrometer station where correction for cold end temperatures are made and the temperature of the thermocouples recorded. Pyrometer readings serve to check the progression of temperature throughout the kiln enabling the fireman to maintain the various sections at even temperature and to adhere to a pre-determined schedule of kiln firing. Pyrometric cones consisting of special clay mixtures which fuse and bend over at pre-determined temperatures are also placed at

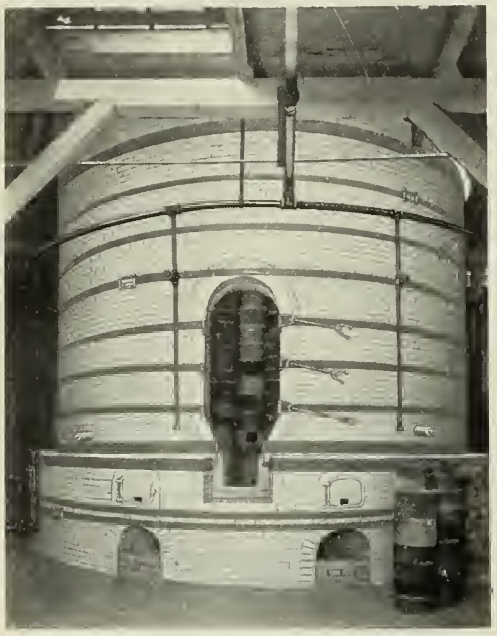


Fig. 12—Gas Fired Kiln Ready for Unloading.

important locations in the kiln where they may be observed through peepholes during firing. The cones are used in conjunction with the pyrometers for kiln control, they introduce a time and temperature reaction element which determines the finishing point of firing. Pyrometric cones are numbered, the number indicating the temperature at which fusion and bending takes place. If it is desired to fire a kiln until No. 10 cone bends half over, a small group of cones numbering 8, 9, and 10 are placed at each observation point. The Nos. 8 and 9 cones indicate the approach to the critical finishing temperature of 2,300 degrees F. at which No. 10 cone bends. Electrical porcelain is fired to temperatures ranging from that shown by No. 10 cone (which commences to bend at 2,280 degrees F.) to cone 12 (which bends at 2,390 degrees F.) depending upon the nature of the raw materials from which the porcelain is made and the structure desired in the fired material. Heat must be applied slowly during the early part of the firing to allow the escape of any moisture present, an even distribution of heat throughout the brittle pieces and the oxidation of organic matter from the ball clay. At a temperature from 850 degrees F. to 1,400 degrees F. the water of combination is driven off. At temperatures beyond 1,600 degrees F. vitrification commences, the feldspar begins to fuse and combine with the flint, the aluminum silicates break down and re-crystallize to mullite crystals $3Al_2O_3\ 2SiO_2$ as the heat progresses. These reactions are accompanied by a marked shrinkage of the porcelain pieces. The glaze also fuses, forming a dense smooth coat over the surface of the porcelain. At a temperature of 2,300 degrees F. firing is completed, and the kiln doors are sealed to prevent cool air drafts from sweeping through the kiln and chilling the hot ware. Cooling progresses at a slow rate giving a perfectly annealed porcelain. The complete firing and cooling cycle requires one hundred and eighty to two hundred hours depending upon the kiln size. It is of the utmost importance that the firing of electrical porcelain be completed at the proper temperature. Underfiring results in porous material which slowly absorbs moisture in service, ultimately causing failure of the insulator. Overfiring produces warping of shells and a brittle porcelain with reduced resistance to mechanical and thermal shock. For these reasons a close check of the accuracy of pyrometers and cones is necessary.

During firing the fragile mixture of raw materials undergoes a complete transformation to a hard, ivory white porcelain, impervious to moisture and having the following characteristics:—

Tensile strength in uniform sections 3,000 pounds per square inch.
Tensile strength in irregular sections 1,800 pounds per square inch.
Crushing strength for uniform sections over 50,000 pounds per square inch.
Minimum crushing strength for irregular sections 15,000 pounds per square inch.
Specific gravity 2.38.
Dielectric strength 250 kv. per inch for uniform sections up to 3/8 inch thick, and 170 kv. per inch for uniform sections from 3/8 to 1 inch thick.
Coefficient of expansion (per degree F.) .0000025.
Dielectric constant (approximate) 6.3.
Power factor 0.0065.

Note:—When a dielectric is subjected to a periodic alternating e.m.f. there is a loss of energy within the dielectric from two causes, the leakage conduction current and the dielectric hysteresis. Thus the volt-ampere input to the dielectric has a power factor of finite value but usually of small magnitude. The product of the power factor and the dielectric constant gives the loss factor, which is of special importance in the insulation of apparatus operated at high frequencies.

Fig. 13—Pan Test of Unassembled Shells.

When the kiln cools to the proper temperature the porcelain pieces are removed and subjected to a critical inspection for improper firing, cracks, bloats, warping, pinholes in the glaze or defects in the sand-coated surfaces. (Fig. 12.)

Samples from each lot of insulators passing the kiln inspection are broken and fragments selected for the porosity test. This consists of an immersion in a solution of fuchsine dye and alcohol under a pressure of 4,000 pounds per square inch for twenty-four hours. The fragments are then removed, thoroughly dried, fractured, and

Fig. 14—Routine Tension Test.

examined for evidence of penetration of the dye. Penetration of the dye indicates porous porcelain, and when this is discovered the representative batch of insulator parts are rejected.

The thermal test follows next, in which sample porcelain shells of each batch are clamped in frames and plunged into a bath of boiling water, where they remain for fifteen minutes. They are then removed and immediately plunged into a bath of cold water at 34 degrees F. for fifteen minutes. Two such immersions, one hot and one cold, constitute a thermal cycle. After five such cycles in succession the porcelain parts are tested electrically. If free from defects they are again subjected to five additional thermal cycles and tested electrically. Failure of any shells during the thermal test will result in rejection of that batch of insulators. The frames in which the shells are fastened are arranged to shield the interior of the shells from the water baths. This practice increases the severity of the test by retarding the temperature change on the interior of the shell where temperature change will be relatively slow in the assembled insulator.

All porcelain shells are next subjected to high frequency flashover at 200 kilocycles per second for ten seconds. They are then placed on a rack holding from sixty to eighty pieces and given a vigorous flashover for five minutes at normal frequency 25 or 60 cycles. The combined capacity of the rack and shells creates a vicious flashover which destroys any parts which may be below average dielectric strength. This test is termed a pan test. These tests are usually witnessed by a customer's inspector, who personally examines and stamps each piece before releasing them to the assembly department.

In the assembly department all surfaces of the porcelain which will be in contact with cement or hardware are treated with asphalt paint. The surfaces of the hardware which are in contact with the cement or porcelain are treated in a similar manner. A twenty-four-hour drying period is then allowed for evaporation of the volatile constituents of the paint. The paint eliminates the possibility of thermal stress originating from the union of dissimilar materials subjected to rapidly changing temperatures. It also encourages an even distribution of mechanical load, preventing point contacts.

Malleable iron, forged steel and bronze are the chief metals used for insulator hardware. All hardware is manufactured to rigid specifications of the insulator manufacturer. Pieces picked at random from each lot of hardware are tested in his laboratory for quality and ultimate mechanical strength, while each piece accepted is given a critical visual inspection. Malleable iron and steel pieces are hot-dip galvanized before assembly to prevent oxidation.

Cork discs for the absorption of mechanical shock are fastened to each porcelain shell before it passes to the assembly table. Busbar pin and post type insulators are assembled with neat Portland cement in jigs which insure the proper height and accurate alignment of the porcelain and hardware. The insulators remain in these jigs for sufficient time to allow the initial set of the cement. They are then removed and subjected to a cement-curing operation. Suspension insulators are assembled with neat Portland cement in a press which gives perfect alignment of the cap and pin. After the initial cement set they are also subjected to a cement-curing operation.

Due to the high mechanical loads which insulators are required to carry, only the highest grade Portland cement available is used for assembly, each batch is tested for chemical composition, fineness of grind, setting qualities and mechanical strength at the laboratory of the manufacturer.

Tests for mechanical strength, soundness and freedom from excess lime and magnesia are again repeated in the laboratory of the insulator manufacturer before using a batch of cement. The cement and water are carefully weighed out and mixed in a mechanical mixer for insulator assembly. Only small quantities are mixed at a time in order that they will be quickly used to avoid the possibility of cement which has commenced to set being placed in an insulator joint.

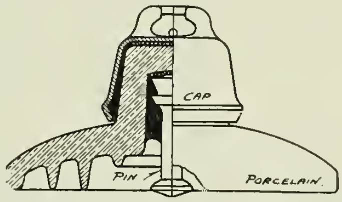


Fig. 15—Suspension Insulator.

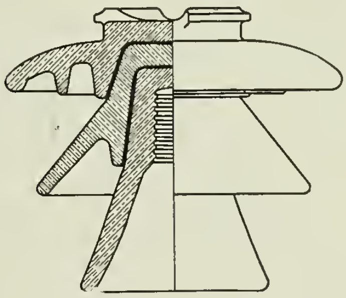


Fig. 16—Three-Piece Pin Type Insulator.

After assembly the insulators are allowed to stand five days, they then pass to the cleaning department where excess cement is removed and the porcelain and hardware are thoroughly cleaned. All exposed cement surfaces are next treated with a weather-proofing compound.

Suspension insulators are given a routine tension test seven days after cementing. A load of 5,000 pounds is placed on light duty insulators and a load of 10,000 pounds on heavy duty. Following the tension test the high frequency flashover and pan test is repeated on each assembled insulator, under observation of the customer's inspector, who again examines and stamps each insulator. Samples of each batch of insulators are also tested in the laboratory to determine the wet and dry flashover values of the insulator, the load at which the insulator fails electrically, the load at which it pulls apart, the thermal performance of the insulator, its dielectric strength, and occasionally its lightning flashover value. Failure of any of the insulators to meet the specified requirements or failure of more than 8 per cent of any batch on the final pan test will result in the rejection of that batch of insulators.

Post, pin type and busbar insulators are given similar treatment after assembly, with the exception of the routine tension test. Tubes for entrance and transformer bushings are tested similarly to parts for other insulators. They are then set up in jigs and placed in a heating cabinet in preparation for the gum filling operation. The temperature of the cabinet is raised to 280 degrees F. to drive all moisture from the tube surfaces and to allow the gum to seal each joint. Transformer bushings are treated to prevent oil leaks or creepage. All bushings are given a five-minute flashover at normal frequency before shipment.

This completes the manufacture of porcelain insulators as practised at the present time. In the modern insulator the customer receives a product which represents the best that modern applied science and technical research can yield in the selection of raw materials and control of manufacture, a product which is tested at potentials from three to ten times greater than those at which it is designed to operate, with mechanical strength many times beyond the most severe service requirements. For example a standard suspension insulator, which under normal conditions carries a tension load of 4,000 pounds at an operating potential per unit of 15 kilovolts, has a dry flashover value of 85 kv., and a wet flashover value of 45 kv. The load at which the insulator will fail electrically is 15,000 pounds, that at which it will pull apart is 17,000 pounds. The dielectric strength of a single unit is more than 140 kv.

Wet process porcelain has many applications in the electrical industry, such as the insulation of transmission lines, station busbar and switching equipment, circuit breakers and transformers. It is also used for insulating mercury arc rectifiers, potheads, electric signs, radio transmitting equipment, for electrode entrances and spacers in electric steam generators, and for the production of cutout and fuse boxes. There are many other minor applications in the manufacture of electrical specialties.

There are two manufacturers of high voltage porcelain insulators in Canada. They not only supply all domestic requirements, but are in competition with the industry throughout the world. Canadian insulators carry power lines in Great Britain, Norway, Sweden, Italy, Spain, Africa, India, Australia, New Zealand, Mexico and many other smaller countries. Ninety per cent of the insulators on the Scottish Grid and a high percentage of those on the English Grid were manufactured in Canada. Thus Canada occupies an enviable position in an industry which is a unique combination of one of the oldest arts known to mankind and the latest efforts of modern applied science.

The Annual Meeting - Hamilton

Make Arrangements to Attend—

Call your Branch Secretary regarding special railway rates.

Courtesy of Canadian Pacific Railway.

Gore Park, Hamilton, Ont.

The Fiftieth Annual General and General Professional Meeting

The Annual General Meeting for 1936 will be convened at Headquarters, 2050 Mansfield Street, Montreal, on Thursday, January 23rd, 1936, at eight o'clock p.m.

After the transaction of formal business, the meeting will be adjourned to reconvene at the Royal Connaught Hotel, Hamilton, at ten o'clock a.m. on Thursday, February 6th, 1936, continuing with the professional sessions on the following day.

Programme of Meeting at Hamilton

(Subject to Minor Changes)

Headquarters: The Royal Connaught Hotel

THURSDAY, FEBRUARY 6th

9.00 a.m. REGISTRATION (Mezzanine Floor).

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

12.45 p.m. FORMAL LUNCHEON (Ball Room).
Members $1.00. (Complimentary to Visiting Ladies.)
Welcome by the Chairman of the Hamilton Branch, W. Hollingworth, M.E.I.C., and by His Worship the Mayor of Hamilton.

2.15 p.m. PROFESSIONAL SESSIONS for the Presentation and Discussion of Papers will be held in two rooms concurrently:

(*a*) Connaught Room. *Chairman*, MAJOR H. A. LUMSDEN, M.E.I.C.
A series of papers on Transportation Topics, including the following:—
Advance Through Adversity, by L. K. Sillcox, Vice-President, New York Air Brake Company, New York.
Highways and Highway Transportation, by A. H. Foster, President, Ontario Association of Motor Coach Operators, Toronto.
Motor Truck Transportation, by W. H. Male, Director Automotive Transport Association of Ontario, Toronto.
An Outline of Commerce on the Great Lakes and St. Lawrence, by C. G. Moon, A.M.E.I.C., St. Catharines, Ontario.
The World's Airway System, by J. A. Wilson, A.M.E.I.C., Controller of Civil Aviation, Department of National Defence, Ottawa.

(*b*) Room 1110. *Chairman*, JAS. J. MACKAY, M.E.I.C.
Ceramics, an address by F. W. Paulin, M.E.I.C., President, Canadian Engineering and Contracting Company, Hamilton.
The Blast Furnace Process, by N. B. Clarke, Assistant Superintendent of Blast Furnaces and Coke Ovens, Steel Company of Canada Limited, Hamilton.
Substitute Fuels for Internal-Combustion Engines, by H. L. Wittek, Consulting Engineer, Toronto.

4.30 p.m. RECEPTION AND TEA for Ladies (Main Dining Room), complimentary.

7.00 p.m. ANNUAL DINNER of The Institute (Ball Room).
The President in the chair.
Sir Edward Beatty, President, Canadian Pacific Railway, will address the members and ladies present.

9.30 p.m. RECEPTION AND DANCE (Ball Room).
Tickets for Dinner, $1.75 per person.
Tickets for Dance, $1.50 (including Buffet Supper).

FRIDAY, FEBRUARY 7th

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

(*a*) Room 1110. *Chairman*, R. K. PALMER, M.E.I.C.
The Superstructure of the Reconstructed Second Narrows Bridge, Vancouver, by P. L. Pratley, M.E.I.C., Monsarrat and Pratley, Consulting Engineers, Montreal.

(*b*) Dining Room A. *Chairman*, L. P. RUNDLE, M.E.I.C.
The 45,000-kv.a. Frequency Changers at Chats Falls, by H. V. Hart, Vice-President and Chief Engineer, Canadian Westinghouse Company, Hamilton.
The Manufacture of High Voltage Porcelain Insulators, by J. M. Somerville, Chief Engineer, Canadian Porcelain Company, Hamilton.

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

2.15 p.m. Arrangements will be made for visits to engineering works of interest, including the following:—
Steel Company of Canada, Limited.
Canadian Westinghouse Company Limited.
Dominion Foundries and Steel Limited.
Canadian Porcelain Company Limited.
Water Filtration Plant of the city of Hamilton.
Details will be announced later.

9.00 p.m. SMOKING CONCERT (Ball Room). Tickets $1.50.
A varied entertainment including films has been provided. Light Refreshments will be served.
The Ladies Programme in addition to the Reception and Tea on Thursday, will include a visit to the works of Sovereign Potters Limited, followed by tea, on Friday afternoon.
For details of Ladies' entertainment, see Ladies' Programme to be issued later.

Hotel Arrangements

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

The Royal Connaught Hotel quotes the following rates:—

Single room with bath for the occupancy of one person—
$3.00, $3.50 and $4.00 per day.

Double bed, with bath, for two persons—
$4.50 per day.

Twin beds, with bath, for two persons—
$5.00, $6.00 and $7.00 per day.

Railway Rates

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

Party fares are available from any point to Hamilton for groups travelling together on the same train and date. They permit individual return within the specified limit shown.

Individuals, or parties less than the minimum number, travelling on other trains than the party itself will require to pay the regular one-way or round trip fares.

There are two classes of Party Fares, namely, "Good in Coaches only" and "Good in Parlor Cars or Sleepers" on payment of charge for accommodation occupied.

	Coach	*Parlor or Sleeper*
Parties 10 to 14.......	Fare and one-quarter.	Fare and one-half.
Parties 14 to 24.......	Fare and one-tenth.	Fare and one-quarter.
Parties 25 or over.....	Single fare.	Fare and one-tenth.

Arrangements for parties will be made by Branch Secretaries.

THE
ENGINEERING JOURNAL
THE JOURNAL OF
THE ENGINEERING INSTITUTE
OF CANADA

VOLUME XIX JANUARY 1936 No. 1

The New Year

The President and Council extend to all members of The Institute Best Wishes for 1936.

The continued improvement in economic conditions justifies our past confidence, and gives renewed hope for a substantial increase in engineering activity which will follow a revival of the construction industries.

We look forward to the New Year with assurance in the future success of our organization, and, with your co-operation, a new vigour in the furtherance of its objects and ideals.

Engineer and Cabinet Minister

A report of the largely attended dinner held by the Ottawa Branch on December 5th in honour of the attainment of cabinet rank by the Hon. C. D. Howe, M.E.I.C., is printed elsewhere in this issue.

This important gathering afforded an opportunity for the President of The Institute to present to Mr. Howe the felicitations of his fellow members of the engineering profession, and the President's good wishes were ably seconded by other speakers.

Mr. Howe's appointment is one which has met with general approval, coupled with an expression of some surprise that so few engineers, who possess a specialized type of training that should prove of great value in dealing with public affairs, have hitherto found it possible to enter public life in Canada.

As one paper puts it "...An engineer, in any body of men directing the affairs of state, should have a leavening influence. By nature and training he is used to cutting direct to the heart of things, of balancing known facts on the one hand with known requirements on the other, of solving his problems uninfluenced by any set of extraneous considerations. Logical deduction is part of his stock in trade... Politics is a field in which professional experience tells for usefulness and effectiveness and there is no doubt that one whose career has been devoted, as that of Mr. Howe has been devoted, to successful, constructive enterprise, will be useful to the public in the administration of public business."

It is to be hoped that the example set this year by Mr. Howe, and in the last administration by the Hon. Grote Stirling, M.E.I.C., may be followed by a number of their professional colleagues.

Forebodings and Realities

The hard times of the few years have given the habitual viewer-with-alarm many opportunities for the exercise of his peculiar talent. In taking advantage of them he has given us his predictions of disaster in matters social, economic, and political, most of which have fortunately failed of fulfilment. He is found—happily not in large numbers—even in the ranks of The Institute membership, shaking his head over the present condition or future prospects of the organization to which he belongs. There are occasionally viewers who are well informed and whose warnings therefore deserve some attention. But in too many instances the alarm is exhibited by people who have no real basis for their lamentations, or knowledge of the facts necessary to form a sound opinion. It is somewhat surprising to find that even among engineers, who are trained seekers after truth, there are some who are quite ready—and often seem anxious—to make pronouncements on subjects of which they have not exact knowledge.

The above dissertation has been written because the editor has met with cases where members of The Institute, who should have known better, have permitted themselves to announce that as a body we are rapidly approaching a condition of innocuous desuetude or even total eclipse. Some of these prophets of calamity consider that The Institute has been overwhelmed by the depression, some complain that no progress is being made in regard to policies which they favour, some disapprove of the actions of the Council whose members they helped to elect, and others, perhaps connected with one of our less active or more isolated branches, measure the whole Institute by the wrong yard-stick.

The complete information contained in the reports of Council and its committees, which will be presented at The Annual General Meeting next month, will be available for those who wish to see what justification there is for such pessimistic ideas. They will find unmistakeable evidence of activity and progress.

As compared with last year the active membership has increased, the collection of current fees and arrears has been better, and a large proportion of the members whose circumstances compelled them to ask to be placed on the Non-Active List have resumed active membership.

Money has been found for the publication of a List of Members, the Catalogue has paid its way, revenue has met expenditure. Thus, it seems that we may congratulate ourselves on having successfully weathered an economic storm which has severely affected many organizations which have much larger memberships and greater financial resources.

The future of The Institute is bound up with the ques-tion of Consolidation, and the work of The Institute's Committee and of various Branch committees on that subject is throwing light on this intricate and difficult problem. In many of our Branches lively interest has been aroused regarding our possible future relations with the Provincial Professional Associations and other engineering bodies in Canada. In fact, discussions on the subject have revealed so many local problems and have been so active, that they have tended to divert attention from the real progress which has been made in Institute affairs generally.

As regards the main aims of The Institute, the records of our professional meetings and Branch reports show that The Institute as a body and the Branches individually are effectively fulfilling The Institute's educational and social aims, and that there is no logical basis for the pessimist's attitude.

The Committee on Consolidation

Whatever comment may be made on the work of the Committee on Consolidation, a charge of inactivity certainly cannot be sustained. The Committee held its first meeting before the close of the 1935 Annual General Meeting, at which it was appointed. Since that time it has been at work continuously. Its report will be presented at the 1936 Annual General Meeting.

To those who do not realize the magnitude of the task, the preparation of a report of this kind may seem a comparatively easy matter. Actually, the writing of the report itself, after the necessary preparation work has been done, is not a lengthy operation. But before the Committee could begin to plan its recommendations, a long road had to be travelled. All pertinent information had to be collected and put in shape for communication to everybody concerned, in this case including the members of the Professional Associations as well as The Institute. Arrangements have had to be made for the expression and collection of the views of all interested parties, putting them in such form as to be capable of statistical treatment, while at the same time giving expression to their real wishes in the matter. The resulting material had then to be summarized, digested and considered by the Committee, so that proposals might be drafted which seem workable, express what is probably the desire of the majority of the interests affected, and involve the minimum of inconvenience for the few people whose toes appear likely to be trodden on.

In a discussion of this kind there usually arise divergent schools of thought, and ideas which at first seem hopelessly in conflict. These differences must be ironed out by the Committee before their report can be put in final form. It is thus a matter for congratulation that the Committee on Consolidation has been able to compress so much work into so short a time, and that at the forthcoming Annual General Meeting its report (of which we publish the first part in the present issue of The Journal) will be available for discussion by the members present.

The section of the report now printed constitutes an historical record of the manner in which the problem of the organization of the engineering profession in Canada arose, and of the happenings in connection therewith during the past twenty years. From the story thus unfolded it will be realized that familiarity with this background is very necessary in order that a sound judgment may be formed in regard to the practicability and wisdom of the Committee's recommendations. These are contained in the second section of their report and will be preceded by an account of the way in which they obtained the information on which their findings are based.

In the discussions which will follow the presentation of the report, it is to be hoped that personal prejudices and preconceived opinions will be laid aside by everybody. An open mind is essential. It is safe to say that no workable solution will emerge unless both individuals and societies are prepared to give as well as take. Cherished views will have to be sacrificed by some. All should bear in mind that the ultimate aim is to discover the best course to be taken to promote the real interests of all those in Canada who follow what used to be called the "art and mystery" of engineering.

OBITUARY

Henry Percy DePencier, M.E.I.C.

Deep regret is expressed in placing on record the death at New York, N.Y., on November 29th, 1935, of Henry Percy DePencier, M.E.I.C.

Mr. DePencier was born at Wakefield, Que., on August 29th, 1875, and graduated from McGill University with the degree of M.Sc. In 1903-1904 he was in South Africa, engaged on sampling, surveying, examining properties and geological work with H. Eckstein and Company. In 1905 Mr. DePencier became mine overseer of the Princess Estate Gold Mining Company Limited, at Roodepoort, Transvaal, being appointed general manager in the same year. In 1909 he returned to Canada and was for nine months with the Dr. Reddick Larder Lake Gold Mining Company Limited in Northern Ontario on behalf of the Canadian Mining and Exploration Company and other interests. In 1910 Mr. De Pencier was again in South Africa, examining mining properties, and was later in the same year mine overseer of the Roodepoort United Main Reef Gold Mining Company Limited at Roodepoort, Transvaal. In 1911 he was in private practice as a consulting engineer in Montreal. In 1913 Mr. DePencier joined the engineering organization of the International Nickel Company, and passed several months at the Frood mine near Sudbury. His first official connection with Dome Mines Limited was in 1915, when he became third vice-president. Early in 1920 he became also acting general manager, and later he was appointed general manager and first vice-president, a position he held until his death.

Mr. DePencier became a Member of The Institute (then the Canadian Society of Civil Engineers) on October 14th, 1911.

PERSONALS

Philip M. Schear, S.E.I.C., who graduated from McGill University in 1935 with the degree of B.Eng., has joined the staff of the Buchan Mining Company, Limited, at Buchan, Nfld.

W. F. Miller, S.E.I.C., has received an appointment as Inspector of Electricity and Gas in the Civil Service, and is located at Sudbury, Ontario. Mr. Miller, who is a graduate of Queen's University, was for a time with the Hydro-Electric Power Commission of Ontario, at Elmira, Ont.

W. D. Donnelly, S.E.I.C., who was formerly with the Candian Johns-Manville Company at Asbestos, Que., is now connected with the engineering department of the Ford Motor Company of Canada Limited, at Walkerville, Ontario.

Jacques Royer, S.E.I.C., a fourth year student in metallurgical engineering at McGill University, is the recipient of a prize from the University for his summer essay.

W. A. Dawson, A.M.E.I.C., has accepted the position of assistant superintendent of the machine division of the Algoma Steel Corporation, Limited, Sault Ste. Marie, Ontario. Mr. Dawson graduated from Queen's University in 1934 with the degree of B.Sc., and shortly afterwards became associated with the Ford Motor Company of Canada, Limited, rising to the position of head of the Department of Mechanical Design. He was this year elected vice-president of the Queens Alumni Society of Windsor. Mr. Dawson has also been active in civic affairs, having served as chairman of the Walkerville Board of Education.

Jules A. Beauchemin, A.M.E.I.C., has been appointed engineer of the new Quebec Electricity Commission. Mr. Beauchemin graduated from Laval University in 1911 with the degree of B.A.Sc. and was subsequently, until 1912, assistant to the resident engineer on Richelieu river improvements. From 1912 until 1917 he was engineer in charge of metering party on the St. Lawrence river, in connection with the Chicago Drainage scheme, and during the winters of the same years, and from 1917 until 1919, he was engineer in charge of a metering and survey party on the Ottawa and Quinze rivers and tributaries in connection with Upper Ottawa storage works. In 1919 Mr. Beauchemin became connected with the Riordon Company Limited at Temiskaming, Que., as hydrometric engineer, and was later with the Donnacona Paper Company at Donnacona, Que., as chief engineer of mills and hydro-electric developments. In 1927 Mr. Beauchemin was appointed town manager of the Town of Dolbeau, Que. In 1930-1931 he was manager of personnel and properties for the Canada Power and Paper Company and in 1931-1932, resident engineer on the Wellington Street tunnel, Montreal. In 1932 Mr. Beauchemin was resident engineer of the Lake St. Louis Bridge Corporation, later becoming comptroller of the same organization.

J. A. Beauchemin, A.M.E.I.C.

Addresses Wanted

The following is a list of members of The Institute for whom we have no addresses, and any information regarding their present addresses would be much appreciated.

Members

Walter S. D. Cook
J. Hardy Devey
Harry Kay
A. T. Leavitt
Jos. C. Tache
R. F. Uniacke

Associate Members

Wm. A. Abbott
Alphonse O. Beauchemin
Harold R. Bissell
Chas. Kenneth Brown
Leonard S. Daynes
Harry B. Dickens
Georges Dupont
Wm. L. Fraser
M. H. French
A. Granger
John Alex. Henderson
L. E. Kendall
G. B. Lomer
Andrew J. McFadyen
Frank L. Mitchell
F. G. O'Brien
G. C. Perkins
Lewis A. Perry
Hamilton E. Smith
J. C. K. Stuart
C. James Swift
Harold M. Thompson
H. E. Thornton
Laurence B. Tillson
O. H. Tjonnaas

Juniors

Thos. E. Dwyer
R. B. Elderkin
Wallace L. Foss
Thos. J. Higgins
Allan C. Knapp
W. J. Kwiecien
Arne Laland
H. A. Merton
Reg. A. Moore
F. Stewart Morgan
C. J. R. B. Stewart

Students

Stephen H. Clarke
Herman M. Cohen
P. D. Dalton
Julius H. Haines
A. S. Marshall
Phillip M. Newman
R. M. Nicholson
C. C. Parker
H. Douglas Short

Publications of Other Engineering Societies

From time to time announcements have appeared in The Engineering Journal regarding the exchange arrangements which exist between The Engineering Institute of Canada and the founder engineering societies of the United States, whereby members of The Institute may secure the publications of the American societies at special rates which in most instances are the same as charged to their own members. A list of these publications with the amounts charged is given below, and subscriptions may either be sent direct to New York or through Headquarters of The Institute.

	Rate to E.I.C. Members	*Rate to Non-Members*
American Society of Civil Engineers		
Proceedings, single copies	$ 0.50	$ 1.00
Per year	4.00*	8.00†
Civil Engineering, single copies	.50	.50
Per year	4.00	5.00
(Plus $.75 to cover Canadian postage.)		
Transactions, per year	6.00‡	12.00¶
Year Book	1.00	2.00
(Other publications 50 per cent reduction on catalogue price to E.I.C. members.)		

* *If subscription is received before January 1st, otherwise $5.00.*
† *If subscription is received before January 1st, otherwise $10.00.*
‡ *If subscription is received before February 1st, otherwise $8.00.*
¶ *If subscription is received before February 1st, otherwise $16.00.*

American Institute of Electrical Engineers		
Electrical Engineering, single copies	$ 0.75	$ 1.50
Per year	6.00*	12.00*
(*Plus postage $1.00.)		
Transactions—annual, bound	6.00*	12.00*
(*Plus postage $1.00.)		
(The single copy price for Electrical Engineering includes postage charge.)		
The American Society of Mechanical Engineers		
Mechanical Engineering, single copies	$ 0.50	$ 0.60
Per year	4.00*	5.00
(*Additional Postage to Canada $.75, Outside United States and Canada, $1.50.)		
Transactions, bound, published annually, about May 15 (price of current volume)	10.00	15.00
(Other publications, same rate to E.I.C. members as to A.S.M.E. members.)		
Journal of Applied Mechanics—Quarterly publications. Dates of issue: March, June Sept., Aug	4.00	5.00
American Institute of Mining and Metallurgical Engineers		
Mining and Metallurgy, single copies	$ 0.50	$ 0.50
Per year	3.00*	3.00
(*Plus $1.00 for foreign postage.)		
Metals Technology, single copies	1.00	1.00
Per year	7.00*	7.00
(*Plus $.50 for foreign postage.)		
Transactions, per volume	5.00*	7.50
(*Plus $.60 for foreign postage.)		
Technical publications: Supplied at $.01 per page, with a minimum charge of $.25 for single copies, or at a subscription rate per year of	7.00*	7.00
(*Plus $1.00 for foreign postage.)		

Report of the Committee on Consolidation

Part I*

At the Forty-ninth Annual General Meeting of The Engineering Institute of Canada, held in Toronto on February 7th, 1935, the following motion constituting this Committee was passed with two dissenting votes:—

"That it be resolved that the following Committee be appointed with power to add to their number, to develop the possibilities of consolidation of the Engineering Profession in Canada, and that they report their findings to Council and through Council to the next Annual General Meeting of The Institute, or to a Special General Meeting called for the purpose:—Dr. A. R. Decary, Quebec; Mr. G. J. Desbarats, Ottawa; Mr. J. B. Challies, Mr. R. F. Legget, and Mr. G. M. Pitts, Montreal."

The circumstances which prompted the formation of this Committee may be reviewed briefly as follows:—

Probably the first engineering society in Canada was incorporated some seventy-five years ago under the laws of Upper Canada, as "The Association of Provincial Land Surveyors and Institute of Civil Engineers of Canada." This association held its first meeting on October 10th, 1860, its membership being quite comprehensive in a professional sense in that it included land surveyors, civil engineers and architects. With an increase in the number and importance of the profession in Canada, a new organization was incorporated by Dominion Act on June 23rd, 1887, under the name of "The Canadian Society of Civil Engineers," its stated objects having special reference to the promotion of that species of knowledge more particularly related to the profession of civil engineering. This apparent limiting of the scope of the activities of the Society no doubt reflected the nature of the development taking place in Canada during that period in her history.

Reference is made to this phase in the growth of our national engineering body because even today there are those in other branches of engineering activity who claim that as the foundations of The Engineering Institute of Canada were laid largely by that branch of the profession known as "civil engineering," it is by tradition and concept essentially a civil engineering organization, and is therefore quite unsuited to function as the national engineering organization expressive of any of the other more latterly developed branches of science included in the modern practice of our profession. This contention is adequately answered by the all-embracing character of the activities and services which The Institute so efficiently performs at present.

The rapid developments which took place in Canada during the years immediately following the establishment of the Canadian Society of Civil Engineers were reflected in an increase in the membership of the Society throughout the country. This prompted the establishment of a series of branches, inaugurated by the formation of the Toronto Branch in 1890. These branch organizations performed a very useful function, disseminating the culture peculiar to our profession in a local sense, and creating a definite professional consciousness among its members. They had the added benefit of stimulating in the public mind an appreciation of the engineer both in a personal and in a professional sense.

With the advance in scientific knowledge and the resulting tendency toward greater specialization within the profession, a sentiment developed among its members that the usefulness of the Society should be increased and its activities extended. This idea was reflected in the motion made at the Annual Meeting of January 26th, 1916, which constituted a "Committee on Society Affairs,"—"for the purpose of studying and reporting upon a policy for increasing the prestige and influence of the Society, and including a consideration of the organization and By-laws and for making such recommendations for amendments, if any, as they see fit."

The work of this committee culminated in its report to Council on October 31st, 1917, which included a proposed revision of the By-laws, and suggested the name of the Society be changed to "The Engineering Institute of Canada" as being more expressive of the function which the organization aimed to perform. Thus, by Dominion Act of April 15th, 1918, "The Engineering Institute of Canada" was constituted.

Under its new and comprehensive charter, the national organization of the profession proceeded to increase materially its usefulness to its members and to the community. A permanent secretariat was established and in 1918 the "Journal" of The Institute was inaugurated, a medium of expression of incalculable value to the profession throughout Canada and abroad.

In this year the new By-laws came into effect and the first professional meeting of The Institute was held in Toronto on March 26th-27th. Mr. H. H. Vaughan, in his presidential message, made the following remark,—"The change in name implies the attempt to unite all engineers in Canada, to whatever branch of the profession they may belong, into one society."

At the second General Professional Meeting of The Institute, which was held in Saskatoon, on August 10th, 1918, a paper was read by Mr. F. H. Peters, which drew attention to the benefits to be derived by the profession through legal enactments, discussion of this matter having been introduced by a resolution passed by the Calgary Branch during the summer of 1917. It will be recalled that at this time there was in force in the Province of Quebec, an Act respecting the practice of engineering passed in 1898, and revised in 1900, and in the Province of Manitoba an Act passed in the year 1896, incorporating the Canadian Society of Civil Engineers in that Province.

The sentiment throughout the profession that the engineer could attain more adequate remuneration and public recognition through the legal establishment of his professional rights found expression at the Annual Meeting in Ottawa, of February 12th, 1919, in the formation of a committee for the purpose of drawing up a Model Act to be promoted in the various provinces of Canada which would give similar protection to engineers as was enjoyed by sister professions. It is of interest to note that Past-President G. H. Duggan, in expressing his views on this Model Act, in the June issue of the "Journal" of 1919, visualized the situation that at present exists within the profession, due to these provincial enactments, which your Committee on Consolidation is now endeavouring to find an acceptable means of rectifying.

At its meeting of September 23rd, 1919, Council approved the proposed legislation and encouraged the Branches and Provincial Divisions to co-operate in the promotion of provincial enactments, and gave Council's moral support to this movement. On the ballot which approved the Model Act, seventy per cent of the votes cast by Institute members were in the affirmative.

It is to be noted that no provision was made in the Act to relate these new legal organizations to The Institute in any way.

On March 23rd, 1920, Council appointed a Committee on "Remuneration of Engineers," this being a matter very much to the fore in the profession at this time, reactions in this regard being largely responsible for the great activity in the promotion of Provincial enactments.

On April 13th of that year a special conference of the Council was called, which resulted in the formation of a "Committee on Policy" under the chairmanship of Mr. J. B. Challies:—"To plan a definite programme along the

*Part II reviewing the work of the Committee with its conclusions and recommendations will appear in an early issue of The Journal.

lines of membership, welfare and promotion." During 1920 provincial enactments were obtained in British Columbia, Quebec, Manitoba, Alberta, New Brunswick and Nova Scotia. These enactments raised the point as to the definition of the term "professional engineer." This was discussed at great length and was comprehensively dealt with by Mr. A. D. Flinn, of the American Engineering Council, on page 387 of the "Journal" of that year.

A plenary meeting of the Committee on Policy was held on April 11th, 1922, and the Council approved the changes in the By-laws proposed by this Committee on November 21st. The report of the Committee was passed at the Annual Meeting of January 23rd, 1923. The outstanding features of this report were,—a broadening of the objectives of The Institute, effective co-operation with sister bodies, strengthening of Branch expression in the governing body, development of an Institute policy with regard to education, review of the Code of Ethics, action with regard to remuneration, plenary meetings of Council, and "a gradual verification of the status of The Institute as the national, all-embracing professional organization."

The Ontario Act was passed on June 5th, 1922.

By 1923 Provincial Acts had been granted in all provinces of Canada with the exception of Saskatchewan and Prince Edward Island. At this early date it was becoming apparent that there was a tendency in some sections for the new provincial organizations to function in a manner contrary to the idea which prompted their formation, and certain representations having been received from the west, the Council of The Institute at its meeting in February 1923, unanimously adopted the following resolution:—

> "Whereas it is the opinion of the Council of The Engineering Institute of Canada that all technical matters in connection with engineering should be the function of The Engineering Institute of Canada, and that the various Corporations and Associations of Professional Engineers in the different provinces are, or should be, designed solely for the purpose of administering the provincial laws in connection with legislation.
>
> Be it resolved:—That the Council of The Engineering Institute of Canada go on record as approving the above principle and that all possible steps be taken towards the adoption of this principle.
>
> Be it further resolved:—That the Secretary be instructed to write the various Provincial bodies calling their attention to this resolution and asking their co-operation to that end.
>
> Also be it resolved:—That the Council of The Engineering Institute of Canada suggest to each of the various provincial bodies that they send one or more representatives to a meeting for the purpose of discussing the relations of those bodies to The Engineering Institute of Canada, to the end that finally an Act may be enacted similar in principle to the Roddick Medical Bill."

On the invitation of the Council of The Institute, in December, 1925, a conference of delegates of the provincial professional associations was held in Montreal, on February 2nd, 3rd and 4th, 1926. The agenda of this meeting as reported, consisted of twenty-five items of interest to the engineer. The twenty-fifth read as follows:— "Co-operation with The Engineering Institute of Canada." The delegates of the seven Provincial Professional Associations left for home with a resolution expressing their sense of good fellowship and close association developed and strengthened by the conference, and their appreciation of the courtesies extended to them by The Institute in inviting them to such a conference.

There was a growing tendency at this time for the provincial associations, by virtue of their Acts and by an active policy, to draft university men into their association directly on graduation. The problem of the young engineer was very much to the fore in the profession.

At its meeting of January 18th, 1927, Council was advised that, in accordance with its instructions, the Secretary of The Institute had written the Secretary of the Corporation of Professional Engineers of the Province of Quebec, requesting him to communicate with the governing bodies of the various Provincial Associations of Professional Engineers, with a view to initiating discussions as to the best method to be adopted to bring about substantial uniformity in the requirements for admission by examination to the several provincial associations and to The Institute.

The first Plenary Meeting of Council was held in Montreal on October 10th, 11th and 12th, 1927. Twenty-nine members attended out of a possible forty-three. The afternoon session of October 11th, was devoted to a consideration of the policy to be pursued as regards The Institute's relations with the various provincial associations. The necessity of developing uniform admission examination requirements was stressed and it was resolved "that a standing committee representative of all the interested provinces of the Dominion of Canada, be appointed by the Council of The Engineering Institute to study the problems involved in co-ordinating the activities of The Engineering Institute of Canada and the several Associations of Professional Engineers." The personnel of this committee was named at the Council meeting of November 25th, 1927.

The report of Council for the year 1927 contained the following reference to the Professional Associations:—

> "During the year the relations of The Institute to the Associations of Professional Engineers of the various Provinces have been the subject of considerable thought and discussion, and it is satisfactory to record that the first step has been taken toward the very desirable object of greater uniformity in the requirements of admission to these bodies and The Institute itself. The Institute's Board of Examiners and Education, in preparing its revised syllabus for examinations for admission, is in consultation with the examination boards of the several Professional Associations, with a view to ascertaining what steps can be taken towards uniformity in this matter."

The Committee on Relations made no report at the Annual Meeting of February 1928, and on June 15th, Mr. George McLeod, the chairman of the committee, resigned, and Mr. S. G. Porter was appointed chairman.

The second Plenary Meeting of Council was held in Montreal on October 15th, 16th and 17th, 1928. At this meeting Mr. Shearwood, as chairman of a committee on Grades of Membership presented a report which indicated two schools of thought, one carrying the suggestion that the scope of the membership of The Institute should be widened so as to admit men who cannot be considered fully and broadly educated engineers, but whose experience in engineering work gives them a technical knowledge which would be a valuable contribution to the principal object of The Institute, and the other holding for the maintenance of a high standard of educational and practical requirements for admission.

Mr. S. G. Porter, Chairman of the Committee on Relations of The Institute with the various Provincial Associations, presented an interim report and stated that this committee had considered the following questions:—

> "1. Considering the welfare of the profession in its broadest sense, what relationship should exist be-

tween The Engineering Institute of Canada and the various Provincial Associations?

2. What obstacles are there in the way of attaining the desired end?

3. What procedure do you suggest for overcoming them?

While the Committee was not in a position to make a definite recommendation, it appeared that a considerable number of its members believed that the ultimate integration of all Provincial organizations or their amalgamation into one body was attainable, but the Committee had not been able to define the action which in its opinion The Engineering Institute should take in this movement."

The Committee was continued under the chairmanship of Mr. Porter to make a report at the next Plenary Meeting of Council, and discussion developed, "that in some places it had been suggested that the provincial associations might possibly function as Provincial divisions of The Institute."

At the meeting of Council held on January 22nd, 1929, upon the request of Mr. S. G. Porter, Chairman of the Committee on Relations of The Institute with the various Provincial Associations, the Secretary was directed to communicate with the Council of each of the Provincial Associations suggesting the appointment of Provincial Committees to co-operate with the Committee of The Engineering Institute. In its report for the year 1928, Council indicated "that some progress had been made towards the establishment of a more uniform standard of requirements for admission to these bodies (Professional Associations) and to The Institute, whether by examination or otherwise."

The Committee on Relations of the E.I.C. with the Provincial Associations made a report to the Annual Meeting in February, 1929, indicating that this Committee was in active correspondence with members of the Provincial Associations and stating,—"it is felt that events are tending towards the amalgamation of the various provincial associations into some kind of Dominion-wide organization, and that the time is now opportune for The Engineering Institute to offer the benefit of its organization and machinery to bring all these organizations together... The sentiment for Consolidation with The Engineering Institute is favourable among a large body of members of the Provincial Associations."

At its meeting of March 5th, 1929, Council appointed a new "Committee on Policy" under the Chairmanship of Mr. O. O. Lefebvre, to investigate and make recommendations regarding the present classes of membership, publications, organization, activities and general policy.

At its meeting of September 10th, 1929, on the suggestion of Mr. S. G. Porter, Council decided to invite a representative from each Provincial Association, who was also a member of the Committee on Relations of The Institute, to take part in a meeting of that Committee to be held at Headquarters on October 5th, 1929, just previous to the Plenary Meeting of Council.

The third Plenary Meeting of Council was held in Montreal on October 7th, 8th and 9th, 1929. To this meeting Mr. S. G. Porter presented the report of the Committee on Relations. This report was unanimously adopted by the Council, and on the motion of Dr. Lefebvre it was unanimously resolved,

> "That the Secretary renew the invitation sent to each of the Provincial Associations in February 1929, requesting them to co-operate with The Engineering Institute of Canada, and sending them a copy of the report of Mr. Porter's Committee, with the statement that the Council of The Institute had adopted the recommendations contained therein."

The interim report of the Committee on Policy indicated that certain important matters delegated to them for consideration could not be dealt with in a definite manner pending a determination of policy as respecting co-ordination between The Institute and the Professional Associations.

The report of the Committee on Relations was presented at the Annual Meeting of February 12th, 1930, and after considerable discussion was adopted, one member dissenting. This report featured uniformity of requirements for admission; reciprocal registration arrangements; advantages of a national organization to represent the whole profession, especially in connection with legislation and public welfare; and the increased ability to promote the educational function of the profession. Its recommendations were as follows:—

1. That this Committee or a similar one be continued.
2. That at least one member of Council in each Province be added to the Committee to act during his term of office in all cases where Council is not already represented.
3. That this committee be authorized to appoint a small Sub-committee whose duty it shall be to approach the Provincial Associations and in conjunction with them devise a detailed proposal to bring about a co-ordination of the interests and activities of the various Provincial Associations and The Engineering Institute of Canada; and further, it is recommended that a sum of $1,800 be appropriated towards a fund to provide for the expense of this work.
4. That The Engineering Institute of Canada, through the "Journal" and otherwise, continue to encourage and support the activities of the Provincial Associations, and contribute in every reasonable way to their success.
5. That immediate steps be taken to arrive at an agreement among the Professional Associations, and The Institute, for the adoption of standard uniform requirements for admission to membership, and that these requirements be rigidly adhered to.
6. That upon the acceptance of such standard requirements, The Institute should adopt the policy of accepting membership in a Professional Association as sufficient evidence of qualifications for admission to The Engineering Institute of Canada.
7. That steps be taken to secure the necessary amendments to the By-laws so that membership or registration in a Professional Association be one of the requirements for admission to Corporate Membership in The Engineering Institute of Canada for all applicants residing in a province where an Engineering Professions Act is in effect.

At the Council meeting of April 11th, Past-President H. H. Vaughan was appointed Chairman of the Committee on Relations. The Council was advised that the Professional Association of New Brunswick had appointed a committee to consider the question of closer co-operation between the various Provincial Associations and The Institute. The engineers of Saskatchewan obtained an Act which went into effect on May 1st, 1930.

The Fourth Plenary Meeting of Council was held in Montreal on September 22nd, 23rd and 24th of 1930. At this meeting Mr. Vaughan, Chairman of the Relations Committee, presented a report on behalf of a Sub-committee which had been appointed to approach the Provincial Associations, and in conjunction with them, devise a detailed proposal to bring about a co-ordination of interests and activities of the various Provincial Associations and The Engineering Institute of Canada. The report made the suggestion that a study of these possibilities should be made by a committee of members nominated by all the Provincial Associations and The Engineering Institute, to be known as the "National Committee." It was further suggested that this National Committee prepare an analysis and comparison of the various provincial Acts and requirements for admission to membership, after which three members should be selected from the National Committee to prepare a draft set of By-laws and Requirements which would apply to both the Associations and The Engineering Institute. The Council unanimously adopted the recommendations of the Report and the Secretary was instructed to advise the Councils of the various Provincial Associations accordingly.

At this Plenary Meeting of Council there was an extended discussion on "grades of membership" and "qualifications for admission" and a special committee was appointed to study the whole question of membership and to report to Council at the next Annual Meeting.

At the Annual Meeting of February 1931, the Committee on Relations presented its report as approved by the Fourth Plenary Meeting of Council, which was duly accepted by the Annual Meeting. Ultimately, in accordance with the suggestion of the above report, members of the National Committee were appointed by the Councils of seven of the eight Professional Associations, who thus concurred in the course proposed. The Council of one of the Provincial Associations, however, maintained that co-ordination of all activities of the engineering associations throughout Canada, might be obtained more readily by developing a plan which would first apply only to the Provincial Associations, and definite objection was made to any plan which would at once include The Engineering Institute. Further, the Council in question was unable to approve of the proposed Committee of Four unless its members were accredited by the Associations alone, The Institute taking no further part for the time being.

The Institute acquiesced in the above suggestion and withdrew from further deliberations on this matter and a "Committee of Four" representatives of the Provincial Associations was convened in Montreal on August 24th, and the report of that Committee was made to the Councils of the Provincial Associations on September 4th, 1931. Its recommendations included the formation of a "Dominion Council of the Engineering Profession" composed of eight members, one appointed by each Provincial Association.

The fifth Plenary Meeting of Council was held in Montreal on September 21st, 22nd and 23rd, 1931. At this meeting the report of the Committee on Relations was received which outlined the formation and policy of the Committee of Four of the Provincial Associations, and advised that The Institute had officially withdrawn from deliberations on consolidation for the time being on the recommendation of the British Columbia Association. The Institute, however, stood ready to co-operate in every possible way to promote the work of this Committee of the Associations.

This Plenary Meeting of Council recommended the formation of a "Committee on Development," which was appointed by Council at its meeting of November 17th, 1931, under the chairmanship of Mr. J. L. Busfield, its object being to review the constitution and aims of The Institute in the light of present day conditions, and to bring in such recommendations as it might determine were best suited to meet the requirements of The Institute. An interim report was made of the work on the Committee on Development at the Annual Meeting of February 1932, at which time also The Institute approved the action of the Plenary Meeting with reference to the activities of the Committee of Four of the Professional Associations. An interim report of the Committee on Development was made in September 1932, which included a review of the activities and growth of The Institute up to that time, together with suggestions for a realignment of its membership classification, qualification requirements, Code of Ethics, fees, etc.

The Provincial Professional Associations, having appointed representatives to a "Dominion Council of the Engineering Profession" as recommended by the Committee of Four in its report of September 4th, 1931, this Council, or "Committee of Eight" met in Montreal on February 1st, 1933, and issued its report under date of February 4th, in which it is stated,—"We believe that there is every reason to expect that the ultimate outcome of such studies will be the complete co-ordination of all activities of the Engineering Profession in Canada." A proposed Constitution for the Dominion Council was drawn up and included in the Report. The "Committee of Eight" has held no further meetings.

At the Annual Meeting of February 7th, 1933, the interim report of the Committee on Development was discussed, and modifications in its proposals were suggested by a number of Branches and individuals. The close relationship of the work of this Committee to the work of the Committee of Eight of the Professional Associations was stressed. There was much criticism of the proposals of the report which apparently would lower the standard of professional requirements of candidates for admission to membership. The Quebec Branch stressed the importance of maintaining the truly professional quality of the membership of The Institute, indicating that in its opinion some means would eventually be found whereby the "total membership of all Provincial Associations would join The Institute." Finally the interim report of the Committee on Development was referred for further study to a Plenary Meeting of Council.

The Sixth Plenary Meeting of Council was held in Montreal on October 30th, 31st and November 1st, 1933. It considered in detail the report of a Committee of Council delegated to study the proposals of the Committee on Development, after which the proposals were approved for submission at the Annual Meeting and subsequent ballot by the membership. The Council placed on record its desire to co-operate in every way possible with the Provincial Associations of Professional Engineers and it was resolved that The Institute should take advantage of every possible opportunity to collaborate with the Provincial Associations in furthering the best interests of the engineering profession and more particularly in endeavouring to secure a generally acceptable scheme of registration of engineers in all parts of the Dominion.

At the Annual Meeting of The Institute held in Montreal on February 8th, 1934, the final report of the Committee on Development, as expressed in the revision of the By-laws of The Institute, was received and was productive of considerable discussion. It was pointed out that the drafting of these By-laws was very intimately involved with the policy to be followed regarding closer relationships with the Provincial Associations, and the suggestion was put forward that it might be wise to forgo issuing these By-laws to a ballot until some further efforts had been made toward closer co-operation between The Institute and the Professional Associations, which might modify to a considerable extent some of the By-laws proposed. It was decided, however, that the regulations of The Institute required that these By-laws be submitted to a ballot of the general membership. This was done with the result that the amendments were not sustained by the required affirmative vote of two-thirds of all valid ballots cast.

At the meeting of Council of June 5th, 1934, a proposal was presented for renewed action by The Institute looking toward the co-ordination of the profession in Canada, but consideration of this matter was postponed until the fall. This Council meeting decided that the subject for the Past-

Presidents' Prize for the year 1934-35 should be, "The Co-ordination of the Activities of the Various Engineering Organizations in Canada."

At the Council meeting of October 10th, 1934, communications from the Winnipeg Branch were considered suggesting certain changes in the organization of the Branch Executive Committee "which it is hoped will facilitate the Branch's co-operation with the Association of Professional Engineers of Manitoba." The proposals were approved by Council.

At its meeting of November 16th, 1934, Council received a communication from the Vancouver Branch under date of October 3rd, dealing with the future policy and lines of development of The Institute. At this meeting the Council approved certain amendments to the Winnipeg Branch By-laws, which were calculated to facilitate the co-operation of that Branch with the Association of Professional Engineers of Manitoba. This meeting of Council also discussed a suggestion from the President of the Association of Professional Engineers of Alberta, that The Institute might act as a clearing house in communications between the Associations of Professional Engineers and the Department of Immigration with regard to applications for admission of foreign engineers to Canada. The suggestion was approved, provided the consent of all Professional Associations to the arrangement could be secured.

At its meeting of October 12th, 1934, the Halifax Branch forwarded a resolution to Council favouring the consolidation of the profession in each Province and throughout the Dominion.

At its Annual Meeting of January 10th, 1935, the Montreal Branch discussed the question of Consolidation, and at a further meeting of January 30th, forwarded to the Council for presentation at the Annual Meeting, a resolution similar to that of the Halifax Branch.

At the Annual General Meeting of The Institute held in Toronto on February 7th, 1935, the above resolutions, together with resolutions from the Ottawa Branch, the Executive Committee of the Quebec Branch, the Executive Committee of the Border Cities Branch, the Lethbridge Branch, and the Association of Professional Engineers of the Province of New Brunswick, were presented, and thus the question of Consolidation became an important one on the agenda of the meeting.

The Annual Meeting passed the following resolution unanimously:—

> "That The Engineering Institute of Canada, in Annual Meeting assembled, hereby goes on record as being in favour of the Consolidation of the Engineering Profession in Canada."

As a means of implementing the above resolution the resolution already cited constituting the "Committee on Consolidation" was passed.

Attention is drawn to the fact that this movement was not initiated by the Council of The Institute.

Gordon McL. Pitts, A.M.E.I.C.,
Chairman.

Elections and Transfers

At the meeting of Council held on December 20th, 1935, the following elections and transfers were effected:

Member

WATERS, Allan James, asst. engr., B.C. Electric Rly. Co., Vancouver, B.C.

Associate Members

BOYD, David, B.Sc., (McGill Univ.), asst. works mgr., Lachine plant, Dominion Bridge Co., Ltd., Lachine, Que.

GODDARD, Harold Oliver, B.Sc., (McGill Univ.), engr., Nichols Engineering & Research Corpn. of Canada, Ltd., Montreal, Que.

KINGHORN, Hayward Coburn, B.Sc.F., (Univ. of N.B.), asst. engr., D.N.D., Work Point Barracks, Esquimalt, B.C.

McLENNAN, Duncan Osborne, B.Sc.F., (Univ. of N.B.), forest engr., The E. B. Eddy Co. Ltd., Hull, Que.

Junior

*MOSLEY, Harold Gordon, 119 Main St., Glace Bay, N.S.

Transferred from the class of Associate Member to that of Member

WALKER, James Alexander, B.A.Sc., C.E., (Univ. of Toronto), private practice and engr.-Secretary, Vancouver Town Planning Commission, Vancouver, B.C.

Transferred from the class of Junior to that of Associate Member

MIDGLEY, George Henry, B.Sc., (N.S. Tech. Coll.), sales mgr. Dodge Mfg. Co. Divn. of United Steel Corpn. Ltd., Montreal, Que.

SINCLAIR, Archibald Beairsto, B.Sc., (Univ. of Man.), chief operator, Kenogami substation, Price Bros. & Co. Ltd., Kenogami, Que.

Transferred from the class of Student to that of Associate Member

CRAWFORD, James Merrill, B.Sc., M.Eng., (McGill Univ.), elect'l. engr., Shawinigan Water and Power Company, Montreal, Que.

GAUER, Edward, B.Sc., (Univ. of Man.), private practice, land surveyor and municipal engr., Winnipeg, Man.

JACOBSEN, Eric Rivers, B.Sc., M.Eng., (McGill Univ.), designer, Dominion Bridge Co. Ltd., Montreal, Que.

MacGREGOR, James Grierson, B.Sc., (Univ. of Alta.), dist., supt., Canadian Utilities Ltd., Vegreville, Alta.

MOLLARD, John Ellis, B.Sc., (Univ. of Sask.), dist. supt., Saskatchewan Power Commission, Tisdale, Sask.

STOREY, Thomas Edwards, B.Sc., (Univ. of Man.), chief operator, Slave Falls power house, City of Winnipeg Hydro-Electric System, Pointe du Bois, Man.

WHITSON, Duncan David, B.A.Sc., (Univ. of Toronto), struct'l. engr., dept. of bldgs., City of Toronto, City Hall, Toronto, Ont.

Transferred from the class of Student to that of Junior

BROWNIE, Frank Austin, B.Sc., (Univ. of Alta.), inspr. of assessments, Dept. of Municipal Affairs, Edmonton, Alta.

CRAIN, Harold Fowler, B.Sc., (Queen's Univ.), vice-president in charge of production, Crain Printers Ltd., Ottawa, Ont.

LOCHHEAD, Kenneth Young, B.Eng., (McGill Univ.), asst. to supt. of bldgs., Hudson's Bay Co., Winnipeg, Man.

RODGER, Norman Elliott, Capt., R.C.E., (Grad., R.M.C.), B.Sc., (McGill Univ.), General Staff, National Defence Headquarters, Ottawa, Ont.

RYDER, Frederick James, B.Sc., (McGill Univ.), material dept., and gen. office work, Motor Products Corpn. Ltd., Walkerville, Ont.

VINCENT, Paul, B.A.Sc., C.E., (Ecole Polytechnique, Montreal), junior engr., Water Levels Investigation Board, Dept. of Marine, Montreal, Que.

WHEATLEY, Eric Edmund, B.Sc., (McGill Univ.), sales engr., Jenkins Bros. Ltd., Montreal, Que.

Students Admitted

DUCKETT, William Anderson, (McGill Univ.), 13 Dollard Ave., Montreal South, Que.

KING, Burton Wensley, (Queen's Univ.), 574 Johnson St., Kingston, Ont.

LaRIVIERE, Marcel Gerard, (McGill Univ.), 6 Weredale Park, Westmount, Que.

LAWSON, George Whytall, B.A.Sc., (Univ. of Toronto), International Nickel Company, Copper Cliff, Ont.

MESSEL, Michael James, (McGill Univ.), 3582 Clarke St., Montreal, Que.

McCRADY, Donald Carman, (McGill Univ.), 3469 Northcliffe Ave., Montreal, Que.

McINTOSH, William Gardner, (Univ. of Man.), 21 Roslyn Road, Winnipeg, Man.

SAVARD, Guy, (R.M.C.), Royal Military College, Kingston, Ont.

SENICIE, Michael, (McGill Univ.), 3582 Clarke St., Montreal, Que.

SMALLWOOD, Robert Edwards, B.A.Sc., (Univ. of Toronto), 2540 Montclair Ave., Montreal, Que.

SMITH, Gerald McRae, B.Sc., (Univ. of Alta.), 11134-83rd Ave., Edmonton, Alta.

SMYTH, William Christopher, (McGill Univ.), 3410 Atwater Ave., Montreal, Que.

WRIGHT, John William, (Mt. Allison Univ.), Central Y.M.C.A., Montreal, Que.

---

*Has passed The Institute's examinations.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Institution of Mechanical Engineers: Proceedings, Vol. 129, 1935.

Reports, etc.

Canada, Dominion Water Power and Hydrometric Bureau: Water Resources, Paper No. 67—Pacific Drainage.
Canada, Dept. of Labour: Labour Organization in Canada: Annual Report, 1934.
Canada, Dept. of Mines, Mines Branch: Gold in Canada, 1935.
Ontario, Dept. of Mines: Bulletin No. 101—Mineral Production of Ontario, First 9 months, 1935.
International Tin Research and Development Council: Improvement in the Quality of Tinplate by Superimposed Electrodisposition of Tin.
Canada, Dept. of Mines, Mines Branch: Limestones of Canada, Part 3, Quebec.
Governor of the Panama Canal: Annual Report, 1935.
Corporation of the County of Wentworth, Ontario: Annual Report on the Road System, 1935.
Canada, Dept. of Mines, Mines Branch: Laboratory Tests on Structural Assemblies of Brick and Tile.
American Society for Testing Materials: Tentative Standards, 1935.
American Institute of Steel Construction:
The Stadium.
Steel Dams.
Structural Behaviour of Battledeck Floor Systems.
Tests of a Steel Model of a 55-storey Wind Bent.
Bridge Welding: a Review of the Literature.

Technical Books, etc., Received

Materials Testing Machines, by C. H. Gibbons. (*Instruments Publishing Company.*)
Explosions in Sewers, by Frank V. Dowd, A.M.E.I.C.

BOOK REVIEW

The Principles of Motor Fuel Preparation and Application, Volume II

By A. W. Nash and D. A. Howes, John Wiley and Sons Inc., New York (Renouf Publishing Company, Montreal). 6¼ by 10 inches, 523 pages, diagrams, etc. $8.00. Cloth.

Reviewed by J. B. PHILLIPS, A.M.E.I.C.*

The second volume of this work comprises chapters 11 to 19, with an appendix. The longest chapter in this volume is devoted to the discussion of all known methods of examination and testing of motor fuels, including tests required by the more recent developments in the industry. Most of the tests are given in detail, making this chapter of great value to refinery men and technicians.

Another chapter deals with knock tendency, knock ratings, and methods of determination. Knock testing engines are described. A review is given of the four main theories to account for knocking. Anti-knock substances such as lead tetraethyl and carbonyl compounds are discussed. This chapter is quite lengthy but presents the whole subject in a clear and concise way.

The formation, estimation and significance of gum in motor fuels is taken up rather fully in this book. Chemical explanations of gum formation are presented in the simplest manner possible. Tests for gum are described and the use of gum inhibitors discussed.

A chapter is devoted to the discussion of internal combustion engines of different types, both automobile and aircraft, with special reference to carburation, fuel consumption, power output and compression ratios. Thermodynamical considerations of a theoretical nature wherever introduced are presented in a very understandable way, and there is no difficulty in applying these considerations to the subsequent discussion of actual engine performance. A separate chapter is given to discussing the bearing of fuel characteristics on engine performance. Only information from American sources is discussed here, since data from other sources are not available. Performance tests and apparatus are described with great clarity. Starting properties of gasolines and blends are discussed, and such subjects as crankcase dilution and vapour lock are also taken up. This chapter is impressive of the importance now attached to the properties of motor fuels and of the exacting demands on the refiner, compared with the simple requirements of only a few years ago.

A notable feature of this book is the discussion of the Diesel engine. Types of automotive Diesels are described, and the aero Diesel is also taken up in some detail. Combustion conditions in the Diesel, the design of fuel injection systems and combustion chambers are included in the subjects of this chapter. The properties of Diesel fuels and their knock characteristics are given.

The special requirements of aircraft fuels are considered in a separate chapter. There is also a brief chapter on sulphur specifications in motor fuels, and the removal of sulphur. In the final chapter, motor fuel specifications are tabulated, chiefly for the United States and Great Britain, with brief references to six other countries.

A very useful appendix contains tables of gravities, hydrometer readings, vapour pressures, viscosities, thermal data, solubilities, etc., for motor fuels. Statistics are given on imports, production, consumption and taxation. Both subject and author indices are given as well as a patent list. Each chapter has a lengthy list of references from recent literature.

These two volumes show evidence of the greatest care in their preparation. They represent the most complete reference work on the subject of motor fuels to date, and there can be no question as to their value to anyone concerned with the manufacture and application of motor fuels.

*Lecturer in Chemical Engineering, McGill University, Montreal.

Main Line Railway Electrification in Great Britain

The most interesting feature about the construction and improvement schemes which the railways, subject to Parliamentary sanction are to put in hand and complete under a governmental guarantee within the next five years, is the electrification of the line from Manchester to Sheffield on the London and North Eastern Railway. This line, 4½ miles long, carries a heavy traffic. It has steep gradients, and includes the well-known Woodhead tunnel. There would be an estimated return of more than 10 per cent on the cost of the electrification but the conversion involves the removal of a locomotive shed from one side of the Sheffield station to the other, and the provision of reception sidings, the cost of which will entirely neutralize the savings. The conditions at Sheffield then illustrate the important point that it is advisable to consider as long sections as possible for electrification in order to reduce the proportion of the costs necessary to provide facilities at exchange points. As this section will be the first main line carrying a heavy goods traffic in England to be worked electrically, the results should be of great instructional value.

An extensive programme of electrification, amounting to 252 miles is also to be carried out on the Southern Railway, enabling electrically-operated trains to be run between London and Portsmouth, so that a very large proportion of the eastern and central sections of the company's system will come under the new method of operation. On the London Midland and Scottish Railway it is proposed to electrify certain sections. Stonebridge Park generating station, near London, and the sub-stations it serves are to be converted to standard frequency. In addition to these electrical developments, all the companies are proposing to carry out more or less extensive work on alterations to stations, including Euston and King's Cross, widening, locomotive and rolling-stock construction and modernization and colour-light signalling. The total cost is estimated to be about £30,000,000. and the financial arrangements will be similar to those in the recent London Transport agreement. All the plant, machinery and manufactured articles required are, as far as practicable, to be of United Kingdom origin, and preference is to be given to firms in the Special areas. Contracts are to be subject to the Fair Wages Clause.—*Engineering.*

FIFTIETH ANNUAL MEETING

**Royal Connaught Hotel,
Hamilton.**

February 6th and 7th, 1936.

University Hall, McMaster University, Hamilton, Ontario.

Annual General Meeting	**Annual Dinner**
Reception and Dance	**Smoker**
Technical Sessions	**Plant Visits**

Programme of Meeting appears on page 31.

BRANCH NEWS

Border Cities Branch

C. F. Davison, A.M.E.I.C., Secretary-Treasurer.
F. J. Ryder, S.E.I.C., Branch News Editor.

The regular monthly meeting and dinner of the Border Cities Branch of The Institute was held in the Prince Edward hotel at 6.30 p.m. on Friday, November 15th, 1935, with twenty-five present.

The guest speaker, Mr. W. D. Canan, M.Sc., was introduced by Boyd Candlish, A.M.E.I.C. Mr. Canan is designing engineer in the organization of Rust Engineering Company of Pittsburgh, Pa., and his subject was "The Design and Economics of Small Industrial Power Plants."

The Design and Economics of Small Industrial Power Plants

In the east, where coal is cheap and plentiful, many of the users of public utilities power are looking into the subject of small private power plants. By small power plants, the speaker included those that generate 500 kw. per hour to 10,000 kw. per hour, and that all steam generated is to be used for power purposes only.

The general considerations in design are:—(1) Cost, which depends on the existing power rate and the amount the client is willing to invest in an independent plant. (2) Return. This is the saving to the investor and usually runs between 16 to 30 per cent. The return should show at least 25 per cent for the very small plant and not less than 15 per cent for the larger one. (3) Operation. The plant for the small industrial user should be simple to operate and easy to maintain owing to the usual lack of any technical supervision. (4) Dependability. This factor depends on the kind of goods to be manufactured and how serious a loss would be entailed by a hold-up in production. If no spare units are provided then it is wise to allow extra capacity for overloads. (5) Capacity. General rating is from 200 to 250 pounds per square inch designed for 250 per cent of rating.

Solid brick settings are satisfactory for small units, but for larger units water-cooled walls are preferred. Pulverized coal installations are not satisfactory on small installations as the initial cost is too high. Heat recovery equipment is not warranted in small units as the saving effected by their use is often wiped out by the increase in the fixed charges. For plants generating 1,000 kw. or over the turbo-generator is usually recommended.

Mr. Canan showed tables of plant cost and data taken from actual designs or constructions.

Following the discussion it was moved by W. H. Baltzell, M.E.I.C., and seconded by T. Jenkins, A.M.E.I.C., that a hearty vote of thanks be extended to the speaker.

H. J. Coulter, A.M.E.I.C., announced that at the next meeting there would be the annual election of officers.

It was moved by C. G. Armstrong, A.M.E.I.C., and seconded by Mr. Jenkins that a letter of congratulation be sent to the Hon. C. D. Howe, M.P., M.E.I.C., who was recently appointed to the Federal Cabinet.

Edmonton Branch

W. B. Cornish, Jr.E.I.C., Secretary-Treasurer.
M. L. Gale, A.M.E.I.C., Branch News Editor.

"One Troy Ounce of Gold" was the subject of a paper presented by Mr. E. J. Carlyle, General Secretary of the Canadian Institute of Mining and Metallurgy, before a meeting held jointly with the local branch of The Institute, the Northern Alberta Branch of the C.I.M.M., the local members of the Professional Engineers of Alberta, the Mining and Geological Society of the University, and the Engineering Students' Society of the University, on Tuesday, November 26th, 1935.

Mr. Carlyle's paper dealt with the recovery of a minute quantity of gold from a large amount of rock. It was non-technical, dealing mostly with the economics of gold mining. Many interesting and comparative figures of Canadian mines were quoted by the speaker. Methods of mining and means of separating the gold, were lightly touched upon during the course of the evening.

The meeting was held at the University of Alberta and about two hundred were present.

Methods for Building Roads Through Muskeg

New road-building methods were described when L. B. Fox, manager of the Edmonton office of Canadian Industries Ltd., addressed a meeting of the Edmonton Branch of The Engineering Institute of Canada, at the Macdonald Hotel, on Friday, December 6th.

Mr. Fox presented details of methods recently developed for building roads through muskeg, involving the use of explosives to produce rapid settlement of the roadbed. The settlement is produced before the road surface is placed, and thus the damaging effect of settlement after the road surface is in place is eliminated.

The speaker also outlined the recent developments in the use of explosives for ditching operations.

Following the address, a motion picture film was presented, which showed the methods used in Canada in the manufacture of dynamite.

Hamilton Branch

A. Love, M.E.I.C., Secretary-Treasurer.
A. B. Dove, Jr.E.I.C., Branch News Editor.

After missing a few years, the Students' Night was revived by the Hamilton Branch, with such encouraging results that it will likely be continued as an annual event.

The meeting was held in the Science Building, McMaster University, on Monday, December 9th, 1935, at 8.00 p.m. W. Hollingworth, M.E.I.C., chairman of the Branch, opened the proceedings with a welcome to the members and visitors, numbering about seventy-five. He outlined the arrangements that had been made so far in connection with The Institute Annual Meeting which is to be held in Hamilton next February. He also referred to the work done by W. J. W. Reid, A.M.E.I.C., in arranging the Students' Night and the gratifying response from the younger members of the Branch. Four Students had entered the competition and were that evening to give an oral presentation of their papers.

A Prize Committee had been appointed as follows:—L. W. Gill, M.E.I.C., Principal of the Hamilton Technical Institute (Chairman); A. R. Hannaford, A.M.E.I.C., city engineer's department; C. D. Meals, M.E.I.C., wire rope engineer, B. Greening Wire Co.; G. Moes, A.M.E.I.C., managing director, Hamilton Sterling Electric Co., and Professor Dawes, Professor of Physics, McMaster University.

Edward C. Hay, S.E.I.C., of the Canadian Westinghouse Co., Hamilton, gave a paper on "Selection Factors of Photo-Electric Cells."

Norman Tucker, S.E.I.C., of the Canadian Westinghouse Co., Hamilton, gave a paper on "Single Phase Fractional Horse Power Motors," explaining the characteristics of the different varieties.

H. F. McLachlin, S.E.I.C., of the Canadian Westinghouse Co., Hamilton, gave a paper on "Modern Electric Lighting."

Walford Preston, S.E.I.C., of the Steel Co. of Canada, Hamilton, gave a paper on "Why that kind of a Bridge?"

Questions were invited after the reading of each paper, such questions being answered by the authors. Mr. Gill spoke briefly, complimenting the speakers on their efforts, and assuring them that their work in this connection would prove very beneficial to them in later years.

The report of the Prize committee will be presented to the Branch in sufficient time to allow of the prizes being presented at the Branch annual meeting on January 14th, 1936.

Following the meeting, refreshments were provided.

We regret to announce that A. B. Dove, Jr.E.I.C., Branch News Editor, has been admitted to hospital in Toronto, but we are glad to state that he is progressing favourably.

Lakehead Branch

G. R. McLennan, A.M.E.I.C., Secretary-Treasurer.

The regular monthly meeting was held in the dining room of the Royal Edward hotel and after an enjoyable dinner the meeting was called to order by the chairman, R. J. Askin, A.M.E.I.C.

Business consisted of appointing a representative to the nominating committee. H. G. O'Leary, A.M.E.I.C., was appointed to act in that capacity.

"Real Estate and Its Relation to Engineering"

The speaker of the evening, Mr. G. R. Duncan, A.M.E.I.C., gave an interesting talk on real estate and its relation to engineering.

He enumerated the various factors that are of importance in the consideration of a site for an industry and stressed the fact that a knowledge of engineering aids the realtor to a great extent in making his choice of a site. Several instances of failures were cited, and it was shown that poor location was a large factor contributing to the cause of the failure. Among the items of importance in locating an industry are:—geographical location, proximity to coal water and raw material, railway connections, facilities for transportation by water, rail or truck, the nature of the ground whether hilly or flat, sandy or rocky, the consideration of the cost of site development, the cost of laying foundations, the nature of the water supply, the housing of employees, and hospital accommodation.

Mr. Duncan related several interesting experiences in business during the last twenty years or so.

A hearty vote of thanks was moved by F. C. Graham, A.M.E.I.C., and seconded by K. A. Dunphy, A.M.E.I.C.

The chairman stated that the next meeting would take the form of a dinner at the dining room of the Provincial Paper Mills followed by a tour of the plant.

Among those present at the meeting were Messrs Doncaster, Rogers Dunphy, Eriksen, O'Leary, Duncan, Graham, Fleming, Antonisen, Askin and McLennan.

Lethbridge Branch

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

The Lethbridge Branch, Engineering Institute of Canada, held its regular meeting in the Marquis hotel on Saturday, November 9th, 1935, commencing with a dinner at 6.30 p.m.

J. M. Campbell, A.M.E.I.C., occupied the chair and thirty members were present.

During the luncheon Mr. and Mrs. G. Brown's orchestra supplied delightful musical numbers. Community singing led by J. Haimes, A.M.E.I.C., and vocal solos by Mr. B. Stott added to the enjoyment of the evening.

Following a few minutes intermission, four reels of motion picture films kindly loaned by the Shawinigan Water and Power Company of Quebec were witnessed. The first reel showed how power was generated in the old days by using the water wheel from which has developed today the huge hydraulic turbines of the modern water power plant. Views of the various water falls on the Shawinigan and adjacent rivers utilized by the above company were shown. Interior and exterior views of the various power plants, including the first plant ever operated by the company, proved highly interesting. Transmission lines and towers, distributing stations, etc., were shown. The fourth reel was given over to a description of the various industrial plants operated by the Shawinigan Power Company including pulp and paper mills, carbide manufacturing, cotton and silk mills and others. J. T. Watson, A.M.E.I.C., made many interesting remarks concerning various phases of the subject and also answered questions during the discussion that ensued at the conclusion of the films.

Mr. Campbell thanked Mr. C. M. Watson for operating the projector and Mr. J. T. Watson for his helpful remarks. The Secretary was instructed to convey the thanks of the Branch to the Shawinigan Water and Power Company for the use of the films.

The meeting closed at 10.30 p.m. with the National Anthem.

LADIES' NIGHT

The Lethbridge Branch held its Annual Ladies Night in the Marquis hotel on Saturday, December 7th, 1935.

Fifty members and guests together with their wives and friends attended a dinner presided over by Chairman W. L. McKenzie, A.M.E.I.C. Delightful musical numbers were supplied by George Brown's Orchestra and community singing ably led by R. S. Lawrence was enjoyed.

Mrs. A. Wright rendered vocal solos, accompanied by Mrs. G. Brown. Mr. H. Baker violin solos, accompanied by Mr. R. Johnson, and Mr. R. Johnson piano solos.

Mr. McKenzie tendered the Committee and artists a very hearty vote of thanks, which was heartily endorsed by the members present.

Following a short intermission motion pictures were enjoyed; one reel entitled "Niagara" gave some beautiful views of the Falls from the air, land and water.

The second film depicted the fabrication of newspaper from forest to press.

Bridge was enjoyed on the mezzanine floor, the honours going to Mrs. J. M. Campbell and Mr. C. S. Donaldson.

Refreshments were served, bringing the evening to a successful close. Some 60 members and guests attended.

London Branch

S. G. Johre, A.M.E.I.C., Secretary-Treasurer.
J. R. Rostron, A.M.E.I.C., Branch News Editor.

The regular monthly meeting of the Branch was held on November 27th, 1935, in the board room of the Board of Education. The speaker of the evening was B. W. Grover of the engineering staff of the Public Utilities Commission, and his subject the "Science of Seeing" of "Better Light, Better Sight".

After the minutes had been read and passed, the chairman, S. W. Archibald, M.E.I.C., called upon E. V. Buchanan, M.E.I.C., to introduce the speaker. In doing this Mr. Buchanan made reference to the excessive strain placed upon the eyes by man, against the intended use of the eyes as designed by nature, as follows:—

Nature's Plan	*Man's Plan*
Distant vision	Near vision
Intermittent application	Continuous concentration
Day ending at sunset	Day ending at midnight
Abundant outdoor light	Insufficient indoor light

"THE SCIENCE OF SEEING"

Mr. Grover opened by giving a table which showed the ill effects produced by inadequate or glaring lighting, viz. headache, vertigo, blurring vision, digestive disturbances and others. These were caused by the greater expenditure of nervous energy required to combat the effect on the muscles of the eyes. These effects were summarized as follows: greater convergence, greater contraction of pupil produced by glare, continuous contraction of ciliary muscles for accommodation.

Our eyes are wearing out too soon as the following startling percentages show:—

Defective vision during school age.

Infants 3 per cent—Pre-school 7 per cent—Elementary School 9 per cent—High School 24 per cent—College 31 per cent.

Defective vision by ages:—

Under 20—23 per cent, Twenty to thirty 39 per cent, Thirty to forty 48 per cent, Forty to fifty 71 per cent, Fifty to sixty 82 per cent, over sixty 95 per cent.

There are four fundamental rules for proper illumination and hese are :—

Enough light; no harsh contrasts; no glare; and light where needed.

Illustrations were shown giving the proper way of arranging the light, the task and the eye so as to satisfy the above conditions. Also the contraction of the pupils of the eyes according to age and consequent extra illumination needed to counteract this, and a chart showing the increased production possible by proper illumination together with the relief or decreased neural and physical strain.

The colouring of the ceilings and walls of rooms is also important.

The speaker also stressed the point that although we can help defective vision by providing glasses, prevention was better than cure and by carefully studying the requirements of all rooms whether in home, school, office or factory and providing adequate illumination accordingly, future defective vision may be allayed.

Tables were shown giving the foot candle power required for various occupations and by using a "light meter" the amount of foot candle power that you are at present getting at the location of your task is clearly shown. This handy instrument was passed round for inspection.

A lively discussion followed the speakers remarks and largely centred around adequate lighting of the home versus artistic lighting, to the advantage of the former.

A hearty vote of thanks was accorded the speaker by the thirty members and guests present.

Montreal Branch

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

HOLLAND AND MID-TOWN HUDSON TUNNELS

On November 14th, Mr. A. C. Davis, superintendent of maintenance for the Port of New York Authority, gave an address on the engineering aspects of the Holland and Mid-Town Hudson Tunnels. Various phases were discussed such as ventilation, drainage, fire protection and operation. The speaker also explained in detail the design and construction of both tunnels. K. B. Thornton, M.E.I.C., was chairman.

ELECTRICITY AND MATTER

Dr. D. Keys, professor of physics, McGill University, on November 18th outlined recent discoveries about the nature of matter. The speaker stated that a knowledge of atoms and electrons and of the recently discovered positrons and neutrons has opened new fields of research and greatly modified former views of matter and electricity. H. J. Vennes, A.M.E.I.C., was in the chair.

STUDENT NIGHT

On November 21st papers were presented before the Montreal Branch by two members of the Junior Section one on the Design, Mixing and Placing of Concrete Mixtures, by C. A. Duranceau, and the other "Le Problème d'Electrification rurale dans la province de Québec", by Guy Belanger.

Mr. Duranceau's paper had reference to concrete mixtures used in the construction of the new Montreal postal terminal on St. Antoine Street, and Mr. Belanger discussed the present rural consumption of electricity, and considered the solution to be the development of the use of electricity on the farm other than for lighting. Mr. J. H. R. Gagnon acted as chairman.

Mr. C. W. N. Sexton, senior lecturer in civil engineering at the University of Melbourne, Australia, was present at this meeting and spoke briefly.

JUNIOR SECTION—PLANT VISIT

On November 15th, by the courtesy of Molson's Brewery Limited, over one hundred members of the Junior Section visited the company's plant on Notre Dame Street East. Those attending inspected the buildings and equipment including the power plant and also the production process.

NAVIGATION

On November 28th, 1935, Mr. Carl Bodensieck, R.N.V.R., presented an exceedingly interesting paper on the history of navigation from the early days down to the present time, including a description of modern aids to navigation. Ladies were invited to attend this meeting, and the Branch was pleased to welcome a considerable number. C. C. Lindsay, A.M.E.I.C., was in the chair.

JUNIOR SECTION

Dr. E. W. R. Steacie, assistant professor of chemistry at McGill University, addressed the Junior Section on December 2nd, his subject being "The Political Situation in Germany." Dr. Steacie has just returned from a year's study in Germany.

Moving pictures of recent developments in crib construction and methods of launching in the Port of Montreal were shown. These accompanied a talk on the construction of cribs by Mr. C. E. Frost. S. Sillitoe, S.E.I.C., was chairman.

THE INDUSTRIAL APPLICATION OF X-RAY

On December 5th, Mr. E. W. Page of the General Electric X-Ray Corporation, Chicago, spoke on "The Industrial Application of X-Ray." F. Newell, M.E.I.C., was in the chair. Prior to the meeting an informal dinner was held at the Windsor hotel.

JUNIOR SECTION

On December 16th, Messrs. Eric G. Adams, Jr.E.I.C., and René Laplante, A.M.E.I.C., presented papers before the Junior Section.

Mr. Adams' paper was on "Trends in Population and Trade Affecting Transportation," and Mr. Laplante's, "Le Commerce des Kilowatt Heures." Both of these papers were most interesting. The chairman was P. E. Savage, S.E.I.C.

The Suspension Bridge at Ile d'Orleans

P. L. Pratley, M.E.I.C., addressed the Branch on December 12th, his subject being "The Suspension Bridge at Ile d'Orleans." The talk dealt with the economics, design, fabrication and erection of the bridge, particularly with the problems involved in the anchorages, the cables, tower and floor. At the request of the membership the discussion of this paper was continued on December 18th. F. P. Shearwood, M.E.I.C., was in the chair.

Block Caving

On December 19th Mr. E. L. Rainboth, the superintendent of the King Mine at Thetford, gave a talk describing the interesting underground method of mining used in the asbestos district, known as the block caving system. This replaces the old open-pit method. The paper was illustrated with slides and motion pictures. Prior to the meeting an informal dinner was held at the Windsor hotel. G. G. Ommanney, M.E.I.C., was in the chair.

Niagara Peninsula

P. A. Dewey, A.M.E.I.C., Secretary-Treasurer.
C. G. Moon, A.M.E.I.C., Branch News Editor.
(Prepared by L. P. Rundle, M.E.I.C.)

A meeting was held at the plant of the North American Cyanamid Company on Wednesday, December 4th, 1935, to discuss various matters concerning co-ordinating the activities of the various Provincial Professional Engineers' Associations and The Engineering Institute of Canada. Early arrivals were conducted on an inspection trip through the plant.

The A.P.E.O. was represented by President J. Clarke Keith, A.M.E.I.C., of Windsor, Registrar R. B. Wosley and Councillors Arch. B. Crealock, M.E.I.C., S. R. Frost, R. Coombs and E. P. Muntz, M.E.I.C.

After some introductory remarks by Mr. Frost, Mr. Keith was introduced to the meeting and gave a brief outline of the history of the development of the A.P.E. in Canada, also of similar societies in the United States, and of the feeling in this country for closer co-operation between the A.P.E. and The Institute.

Mr. Crealock then gave a resumé of the work of the committee of eight and spoke of the difficulties under which this committee laboured due to being so scattered which caused a great deal of correspondence, etc.

Mr. Frost, as chairman of the meeting, led an interesting discussion which finally resulted in a resolution being put before the meeting that this meeting go on record as favouring consolidation of the engineering societies in Canada. Resolution carried.

Various other views and opinions were expressed for the benefit of the Councillors.

A discussion took place regarding the B.N.A. and the activities of the engineering bodies and especially in regard to penalties which seem to be purely a Provincial matter and outside the scope of a national body of engineers.

It was thought by most that the name of the A.P.E.O. was much too long.

At the close of the meeting, Mr. Keith thanked the assembly for the interest shown and for the various view points expressed, some of which would undoubtedly be of value to the Council.

A hearty vote of thanks was given to the North American Cyanamid Company for their courtesy and for the interesting trip through their plant, also for the excellent complimentary dinner at their plant lunch room.

Ottawa Branch

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

Splitting Hairs

At the first noon luncheon of the fall and winter season, held at the Chateau Laurier on November 14th, 1935, J. L. Rannie, M.E.I.C., chief of the triangulation division of the Geodetic Survey of Canada, spoke upon the subject of "Splitting Hairs." His address dealt in a popular manner with some of the problems and difficulties confronting the geodesists in their efforts to extend the geodetic survey throughout Canada.

Dr. R. W. Boyle, M.E.I.C., chairman of the Ottawa Branch, presided, and in addition head table guests included: Hon. T. Riggs, United States International Boundary Commissioner; Major Gen. A. G. L. McNaughton, M.E.I.C.; Hon. Charles Stewart; Group Captain E. W. Stedman, M.E.I.C.; J. M. Wardle, M.E.I.C., Deputy Minister of the Interior; R. A. Gibson, Assistant Deputy Minister, Department of the Interior; Noel J. Ogilvie, M.E.I.C., Director of the Geodetic Survey of Canada; C. M. Pitts, A.M.E.I.C.; L. L. Bolton, M.E.I.C.; Alan K. Hay, A.M.E.I.C.; F. H. Peters, M.E.I.C.; Elwood Wilson, M.E.I.C., and H. F. J. Lambart, A.M.E.I.C.

Geodetic surveyors as well as other people have their dreams, began Mr. Rannie, and sometimes these dreams come true. They are made to come true by the exercise of patience in prolonged research and extensive experimentation.

To the geodetic surveyor even the width of a hair has significance and sometimes, figuratively speaking, hairs have to be split. Methods of accomplishing this feat are, like everything else, subject to revision and improvement as scientific instrumental equipment is improved and perfected.

A decade ago the instruments used for angle measurement on geodetic field operations were cumbersome and slow to operate. They often weighed as much as 150 pounds and as a consequence were difficult to transport.

The surveyors in those days often tried to visualize an instrument that could be packed without discomfort and that would shorten the programme of observations to at least one-half the required time.

Ten years ago a Swiss engineer brought out an instrument that embodied radical features of lightness, saving over a hundred pounds in weight. This instrument also speeded up the time of observation and appeared to give results quite as accurate as those of the old-time design.

But the problem was not yet solved. Such instruments must be able to stand up under field conditions of service.

In co-operation with officers of the National Research Council an extensive programme of tests under both field and laboratory conditions was arranged. After a year's work definite features were brought to light that appeared to be responsible for the apparent deterioration in the results obtained by the instrument. The improvement of these features was the next step.

This course meant continued experimentation and trial; however, after repeated efforts satisfactory modifications were evolved which were applied to the design with conspicuous success. As a result of this effort it was now possible to use these instruments, which had so many desirable features, with perfect assurance as to the accuracy of the results.

At this point, Mr. Rannie quoted from a letter received from a large European instrument manufacturer that in the design of a new model of this instrument certain features resulting from the Canadian experiment and research would be incorporated.

Dinner Dance and Tribute to Hon. C. D. Howe, M.E.I.C.

An outstanding event of the winter season in professional circles at the Capital City was the dinner-dance on the evening of December 5th, 1935, at the Chateau Laurier in honour of the Honourable C. .D. Howe, M.E.I.C., newly appointed federal Minister of Railways and Canals and Minister of Marine. The event was an expression of satisfaction at the appointment of an engineer and member of The Institute to what might be termed an engineering portfolio in the Cabinet.

In addition to many local engineers and government officials, guests at the function included many from out of town. Dr. F. A. Gaby, M.E.I.C., president of The Institute, R. J. Durley, M.E.I.C., general secretary, with Mrs. Durley, and a number of others attended from Montreal; W. E. Bonn, M.E.I.C., chairman of the Toronto branch, with Mrs. Bonn, and others from that city were also present; as well as engineers and their wives from other outside points.

Upwards of four hundred guests were received by Mr. and Mrs. Howe, Dr. Gaby, Mrs. C. P. Edwards, wife of Commander C. P. Edwards, A.M.E.I.C., director of radio of the Marine Department and chairman of the Committee responsible for the function, and Dr. R. W. Boyle, M.E.I.C., chairman of the Ottawa Branch of The Institute. Dr. Boyle also presided at the dinner, while Dr. Gaby introduced the speaker and proposed the toast to the guests of honour, Hon. and Mrs. C. D. Howe.

Guests at the head table were Hon. and Mrs. C. D. Howe, Dr. F. A. Gaby, Mr. and Mrs. R. J. Durley, Mr. and Mrs. W. E. Bonn, Major-General A. G. L. McNaughton, M.E.I.C., president of the National Research Council; E. Hawken, president of the Harbour Commissioners, and Mrs. Hawken; J. M. Wardle, M.E.I.C., deputy minister of the Department of the Interior, and Mrs. Wardle; R. K. Smith, deputy minister of the Department of Marine, and Mrs. Smith; Charles Bland, chairman of the Civil Service Commission, and Mrs. Bland; Dr. Charles Camsell, M.E.I.C., deputy minister of the Department of Mines; Major J. G. Parmelee, deputy minister of the Department of Trade and Commerce; Commander and Mrs. C. P. Edwards; and Dr. R. W. Boyle, chairman.

The chairman expressed The Institute's gratification at the splendid turnout in honour of Mr. Howe who he stated had reached great success and was not yet half way in his career. The Institute's great pleasure at Mrs. Howe's presence was also indicated.

Dr. F. A. Gaby, president, in introducing the Minister, said how much Prime Minister Mackenzie King was to be congratulated on his choice of a cabinet member. Mr. Howe was a long-standing member of The Institute, and was now called upon to fill a responsible position. Let us tonight wish him every success.

The Honourable Mr. Howe stated that he was very glad that his first public address since he entered the Cabinet could be given to his former associates in the engineering profession. His one regret was that he had to sever all connection with the consulting engineering firm with which he had been associated for the past twenty years.

He then referred to the fact that during the previous administration the Honourable Grote Stirling, a member of the Institute, was appointed

Minister of National Defence and Fisheries. This latter was not generally recognized as an engineering portfolio so that he felt that his own case marked the first time in the history of the Dominion government when a professional engineer was made Minister in charge of an engineering department.

It might be worth while to examine why so many years should have elapsed without a Cabinet appointment of this type. Surely the appointment of an engineer to head an engineering portfolio seemed logical.

No doubt the fault lay principally with the engineering profession. Very few engineers were elected to Parliament and, in fact, very few offered themselves for election. Could this be put down to indifference on the part of the profession to matters political? Someone had said, "Let me make the songs of my country and I care not who makes its laws?" With the same fine disregard an engineer might say, "Let me construct the public works of my country and I care not who constructs its politics." He thought that the engineer took as great an interest in politics as any other profession or section of the community, and that the answer lay elsewhere. The real reason was that engineering work was wholly inconsistent with political partisanship. A lawyer might be a political partisan and his business might benefit. The same held true for a doctor. But when an engineer became a political partisan his livelihood was in jeopardy.

He hoped, nevertheless, that he might create a precedent and that when his services were finished he would be succeeded by another professional engineer. If the precedent could be continued it would necessarily serve as an inducement in the direction of more professional engineers entering public life.

The greater portion of Mr. Howe's address dealt with the work of the departments over which he had charge. He traced their history with particular reference to engineering aspects and also touched upon future possibilities in the matter of organization.

Public interest in this portion of the address was indicated by the fact that it was quoted at length not only in the local newspapers but also, through the medium of the Canadian Press, in a great many newspapers in all parts of Canada.

Peterborough Branch

W. T. Fanjoy, Jr.E.I.C., Secretary-Treasurer.
E. J. Davies, Jr.E.I.C., Branch News Editor.

Annual Banquet

The annual banquet was held on Tuesday, November 19th, 1935, at the Empress hotel, with a record attendance, under the chairmanship of A. L. Dickieson, M.E.I.C. Among the guests were the President of The Institute, Dr. F. A. Gaby, M.E.I.C., R. J. Durley, M.E.I.C., general secretary of The Institute, E. W. Bonn, M.E.I.C., chairman of the Toronto Branch.

The toast to The Institute and its branches was replied to by Mr. Durley and Mr. Bonn.

Dr. Gaby gave a brief talk on Institute affairs, in which he stated he believed our organization to be the envy of engineers throughout America. He then gave a very interesting talk on transportation in which he urged that the solution of the present-day transportation chaos is a recognition that each of the numerous modern modes of conveyance has its own field in the world of transportation. Outlining the problems which the railways are facing, he contended a serious present-day duplication of service by railroad, trucks and other carriers must be remedied.

Dr. Gaby predicted the motor bus which has come to the fore in recent years in transportation will never compete with electric traction where large population must be transported with rapidity and efficiency. Electrical traction is still supreme where conditions suitable to its application apply. He mentioned the New York and London subways, Metropolitan street car systems and numerous electrified railroad hauls.

It may be that the railways have gone about meeting the competition of motor traffic in the wrong manner, he said. A tendency has been to lengthen trains and increase loads rather than shorten trains and speed up service.

The great single factor in motor competition in the field of passengers has been the private passenger automobile rather than the motor bus. Railway passenger revenue in Canada has been cut from $75,000,000 in 1923 to $31,000,000 in 1934, the motor bus playing only a small part in the cut.

In certain areas railways have succeeded in recapturing as much as 75 per cent of the freight tonnage lost to trucks in recent years. This has been accomplished largely by institution of door-to-door service and a speeding up of schedules.

Radium Production

Mr. F. B. Friend, physicist at the Eldorado Gold Mines' Port Hope radium refinery, presented an outline of the story of radium production from the ore to the finished product.

Mr. Friend, with the aid of lantern-slide illustrations, described the source of the pitchblende from which radium is refined at Port Hope—the Eldorado Mine on the shore of Great Bear lake in the North West Territories. Of particular interest was his mention of the problems the company faces in mining the ore and bringing it out to civilization.

An average winter temperature of 45 degrees below zero prevails over a long period of the year at Great Bear lake which is over 1,000 miles north of Edmonton and the railway. However, machines capable of carrying two tons of ore or mine provisions and equipment are now in use making a connection with Edmonton in one day possible. While the original cost of air transportation was around $1.00 per pound, the company has now reduced the cost to about 10 cents a pound by use of its own machines.

Mr. Friend described the highly mechanical and chemical processes through which the pitchblende ore is put at the refinery in Port Hope, where out of each 40 tons of ore, about one gram of the required radium salts is secured. For every ton of ore, seven to eight tons of chemicals are required in the refining processes.

Through the courtesy of the publicity department of the Canadian General Electric Company, two reels of motion pictures illustrating the construction of the great tunnel through the Cascades in the State of Washington and telling the story of the adaption of electric power to ships, were shown.

Quebec Branch

Jules Joyal, A.M.E.I.C., Secretary-Treasurer.

Boulder Dam Transmission Line

Le 9 décembre 1935, la Section de Québec de l'Institut des Ingénieurs du Canada tenait, dans une salle du Château Frontenac, une réunion générale à laquelle assistaient plus de cinquante personnes.

Cette assemblée était sous la présidence de M. Alex. Larivière, M.E.I.C., président de notre section et le conférencier était M. O. W. Titus, Ingénieur-Electricien en Chef du Canada Wire and Cable Company, de Toronto.

Cette conférence fut l'une des plus intéressantes qu'il ait été donné à nos membres d'entendre, et le conférencier sut tenir son auditoire constamment en éveil tant par l'intérêt du sujet que par sa faculté d'élocution.

M. Titus nous a surtout parlé de la construction de la ligne de transmission entre Boulder Dam et Los Angeles, une distance de 271 milles, mais il nous fit voir le but du projet qui est de prévenir les inondations, emmagasiner de l'eau pour fins d'irrigation et d'alimentation domestique puis constituer un bassin de sedimentation; le projet comprend aussi la construction d'une usine génératrice qui pourra développer 1,800,000 chevaux-vapeur.

De nombreuses projections lumineuses, commentées par le conférencier, ont permis à l'auditoire de juger de l'ampleur du projet dans son ensemble.

Une des parties les plus intéressantes de cette causerie fut celle dans laquelle M. Titus expliqua le mode de fabrication du fil ou cable employé dans la construction de la ligne de transmission; ce fil est en cuivre, il est creux, son diamètre extérieur est de 1.4 pouces et il est constitué de segments embouvetés au moyen de machines qu'un film nous a permis de voir fonctionner.

M. R. B. McDunnough, A.M.E.I.C., fut invité à proposé un vote de remerciements au conférencier et sa proposition fut appuyée par les applaudissements de toute l'assistance.

Saguenay Branch

L. R. Beath, S.E.I.C., Secretary-Treasurer.

Bayer Process Plant

On Friday, November 9th, 1935, the Saguenay Branch met in Arvida to hear an interesting paper by A. I. Cunningham, A.M.E.I.C., on the design and construction of the reinforced concrete Bayer Process Plant of the Aluminum Company of Canada. The building houses precipitation tanks twenty-four feet in diameter and seventy feet high, each weighing approximately 3,000,000 pounds when full. In addition there are two smaller tanks.

Three types of foundation were considered:

(1) Individual piers; (2) Piling; (3) A reinforced concrete mat.

The building was to be erected on a clay to which a safe bearing value of four thousand pounds per square foot had been assigned. This value was therefore too low to permit the use of individual piers.

Piling was slightly cheaper than a concrete mat if earthquake forces were ignored but was impractical when these forces were considered.

The design finally chosen was a thick reinforced concrete mat built in twelve sections, each 32 by 33 feet. Each panel carried one large tank with the exception of one which bore the two small tanks and an elevator shaft.

The finished mat is 104 by 133 feet and four feet thick, containing 2,050 cubic yards of concrete and 240,000 pounds of steel. It was designed as an inverted floor of the beam and slab type, the bearing pressure of the soil being considered as a uniformly distributed load with the tank columns acting as supports. Each panel of this inverted floor consists of a slab supported by four beams, each beam being supported by two of the eight tank columns.

Plans of all the buildings and pictures of the various stages in their construction were shown. After some discussion on the paper and concrete work in general the thanks of the meeting to Mr. Cunningham was moved by S. J. Fisher, M.E.I.C., and the meeting adjourned.

Saskatchewan Branch

R. J. Fyfe, A.M.E.I.C., Secretary-Treasurer.

The Saskatchewan Branch met in regular session at the Hotel Champlain, Regina, on Friday, November 22nd, 1935, the meeting being preceded by a dinner at 6.15 p.m. at which the attendance was thirty-three.

C. J. McGavin, A.M.E.I.C., convenor, Papers and Library committee, announced that J. H. Lee Grayson would be the speaker at the December meeting, taking for his subject "Some of the Broader Aspects of the Italo-Ethiopia Situation." Mr. McGavin reported further that the January meeting would be addressed by Dr. Stapleford.

There being no further business, the chairman, A. P. Linton, M.E.I.C., introduced the speaker of the evening, M. H. Marshall, M.E.I.C. The subject of Mr. Marshall's address was "The Construction of the Hydro-Electric Power Plant at Island Falls, Saskatchewan." Mr. Marshall was the engineering representative of the Dominion government during the period of the construction of this plant.

After reviewing the details of construction of the dam and power house, the speaker showed a series of lantern slides depicting various features of the construction. This plant is located about one hundred miles north of the Flin Flon area thus the chief obstacle to be overcome was transportation, accomplished by the use of caterpillar tractor hauling trains of sleds during the winter. The train load per tractor varied from 70 to 120 tons. The address was provocative of an interested discussion following which a hearty vote of thanks was tended the speaker.

Regular Meeting

The regular monthly meeting of the Saskatchewan Branch was held in the Champlain hotel, Regina, on Friday evening, December 13th, 1935, being preceded by a dinner. The total attendance was 26.

C. J. McGavin, A.M.E.I.C., convenor of the Papers committee, reported that Dr. Stapleford would take as his subject for the meeting on January 24th, "The Contribution of Engineering to Civilization."

There being no further business the chairman, A. P. Linton, M.E.I.C., introduced the speaker of the evening, J. H. Lee-Grayson, the subject of his address being "The Broader Phases of the Italo-Ethiopian Situation."

The Italo-Ethiopian Situation

Introducing his subject, Mr. Lee-Grayson stated that the present controversy between Italy and Ethiopia is not merely one affecting these two countries alone, it is of far reaching importance in that it affects directly one of the main arteries of the British Empire and thereby affects the Empire itself.

Speaking of the development of the British Empire Mr. Lee-Grayson pointed out that, during the Tudor period, with England torn by internal dissensions and the treasury depleted, Henry VIII, a far sighted monarch, instituted the policy of developing trade and commerce. To this end he obtained control of the Channel Islands. Continuing this policy, strategic points, such as Gibraltar and Malta, were brought under the control of England; and later, with the development of the Red Sea route to India, England obtained control of Suez and Aden. Large sums of money were spent in the development of Egypt and British supremacy extended throughout Africa. In Ethiopia lies one of the sources of the Nile, while its eastern borders are in close proximity to the Red Sea. Thus the passing of control of Ethiopia to a first class power other than England would seriously embarrass England.

If Great Britain withdrew from the League it would collapse—thus the tendency to depend on her own power, which, coupled with a growing desire for closer relations with Germany, would materially alter the European situation.

Turning to Ethiopia itself the speaker pointed out that the African shore line east of Ethiopia is swampy while internal conditions, climatically and topographically, are appalling. The country is mountainous, water is scarce and the heat, for the greater part of the day, unbearable for those not accustomed to it. The natives, though black, are not negroes and are cunning and vicious fighters. Thus the war may not be all in Italy's favour. Should Italy be defeated it may have a marked effect on the supremacy of the white race in Africa.

It is being openly stated that Britain is using the League for her own ends, yet the latest proposals for peace, put forward by British representatives to the League, have been rejected by the League itself, this indicating non-domination of the League by Britain.

In concluding his address the speaker stated his faith in the ultimate solution of the controversy by the League of Nations, urging loyal support of its deliberations.

The address provoked an interested discussion, a hearty vote of thanks being tendered Mr. Lee-Grayson.

The meeting adjourned in due form at 9.00 p.m.

Victoria Branch

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

A general meeting of the Victoria Branch of The Institute was held at the Y.M.C.A., Victoria, B.C., on November 25th, 1935. Forty members and friends of the Branch were in attendance.

Nominations for the officers of the Branch for the year 1936 were called for.

Major J. C. MacDonald, M.E.I.C., chairman of the meeting, introduced C. E. Webb, M.E.I.C., district chief engineer, Dominion Water Power and Hydrometric Bureau, Vancouver, to the Branch, who delivered an exceedingly interesting and instructive address on the Columbia Basin Project in the State of Washington, U.S.A.

The Columbia Basin Project

Originally intended as an unemployment relief project for the North West, the United States Government, in 1933, appropriated $63,000,000, for the construction of a "low" dam at Grand Coulee, on the Columbia river. This dam was to have been utilized for power purposes only, but the decision to build a power dam at Bonneville, near Portland, on the Columbia river, caused a change of plans, and the project is now to be a "high" dam for irrigation and flood control involving two principal stages of construction. The present stage is merely the foundation for the ultimate "high" dam to be used for irrigation in the Columbia Basin.

Plans for the ultimate development include a concrete straight-gravity type dam about 550 feet in height above the lowest point foundation; with a crest length of about 4,200 feet. The power plant will be of 2,520,000 h.p. capacity and the irrigation system for 1,200,000 acres. The reservoir will be 150 miles in length and extend to the Canadian border.

Just over two years ago only the ferry man and his family lived at Grand Coulee. Today there are fifteen thousand people living on the banks of the Columbia. A permanent townsite is being developed by the U.S. Bureau of Reclamation on the left bank and on the right bank is Mason City, the contractor's temporary city, housing over three thousand employees.

The Grand Coulee dam when completed to its full size will be three times as big as Boulder dam now the largest concrete dam in the world. The combined project as now conceived consists of the dam across the Columbia river where it passes the northeasterly end of the Grand Coulee. A 1,890,000-kw. power plant in two power houses, a 20-unit pumping plant each pumping unit having a capacity of 800 second-feet when operating under a total head of 370 feet; a supply canal 1.7 miles in length; an earth and rock fill dam nearly 100 feet in height at each end of the Grand Coulee to form a regulating reservoir 24 miles in length with a useful capacity of 340,000 acre-feet. An 11-mile main canal leading out of the southwesterly end of the Grand Coulee having a capacity of 15,000 second-feet which divides into a main east and main west canal, 156 and 101 miles long respectively; a distribution and lateral system extending to each 160-acre farm; secondary power plants at feasible locations along the canals, and transmission lines; numerous motor-driven pumping plants for raising the water not exceeding 100 feet to various areas totalling 219,000 acres, and finally a drainage system to handle the seepage consequent to irrigation.

Following Mr. Webb's paper a large number of excellent slides were shown covering the progress of the undertaking up to the present stage of development where the pouring of concrete has recently started.

A hearty vote of thanks was extended the speaker for his most interesting address, after which a free and informal discussion of the project was entered into by many of those present.

Winnipeg Branch

J. F. Cunningham, A.M.E.I.C., Secretary-Treasurer.
H. L. Briggs, A.M.E.I.C., Branch News Editor.

Cross Connections Between Water Supply and Drainage Systems

On November 21st, 1935, the Winnipeg Branch was addressed by Mr. James Smith, chief plumbing inspector, City of Winnipeg, on the above subject.

Cross connections, whereby a water supply may become contaminated by sewage, have in the past been the cause of many serious epidemics of water-borne diseases, notably typhoid. The amoebic dysentery epidemic spread from Chicago in 1933 was finally traced to contamination of water supply through cross connections in the plumbing of two hotels, and was not due, as was first believed, to origination of the disease among the food handlers in these hotels. A large amount of residual chlorine was present in this water supply, which probably prevented a typhoid outbreak at the same time. Chlorine has little or no effect upon the amoebic dysentery organisms.

Cross connections are possible with many types of ordinary plumbing equipment and, strange as it may seem, hospital apparatus, unless special means are adopted to overcome the difficulty. Any fixture such as a bath or toilet which has the water enter at the side or bottom, is likely (if lacking special provision to the contrary) to allow the water or wastes therein to be sucked back into the water supply system if the tap to the fixture is open at the time the pressure goes off the water supply. Special methods must be adopted in connecting up swimming pools, milk can washers, tumbler washers, etc.

Dual water supplies, particularly if the second supply is from a polluted source, are to be frowned upon in this connection. Check valves or even double check valves are not the answer to securing a thorough separation of two such systems.

A large number of slides indicated remedies which had been provided for specific cases of cross connections.

The Old Fashioned Universe

W. T. Allison, Ph.D., Professor of English, University of Manitoba, addressed the December 5th meeting of the Branch.

Although Pythagoras (500 B.C.) ventured the idea that the world was round, it was almost 2000 years before the idea was again considered.

In ancient Greece, Plato and Virgil believed in the Piolemaic theory of a flat Earth, surrounded by a number of crystal spheres which were concentric with the Earth, the whole being suspended by a golden chain from the floor of Heaven. Below the Earth was Hades, whose bottom section was made up of dungeons and known as Tartarus. Above Tartarus, the river Lethe flowed, and above Lethe was Elysium, where the inhabitants reclined upon beds of flowers. They believed that the day would surely come when they would partake of the water of the river Lethe and come back to Earth reincarnated. A third section of Hades was the Acherusian lake, fed by the Styx and three other rivers; those who had sinned moderately while on Earth were dipped in the lake and purged of their sins.

In 1300 A.D., people such as Dante still believed in the crystal spheres surrounding the Earth, and that the devil on being cast out of Heaven had struck the Earth at Jesuralem so hard that on the under side there had been bulged out Mount Purgatory. In his 'Inferno,' Dante imagines that Virgil comes back to Earth to act as Dante's guide through the lower regions. They descend the hole made by the devil in his fall, and at the middle of the Earth the two of them somersault in order to change to an upright position to climb Mount Purgatory. At the top of Mount Purgatory is a restored Garden of Eden. From there, Dante continues onward through the the spheres, and is conducted by Beatrice through Paradise.

Plasticized Sulphur as a Road Building Material

Bituminous compounds and cement grout are usually used as filler materials in the construction of brick pavements. Although bituminous compounds seem to be preferred, they have a tendency to exude from the joints in hot weather and cause the pavement to become slippery. Investigations have been made to determine the type of jointing material most useful in the construction of brick pavements. The filler materials tested consisted of a bituminous material made from a semi-asphaltic base oil, a bituminous material made from an asphaltic base oil and plasticized sulphur. With this latter material compositions can be produced which range from hard materials having slight flexibility to very resilient and flexible products resembling rubber.

Plasticized sulphur is interesting because it combines the desirable property of low expansion coefficient with the ability to be deformed under pressure. Also the fluidity of plasticized sulphur at its application temperature which is about 300 degrees F., is much greater than that of heated asphalt. The width of the joints may therefore be reduced and the cost per square yard will be commensurate with that of asphalt filler despite the difference in the cost for equal volumes of the two materials.

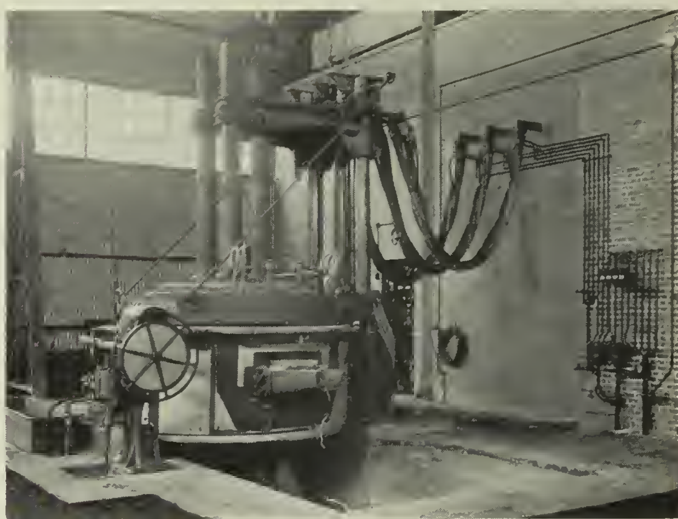
The interesting results obtained with plasticized sulphur warranted its application in the construction of a test brick road on the campus of Ohio State University. This road has been in service since last October and during this time has been subjected to severe cold weather. It was anticipated that the only objectionable feature of this material might be its brittleness at low temperatures. Such has not been the case and observations to date indicate that plasticized sulphur is satisfactory in all products.

The excellent results obtained in the use of plasticized sulphur as a bending agent for paving brick suggest its use as a jointing medium for sewer pipe, segmental tile and sewer brick. The ideal jointing material for these products should be waterproof, flexible, resilient, a good bending agent and easy to apply. Furthermore, it must approximate the chemical inertness of the clay product itself, and it must resist attack of hydrogen sulphide, sewage and soil water, and also be impenetrable to plant roots.

Copies of the full report of Rueckel and Duecker on this subject will be sent to interested specialists upon direct request to Mellon Institute of Industrial Research, Pittsburgh, Pa.

Canadian Patent Practice

A new Canadian Patent Act has recently come into force, and rules have been made under it. The time it has been working is too short to ascertain exactly what its effects will be, but some of the new points may be worth noting at this stage. At present, applications may be made in Canada within two years of the grant of a patent for the same invention in any other country, but after January 31st next, applications for filing in Canada must be lodged before the sealing of the first patent for the same invention in any other country. According to the new law, and contrary to general custom when new patent laws are being made, the duration of the Canadian patent has been shortened from eighteen years to seventeen years, but this is still one year longer than that of a British patent, which is sixteen years. The Canadian practice has followed the United States practice in reducing the twelve months previously allowed for replying to office actions, to a period of six months. One important new alteration is that the Commissioner, on payment of a fee, shall inform any person whether there is a Canadian application pending corresponding to any given patent granted elsewhere. Another addition refers to the working of patents in Canada, and in accordance with this, the Commissioner may require a patentee at any time to advise him whether the invention is being worked commercially in Canada, furnishing full particulars, or if not being worked, giving the reason why, failure to comply being deemed an admission that no commercial working has been made. As a result of this admission, or on other evidence, a compulsory licence may be granted by the Commissioner. The law requires that patents must be worked commercially in Canada within three years from the date of the grant. If not so worked—although there is a certain amount of latitude apparently possible in the sense that the working is to be adequate and reasonable in the circumstances of the case in question—the patent does not lapse, but becomes subject to the grant of a compulsory licence to anyone who may apply, on such terms as the Commissioner may think expedient, including a term precluding the licensee from importing into Canada any goods, the importation of which, if made by persons other than the patentee, would be an infringement. A licensee, under these provisions, is entitled to call upon the patentee to take proceedings to prevent infringement of the patent, and if the patentee refuses or neglects to do so, the licensee may institute proceedings in his own name, and make the patentee a defendant. The principle underlying the working conditions is practically the same as that underlying the Abuse of Monopoly rights under the British law, that is to say, there is an attempt to secure the widest possible user of the invention in Canada consistent with the patentee deriving a reasonable advantage from his patent rights. There are no provisions for amending a specification in Canada after the grant of a patent, such as can be done in England; United States practice is being followed, in that whenever a patent is deemed defective or inoperative, the patentee can apply for the re-issue of the patent, and surrender the original patent, but where it is merely a case of the claims being too broad, the defect can be cured by a disclaimer. There is also a provision on the re-issue of a patent that it may form a part continuation of the original patent, and date from the original grant. Something of the nature of interference proceedings between applications is provided, and the Commissioner is given power to re-examine conflicting applications, and determine the question of patentability in these circumstances. The provisions regarding assignments seem to be causing some difficulty, and an inventor likely to have resort to these will need to proceed with caution.—*Engineering.*



6-Ton Electric Steel Milling Furnace, at plant of Burlington Steel Company, Limited, Hamilton, Ontario.

Preliminary Notice

of Applications for Admission and for Transfer

December 26th, 1935

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

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

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

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

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

The Council will consider the applications herein described in February, 1936.

R. J. Durley, Secretary.

*The professional requirements are as follows.—

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

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

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

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

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

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

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

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

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

FOR ADMISSION

AITKEN—GEORGE GRIFFITHS, of Victoria, B.C., Born at Edinburgh, Scotland, April 16th, 1885; Educ., design and arch'ture, Royal Academy, Edinburgh, 1898-1900. Special Course, geodesy, etc., Univ. of Toronto, 1906. R.P.E. of B.C.; 1900-05, geogr'l, education and training, Geographical Institute, Edinburgh; 1905-06, geographical, general practice, New York; 1906-12, Geological Survey of Canada, geographical, incl. geologic, topographic compilation and map design; 1915-19, overseas, C.E.F. 1916-18, commanded 45th Btty., C.F.A. 1918 (Feb.-Nov.), organized and commanded special mobile Canadian Corps Section; 1912 to date (with exception of 1915-19), chief geographer, Govt. of British Columbia, Victoria, B.C.

References: E. A. Wheatley, J. Robertson, H. N. Macpherson, P. H. Buchan, A. S. Wootton.

ALEXANDER—GEORGE BURPEE, of Revelstoke, B.C., Born at Fredericton Jct., N.B., Jan. 12th, 1891; Educ. B.Sc., Univ. of N.B., 1914; R.P.E. of B.C.; 1914-19, overseas; 1919-20, rodman and dftsman, C.P.R.; 1920-22, instr'man., E.D. & B.C., and C.P.R., Edmonton; 1922-29, roadmaster and instr'man., C.P.R., Lethbridge; 1929 to date, divn. engr., C.P.R., Revelstoke, B.C.

References: F. W. Alexander, T. Lees, F. Lee, J. Robertson, E. A. Wheatley.

ANDERSON—CLIFFORD THOMAS, of 461 St. Patrick Square, Port Arthur, Ont., Born at Fairbank, Ont., Mar. 16th, 1907; Educ., B.A.Sc. (Civil), Univ. of Toronto, 1929; 1928 (May-Oct.), topog'l. survey and mapping of sections of townships, etc., for Union Natural Gas Co., Chatham, Ont.; With Abitibi Power & Paper Co. Ltd., Iroquois Falls, Ont., as follows: 1929-30, meter engr., 1931-32, testing supervisor, 1932-33, control accountant, 1933-35, testing supervisor; July 1935 to date, asst. to chief of control, Thunder Bay Paper Co. Ltd., Port Arthur, Ont.

References: R. J. Askin, H. G. O'Leary, P. E. Doncaster, T. R. Loudon, C. R. Young, P. W. Geldard.

ANGERS—ALEXANDRE, of Beauharnois, Que., Born at Quebec, Que., April 25th, 1910; Educ., private study; 1930 (May-June), field surveying party; 1930 (June-Dec.), helper in concrete testing lab., Beauharnois Constrn. Co.; 1930-33, asst. to engr. in charge of testing lab. and of concrete insprs.; 1934 (Jan.-Feb.), instr'man., private land surveying; 1934 (Feb.-Apr.), studies and tests on special types of flooring; Apr. 1934 to date, inspector of concrete in the field and testing concrete and aggregates in the lab., Beauharnois Light, Heat & Power Co., Beauharnois, Que.

References: L. H. Burpee, P. H. Morgan, J. P. Chapleau, M. V. Sauer, P. G. Gauthier, C. H. Pigot.

BOURGET—MAURICE, of 390 St. Joseph St., Lauzon, Que., Born at Lauzon, Que., Oct. 20th, 1907; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1932; 1927-28-29 (summers), dfting., Eastern Canada Steel, Quebec; 1930-31 (summers) and 1932-33, bridge design and constrn., and 1933 to date, asst. engr. for mtce. divn., Dept. Public Works of Quebec.

References: I. E. Vallee, J. G. O'Donnell, A. B. Normandin, O. Desjardins, J. Joyal, T. M. Dechene.

CHEVALIER—J. EMILE, of Quebec, Que., Born at Montreal, Mar. 3rd, 1901; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1928; 1924 (summer), chainman, 1925-26-27 (summers), instr'man., Quebec Streams Comm.; 1928 (May-Sept.), Northern Electric Co., Montreal, on police and fire alarm system; 1928-29, with Associated Engineers (Labrecque, Cailloux & Papineau), on municipal works, mainly road constrn.; 1929-30, constrn. and mtce. work, C.N.R., Levis; 1930 to date, asst. engr., bridge mtce. divn., Dept. Public Works Quebec.

References: I. E. Vallee, J. G. O'Donnell, L. C. Dupuis, A. B. Normandin, J. Joyal, A. Lariviere, H. Cimon, A. Frigon.

DEAN—CURTIS MILFORD, of Vancouver, B.C., Born at Victoria, B.C., Sept. 2nd, 1896; Educ., B.A.Sc., Univ. of B.C., 1923. R.P.E. of B.C.; 1913-14, articled land surveyor; 1920-23 (summers), survey work and timber cruising; 1923-24, operator in flotation mill, Britannia M. & S. Co.; 1924 to date, with Shell Oil Company as follows: 1924-25, lab. chemist (Martinez Refinery); 1925-26 (Martinez), application research; 1926-27, asst. distilling dept. (Martinez); 1927-28, plant chemist (Coalinga Refinery); 1928-29, 1st asst. distilling dept. (Martinez); 1930-31, head of distilling dept.; 1931-32, plant supervisor, Shell Chemical Co.; 1932 to date, mgr., Shellburn Refinery, Shell Oil Co. of B.C. Ltd., Vancouver.

References: E. A. Wheatley, J. Robertson, A. S. Wootton, P. H. Buchan, H. N. Macpherson.

deJONG—SYBREN HENRY, of Fort Garry P.O., Man., Born at East Kildonan, Man., Oct. 20th, 1908; Educ., B.Sc. (C.E.), Univ. of Man., 1931. Sessions 1931-32, 1932-33, 1934-35, demonstrator, Univ. of Manitoba; 1935 (Apr. to Sept.), office mgr. and dftsman., Fort Garry Motor Body & Paint Works, Ltd., Winnipeg; With Manitoba Good Roads as follows: 1927-28 (summers), rodman, 1929-30 (summers), instr'man., 1931 (summer), oil inspector, and 1935 (Sept.-Nov.), instr'man.

References: J. N. Finlayson, A. J. Taunton, G. M. Pearston, A. E. MacDonald, G. H. Herriot, R. W. McKinnon.

FROST—CLIFFORD EARL, of 554a Notre Dame St., Lachine, Que., Born at Danville, Que., Oct. 20th, 1908; Educ., B.Sc. (Civil), McGill Univ., 1931; With Bell Telephone Co. of Canada as follows: 1927-28 (summers), plant mtce.; 1929 (June), student engr.; 1929 (July-Dec.), engrg. asst. in charge of field party; Dec. 1929 to June 1930, engrg. asst. on cost studies for proposed toll cable; 1930 (June-Sept.), asst. to divn. toll and trans. engr.; 1931, student engr., and 1931 to date, asst. engr., Harbour Commissioners of Montreal, Montreal, Que.

References: A. Ferguson, J. P. Leclaire, G. R. Dalkin, J. M. M. Laforest, H. S. Spark, E. H. Brietzcke, E. R. Smallhorn.

JACQUES—ALFRED GEORGE, of Dolbeau, Que., Born at Montreal, April 23rd, 1896; Educ., B.Sc. (Chem.), McGill Univ., 1917; 1919-23, asst. chemist, Price Bros. & Co. Ltd., Kenogami, Que.; 1923-27, technical supt., and 1927-29, paper mill supt., Brompton Pulp & Paper Co., East Angus, Que.; 1929-34, gen. supt., International Power & Paper Co., Corner Brook, Nfld.; 1934-35, gen. supt., and 1935 to date, mill manager, Lake St. John Power & Paper Co. Ltd., Dolbeau, Que.

References: F. L. Lawton, S. J. Fisher, N. F. McCaghey, A. A. MacDiarmid, G. F. Layne.

McCONKEY—MATTHEW F., of Nipigon, Ont., Born at Priceville, Ont., Jan. 18th, 1901; Educ., Home study in maths.; 1918-19, rodman, 1919-21, topographer, 1921-22, leveller and transitman, H.E.P.C. of Ontario; 1922-23, location and field engr., trans. lines; 1923-24, field engr., grain elevator constrn.; 1924-25, field engr. and inspr., paper mill constrn.; 1925-26, field engr. and inspr., grain elevator constrn.; 1926-28, asst. plant engr., plant layout; 1928-29, field engr. and head inspr., grain elevator constrn.; 1934 to date, res. engr., highway constrn., Dept. of Northern Development, Nipigon, Ont.

References: T. F. Francis, J. G. R. Alison, C. D. Howe, A. E. MacDonald, F. C. Graham, J. N. Stanley, R. B. Chandler.

McKECHNIE—THOMAS SCOTT, of 2348 Wallace St., Regina, Sask., Born at Wolseley, Sask., July 4th, 1898; Educ., B.E., Univ. of Sask., 1923; 1921, rodman on survey party; 1922, 1923-24, 1926, instr'man., on highways surveys party; 1924-26, chief of survey party on subdivision work; 1927-28, transitman for Regina Divn., C.P.R.; 1928-32, dftsman., Imperial Oil Refinery; 1932 to date, asst. engr., Imperial Oil Refinery, Regina, Sask.

References: E. A. Duschak, H. R. MacKenzie, J. J. White, P. C. Perry, C. J. Mackenzie.

McMILLAN—HUGH, of White River, Ont., Born at Union Point, Man., March 15th, 1902; Educ., B.Sc. (C.E.), Univ. of Man., 1927; 1929 (June-Nov.) and Feb. 1931 to Feb. 1932, transitman, mtce., C.P.R., Winnipeg; Nov. 1929 to Feb. 1931, concrete dftsman., Northwestern Power Co., Winnipeg, Man.; With Dept. of Northern Development as follows: 1932-34, dftsman. and instr'man., Kenora, 1934-35, res. engr., Kenora, and at present, res. engr., White River, Ont.

References: E. A. Kelly, J. C. Holden, K. A. Dunphy, J. N. Finlayson.

POUDRIER—LOUIS PHILIPPE, of 56 Brown Ave., Quebec, Que., Born at Black Lake, Que., March 7th, 1903; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1928. 1929 (6 mos.), special course, Mass. Inst. Tech.; 1918-28 (summers), on misc. projects for Poudrier & Boulet Ltd., and 1929-31 with same firm, 1930-31, in charge of $150,000 project; 1931 to date, asst. engr., on bridge design and constrn., Dept. Public Works, Quebec.

References: I. E. Vallee, O. Desjardins, A. B. Normandin, J. G. O'Donnell, A. Frigon.

REID—JEAN MARIE, of 405 St. Cyrille St., Quebec, Que., Born at St. Jean, Que., May 1st, 1892; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1917; R.P.E. of Quebec; 1913-17 (summers), and 1917-18, with J. B. Reid, contractor; 1918 (4 mos.), with Standard Construction Co.; 1918 (3 mos.), with American Electric Products; 1919-20, Ste Agathe Lumber & Constrn. Co. (self in charge); 1920-31, with S. Ouimet, Consltg. Engr.; 1931 to date, res. engr. in charge of constrn. of misc bridges, for Dept. Public Works, Quebec.

References: I. E. Vallee, O. Desjardins, A. B. Normandin, H. Cimon, A. Lariviere, P. Methe, J. G. O'Donnell.

SKARIN—EMIL RICHARD TURE, of 11115-89th Ave., Edmonton, Alta., Born at Soderby, Lyckele, Sweden, Apr. 28th, 1882; Educ., B.Sc. (Civil), Univ. of Alta., 1918. R.P.E. of Alta.; 1897-1902 (intermittent), irrigation survey in Sweden; 1903-07, foundry and pattern work, Calgary Iron Works; 1911, erecting paving plant, Calgary; 1920, highway work in Montana, U.S.A.; 1922, road survey, Prov. of Alta.; 1923 to date, in charge of all mechanical equipment for Crown Paving & Constrn. Co. Ltd., and Alberta Concrete Products, and at present, President of both companies. Work included, 1927-29, designing of concrete plant and erecting same; 1931, designing and building plant for asphalt gravel road surface; 1932, designing concrete and steel paving plant; 1935, designing and erecting gravel washing plant.

References: C. E. Garnett, R. S. L. Wilson, J. Garrett, F. K. Beach, H. P. Keith, R. J. Gibb.

SMITH—ALLAN JAMES, of 2076 West 49th Ave., Vancouver, B.C., Born at Perth, Scotland, March 10th, 1890; Educ., M.E. and E.E., Ohio State Univ., 1923. M.A.Sc., Univ. of B.C., 1933; R.P.E. of B.C.; 1905-10, ap'ticeship, Harvard Engrg. Works, Glasgow, Scotland, concurrent with night training at Glasgow Technical College; 1910-13, hydro-electric engr. and mech. engr, (constrn. and operation), Powell River Pulp & Paper Co., Powell River, B.C.; 1913-16, mech'l. engr., Crow's Nest Pass Coal Co., Fernie, B.C.; 1916 (Mar.-Dec.), marine engr., Union Steamship Co., Vancouver, B.C.; 1916-20, with Belmont Surf Inlet Gold Mines Ltd., 1 year—constrn. engr. 300 ton mill, balance—mech'l. elect'l. engr.; 1920-23, consltg. engr., Columbus Rly. Power & Light Co., Columbus, Ohio, concurrent with attendance at Ohio State Univ.; 1923-26, chief engr. of system, for above company; 1926-30, Texas-Louisiana Power Co., Fort Worth, Texas, General Water Works & Electric Co., New York, and 18 subsidiaries. Gen. mgr. and chief engr., 3 years; vice-president and chief engr., 1 year; 1930-31, vice-president in charge of operations, General Management Corpn., New York; 1932-33, post-graduate work, Univ. of B.C.; 1933 to date, manager and chief engr., Windpass Gold Mining Co. Ltd., also consultant for Nicola Mines and Metal, Vancouver, and for City of Vancouver.

References: A. S. Gentles, J. Robertson, E. A. Wheatley, W. H. Powell, E. A. Cleveland.

WARD—FRANK NOEL, of Montreal, Que., Born at Ipswich, England, Dec. 25th, 1898; Educ., 1915-20, Ipswich School of Engrg.; Assoc. Member, Inst. M.E. (Great Britain), 1935; With Reavell & Co. Ltd., Ipswich, as follows: 1915-19, pupil, incl. periods spent in all shops and drawing office; 1919-21, dftsman. on design of air compressors; 1921-26, junior technical asst. to Mr. W. Reavell in engrg. dept.; 1926-30, promoted to second asst. to Mr. Reavell; 1930, proceeded to Canada to advise on technical problems in connection with compressor installations, and at present, vice-president and managing director of Reavell & Co. (Canada) Ltd., Montreal, Que.

References: J. L. Busfield, R. A. Yapp, M. J. Berlyn, A. R. Chadwick, J. T. Farmer, J. H. Maude, D. L. Stewart, H. J. A. Chambers.

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

ALLEN—ROBERT WILLIAM, of Regina, Sask., Born at Middlesborough, England, Apr. 8th, 1889; Educ., 2 years, Arch'l. course, and I.C.S. Civil Engrg.; 1908-12, rodman, 1912-14, instr'man. and dftsman., on waterworks and sewerage; 1914-19, dftsman. on municipal works, including bldg. design, pavements, sidewalks, sewers, sewage disposal works; 1919 to date, asst. city engr., City of Regina, Sask. (1929-30, acting chief engr.) (*Jr. 1918, A.M. 1922.*)

References: D. A. R. McCannel, A. P. Linton, L. A. Thornton, W. W. Perrie, P. C. Perry, J. J. White.

CAMERON—EVAN GUTHRIE, of 169 Ontario St., St. Catharines, Ont., Born at Strathroy, Ont., May 18th, 1886; Educ., Grad., R.M.C., 1906. 1906-07, civil engrg., McGill Univ.; 1904 (summer), rodman, Can. Niagara Power Co.; 1905 (summer), rodman, City of London; 1906, instr'man., Triangulation Survey, Militia Dept.; 1907-09, leveller and instr'man., 1909-11, res. engr., Section 1, Ontario-Rice Lake Divn., and 1911-14, divn. engr., Holland River Divn., Trent Canal; 1914-18, res. engr., Section No. 2, Welland Ship Canal; 1918-20, asst. chief engr., and 1920-24, chief engr., St. John Dry Dock & Shipbldg. Co., Saint John, N.B.; 1924 to date, principal asst. engr., Welland Ship Canal, continuing in that capacity with the Central Harbour Commission, Ottawa, Ont. (*St. 1906, A.M. 1911.*)

References: A. J. Grant, A. E. Dubuc, K. M. Cameron, A. Gray, F. P. Vaughan, M. B. Atkinson.

CONWAY—GILBERT STANLEY, of 1767 Marine Drive, West Vancouver, B.C., Born at Wetheral, Carlisle, England, Aug. 9th, 1886; Educ., Armstrong College, Newcastle-on-Tyne. R.P.E. of B.C.; 1903-06, pupil to firm of civil engrs.; 1906-08, in business as bldg. surveyor; 1909-11, dftsman and field dftsman. for various firms; 1911-13, res. engr., Esquimalt & Nanaimo Rly.; 1914-15, contractor's engr. and supt., reinforced concrete bridges, docks, etc.; 1915-16, constrn. engr., Northern Pacific, Chicago, Milwaukee; 1916-17, contractor's engr., heavy engrg. constrn., Victoria, B.C.; 1917-19, overseas Can. Engrs., Lieut.; 1919-20, res. engr., C.N.R.; 1920-26, logging engr. for major lumber corpns. in B.C., locating and constructing railroads and planning logging operations; 1926-30, consltg. logging engr., Vancouver. Investigations, reports, location and constrn.; 1930-31, res. constrn. engr., P.G.E. Rly.; 1931, contractor's engr., in charge of erection of bridges, Hamilton, Bermuda; Oct. 1931 to date, engr. in charge, British Pacific Properties Ltd , West Vancouver, B.C. Development project—roads—waterworks—paving, etc. (*A.M. 1920.*)

References: A. J. T. Taylor, J. Robertson, C. L. Bates, H. N. Macpherson, J. P. Mackenzie.

DUPUIS—PHILIPPE AUGUSTE, of Quebec, Que., Born at St. Roch des Aulnets, Que., Apr. 6th, 1896; Educ., B.A.Sc., Ecole Polytechnique, Montreal, 1921; R.P.E. of Quebec; 1921-29, engr., and 1929 to date, senior engr., Dept. of Public Works, Quebec. Also 1925 to date, consltg. engr. for The Maple Sugar Producers Assn. (*A.M. 1934.*)

References: I. E. Vallee, O. Desjardins, A. B. Normandin, H. Cimon, J. Joyal, J. G. O'Donnell.

FRAME—STANLEY HOWARD, of Victoria, B.C., Born at Gay's River, N.S., Jan. 30th, 1878; Educ., 1900-02, Dalhousie and McGill Univs.; R.P.E. of B.C.; 1903, rodman, pile driving inspection, coffer dams, etc., Chateauguay & Nor. Rly.; 1903-06, topog'r. and instr'man., 1906-13, res. engr. on rly. constrn., G.T.P.Rly.; 1913-16, asst. to city engr., Calgary; 1916-18, dist. hydrometric engr., Federal Dept. of the Interior; 1918-28, asst. engr., C.P.R., Dept. of Natural Resources, on eastern section of irrigation block; 1928 to date, hydraulic engr., Water Rights Br., Dept. of Lands, Prov. of B.C., Victoria, B.C. (*St. 1903, A.M. 1911.*)

References: J. C. MacDonald, H. B. Muckleston, S. G. Porter, A. Griffin, F. C. Green, J. S. Dennis, F. H. Peters, P. M. Sauder.

JOYAL—JULES, of Beauportville, Que., Born at St. Francois du Lac, Que., Oct. 6th 1894; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1920. R.P.E. of Quebec; 1916-19 (summers), with Quebec Streams Commn., rodman, chainman, instr'man.; 1920-22, various survey parties; 1922 (June-Dec.), divn. engr., road dept., Quebec; With Price Bros. & Co. Ltd., as follows; 1922-23, survey and storage dam constrn., 1923, Kenogami mill extension, 1923-31, asst. logging engr. in charge of surveys and river improvement constrn., including flumes, roads, dams, piers, booms, camps, telephone lines, saw mills, etc.; 1931 to date, engr., Quebec Public Service Commission, Quebec, Que. (*Jr. 1923, A.M. 1925.*)

References: J. B. D'Aeth, H. Cimon, P. E. Bourbonnais, G. E. Lamothe, A. A. MacDiarmid, E. A. Evans, A. Lariviere, J. A. Lefebvre.

KILBURN—DANIEL GEORGE, of Ottawa, Ont., Born at Stratford, Ont., May 6th, 1884; Educ., B.Sc., Queen's Univ., 1907; 1904-06, rodman, instr'man., concrete inspr., T. & N.O. Rly.; 1907-09, terminal engr., North Bay Rly. yards, res. engr., T. & N.O. Rly. & N.C. Rly.; 1909-12, terminal and res. engr., at Cochrane, for T. & N.O. Rly.; 1912-14, constlg. engr. to contractors, N.T. Rly. constrn.; 1914-15, inspecting engr., 1915-28, asst. engr., design, surveys and hydraulic work, Dept. of Railways and Canals; 1928 to date, divn. engr., head office, Board of Railway Commissioners for Canada, Ottawa, Ont. (*St. 1907, A.M. 1913.*)

References: T. L. Simmons, J. Murphy, E. L. Cousins, S. B. Clement, T. T. Irving, A. A. Smith.

MacKENZIE—HUGH ROSS, of 3220 Victoria Ave., Regina, Sask., Born at Scotsburn, N.S., Aug. 9th, 1885; Educ., B.A.Sc., Univ. of Toronto, 1913; With Dept. of Highways, Prov. of Sask. as follows: 1913-19, highway inspector, 1919-29, chief field engr., 1929 to date, chief engr., and at present acting Deputy Minister. (*A.M. 1916.*)

References: H. S. Carpenter, A. P. Linton, D. A. R. McCannel, L. A. Thornton, S. Young.

McGAVIN—CHARLES JAMES, of 25 Mayfair Apts., Regina, Sask., Born at Tiree, Argyleshire, Scotland, July 23rd, 1883; Educ., 1899-1905, West of Scotland Tech. Coll., Cert. 1905; 1899-1904, articled pupil, Messrs. Babtie & Bonn, Glasgow, Scotland. Design, constrn. and survey of various classes of municipal engrg.; 1904-05, asst. engr. to above firm; 1905-06, res. engr. Vale of Leven waterworks; 1907-08, locations surveys, C.N.R.; 1910-12, in charge of engrg. work including design, Harrison & Ponton, Surveyors and Engrs., Calgary; 1913, constrn. and design, Canada Cement Co.'s plant, in Alta. for Hunt Engrg. Co.; 1914, gen. engrg., City of Medicine Hat; 1915, Lethbridge Northern Irrigation survey; 1916-20, dist. engr., Dom. Hydrometric and Irrigation Surveys, Prov. of Alta. and Sask.; With the Dom. Govt. as follows: 1921-22, irrigation studies, 1924, special study for International Joint Commn , 1923, and 1925-31, supervision of irrigation dist., designing, laying out and constructing work, So. Sask.; 1931 to date, in charge of water administration for the Prov. of Sask, and at present, chief engr., Water Rights, Govt. of the Prov. of Sask. (*A.M. 1921.*)

References: M. H. Marshall, B. Russell, D. A. R. McCannel, P. C. Perry, S. R. Muirhead.

McKINNON—RODERICK WILL, of Winnipeg, Man., Born at Battleford, Sask., Nov. 25th, 1885; Educ., 1905-08, Dalhousie Univ.; 1908-10, asst. on location, 1910-12, location engr., C.N.R.; With Dept. of Public Works of the Prov. of Manitoba as follows: 1912-24, dist. engr., 1924-30, asst. chief engr., Reclamation Br., 1924-25, Commissioner, Northern Manitoba, 1930 to date, chief engr., Reclamation Branch. (*A.M. 1917.*)

References: W. P. Brereton, W. M. Scott, F. E. Seibert, G. E. Cole, E. V. Caton, J. N. Finlayson.

MUIRHEAD—STUART ROBERT, of 371 Leopold Crescent, Regina, Sask., Born at Chicago, Ill., May 6th, 1899; Educ., B.A.Sc., Univ. of Toronto, 1924; With Saskatchewan Govt. Telephones as follows: 1915-24, various capacities during summers and before and after overseas service—repair shop work, switchman on dial exchange, head switchman, etc.; 1924-27, equipment supervisor; 1927-28 (6 mos.), plant supt., in charge of all mtce. and constrn. work; 1928 to date, engr., responsible for preparation of specifications for all constrn. and installn. work for inside and outside plant; for material specifications; for specifications covering methods of doing work; in charge of repair shop. (*St. 1920, Jr. 1924, A.M. 1930.*)

References: H. S. Carpenter, H. R. MacKenzie, P. C. Perry, S. Young, A. P. Linton.

ORR—FREDERICK ORMOND, of Vancouver, B.C., Born at Omemee, Ont., March 16th, 1887; Educ., 1903-06, Queen's Univ., Diploma, Mining Eng., received 1914; R.P.E. of B.C., 1914-15, supt., Canadian Peat Co., Alfred, Ont.; 1915-16, private prospecting and development work at Haliburton; 1918-23, plant supt. in charge of constrn. and operation for Peat Committee, Dom. and Ont. Govts., works at Alfred, Ont.; 1923, development geologist, Resources Dept., C.P.R.; 1924-30, bldg. constrn., Vancouver, B C.; 1932, placer mining, Watson Bar Creek; 1933, testing placer ground, Barkerville dist.; 1933 to date, engr. in charge of Canadian Rand Gold Mines, also consltg. engr. and geologist. (*A.M. 1920.*)

References: E. A. Wheatley, J. Robertson, H. N. Macpherson, G. M. Gilbert, C. T. Hamilton.

PARHAM—JOHN BRIGHT, of 2474-23rd Ave. West, Vancouver, B.C., Born at Valleyfield, Que., Jan. 14th, 1882; Educ., B.Sc., McGill Univ , 1908; R.P.E. of B.C.; 1908-09, Intercolonial Rly., Moncton, N.B.; 1909-11, North Pacific Lbr. Co., Barnet, B.C. Prelim. and location surveys, dfting, designing, arranging machy. etc., during erection of sawmill; 1911-31, with Canadian Fairbanks Morse Co., Ltd., Vancouver, B.C. In full charge of elect'l and hydraulic dept., including all styles of pumping equipment and elect'l. apparatus. All engrg. in connection with equipment quoted and sold, also servicing after installn. Since leaving regular employ of company has done considerable engrg. work for them. At present in charge of business of C. W. Brockley & Co., during Mr. Brockley's absence in England. (*St. 1907, A.M. 1913.*)

References: J. N. Finlayson, E. A. Cleveland, W. H. Powell, A. C. R. Yuill, J. C. MacDonald, C. E. Webb, P. H. Buchan, T. E. Price.

PATTON—JOHN McDONALD, of 2324 Rose St., Regina, Sask., Born at Hamilton, Ont., Dec. 15th, 1886; Educ., B.A.Sc., Univ. of Toronto, 1911; 1912-13, supt., Waterworks Dept., City of Regina; 1913-15, chief engr., Saskatchewan Water Commission; 1916 to date, designing engr., bridge branch, Dept. of Highways, Govt. of Saskatchewan. (*A.M. 1917.*)
References: L. A. Thornton, H. S. Carpenter, A. P. Linton, D. A. R. McCannel, S. Young.

RITCHIE—HUGH CRICHTON, of Moose Jaw, Sask., Born at Elmvale, Ont., Apr. 25th, 1883; Educ., Grad., S.P.S., Univ. of Toronto, 1910; 1906-08, asst. engr. in Calgary; With Dom. Govt. as follows: 1908-11, hydrometric engr., 1911, constrn. engr. for Parks Br., 1911-18, irrigation and hydrometric engr.; 1918-21, in private practice; 1921-23, constrn., Alta. Govt. Telephones; 1924, Calgary Gas. Co.; 1925-27, asst. city engr., Calgary; 1927-30, city engr. and gas supt., City of Medicine Hat; 1930 to date, city engr. and commissioner, City of Moose Jaw, Sask. (*St. 1910, A.M. 1913.*)
References: A. P. Linton, H. S. Carpenter, D. A. R. McCannel, H. R. MacKenzie, C. J. Mackenzie.

SPRATT—MAYNARD JAMES CAMPBELL, of 2302 Elphinstone St., Regina, Sask., Born at Ottawa, Ont., Oct. 26th, 1899; Educ., B.Sc. (Civil), McGill Univ., 1922; 1922-23, preparing plans for terminal elevators, 1923-28, supervising constrn. of terminal elevators, at times acting for contractor, but mostly for owner, through consltg. engr., C. D. Howe, M.E.I.C.; 1928 to date, chief engr., for Saskatchewan Pool Elevators Ltd., designing and supervising constrn. of country elevators, also supervising mtce. of same. (*St. 1921, A.M. 1927.*)
References: C. D. Howe, R. B. Chandler, J. J. White, S. Young, D. A. R. McCannel.

WHITE—JOSEPH JAMES, of Regina, Sask., Born at Oldham, England, March 3rd, 1896; Educ., B.Sc. (C.E.), Univ. of Sask., 1925; 1912-15, gen. constrn. work with Frid Lewis Co.; 1915-19, overseas, C.E.F. and R.A.F.; 1920-23, dfting, designing and gen. constrn., Miners & Ball Ltd., Saskatoon; 1923-29, supt. of gen. constrn. work and design, with C. M. Miners Construction Co. Ltd., Saskatoon; 1929 to date, bldg. inspector, City of Regina. (*St. 1924, A.M. 1928.*)
References: C. J. Mackenzie, A. R. Greig, R. A. Spencer, A. P. Linton, R. W. Allen.

FOR TRANSFER FROM THE CLASS OF JUNIOR

AULD—WILLIAM FRASER, of Toronto, Ont., Born at Strathroy, Ont., April 20th, 1902; Educ., B.A.Sc., Univ. of Toronto, 1927. 1½ terms, elec. engrg., post-graduate course, Union College, Schenectady, N.Y.; 1927-29, test course, Gen. Elec. Co., Schenectady, N.Y.; With Can. Gen. Elec. Co. Ltd., Peterborough, as follows: 1929-30, induction motor design; 1930-31, direct current motor and generator design; 1931-33, asst. to D.C. Engr.; 1934 to date, elect'l. engr. and asst. to the president, Lincoln Electric Co. of Canada Ltd., Toronto, Ont. (*Jr. 1929.*)
References: B. L. Barns, B. Ottewell, V. S. Foster, R. L. Dobbin, R. E. Smythies.

BIELER—JACQUES LOUIS, of 643 Milton St., Montreal, Que., Born at Chexbres, Switzerland, Aug. 17th, 1901; Educ., B.Sc., McGill Univ., 1923; 1920 (summer), constrn., Can. Industries Ltd., Brownsburg; With Bailey Meter Co. as follows: Summer 1922, cadet engr., 1922-24, senior cadet engr., Cleveland. 1924, sales engr., Montreal, and 1925, research engr., Cleveland; 1925, charge of survey party, Gatineau Power Co.; 1926-28, sales engr., later chief engr., Industrial Combustion Engineers, London, England (Bailey Meter Licences); 1928 to date, engr. in charge of special machine design and machine layout, with part responsibility for gen. plant engrg., including constrn., Dominion Oilcloth & Linoleum Co. Ltd., Montreal, Que. (*St. 1920, Jr. 1928.*)
References: A. R. Roberts, L. de B. McCrady, R. F. Legget, C. K. McLeod.

BRYANT—JAMES SANBORN, of Drummondville, Que., Born at Montreal, Nov. 16th, 1900; Educ., B.Sc., McGill Univ., 1927; 1921-23 and 1924-25, installn. with Northern Electric Co.; 1927-28, elect'l. prospecting, in charge of field operations, Towagamac Exploration Co.; 1928 to date, junior engr., Southern Canada Power Co., Drummondville, Que. (*St. 1925, Jr. 1930.*)
References: J. S. H. Wurtele, J. H. Trimingham, J. F. Roberts, L. C. Jacobs, C. V. Christie.

DAVIES—EWART JOHN, of 620 George St., Peterborough, Ont., Born at Whitney, Ont., June 19th, 1898; Educ., B.Sc. (Mech.), N.S. Tech. Coll., 1923. Vocational specialist in dfting. and machine design, Ont. Dept. of Education, 1934; 1915-17, 1919, and 1920 (summer), machinist ap'tice, Dom. Coal Co.; 1921-22 (summers), mech. constrn. with same company; 1917-19, fitter and engine tester, R.A.F.; 1923 (6 mos.), dfting. and boiler erection, Babcock & Wilcox, Montreal; 1922-23, asst. instructor, Evening Technical Classes, Halifax; 1924-29, estimating, price adjusting, sales engr., Babcock-Wilcox & Goldie-McCulloch Ltd., Galt, Ont.; 1929 to date, instructor, mech'l. drawing and machine design, Peterborough Collegiate Vocational School, Peterborough, Ont. (*St. 1923, Jr. 1927.*)
References: R. L. Dobbin, A. B. Gates, E. R. Shirley, V. S. Foster, B. Ottewell.

DURLEY—THOMAS RICHARD, of Belleville, Ont., Born at Montreal, Aug. 7th, 1905; Educ., B.Sc. (E.E.), McGill Univ., 1928; 2 summers, installn. dept., Northern Electric Co., 1 summer, dfting, Dom. Bridge Co.; 1928-29, test dept., Gen. Elec. Co., Schenectady, N.Y.; 1929, switchboard engrg. dept., Can. Gen. Elec. Co., Peterborough; With the Canada Cement Co. as follows: 1929-31, in charge of elect'l. constrn., Plant No. 1, Montreal East; 1931-35, asst. supt., Plant No. 1, with exception of 4 mos. at Winnipeg plant during 1932. In charge of plant elect'l. dept. and general work. At present attached to mech'l. engrg. dept., in charge of installn. and erection of rotary cement kiln at Belleville, Ont. (*St. 1926, Jr. 1931.*)
References: F. B. Kilbourn, S. Barr, W. G. H. Cam, K. L. MacMillan, C. V. Christie, F. P. Shearwood, E. Darling.

ELEY—FREDERICK CHARLES, of 62B Summerhill Gardens, Toronto, Ont., Born at London, Ont., Nov. 15th, 1897; Educ., B.A.Sc., Univ. of Toronto, 1921; With Benjamin Electric Mfg. Co. of Canada Ltd., as follows: 1917 (summer), punch press operator; 1918-19, machine and bench work, etc.; 1920 (summer) stockkpr.; 1921-22, in cost dept.; 1922-29, in charge of engrg. design of all products, including switchboards; 1929-30, factory mgr., Benjamin Division, Amalgamated Electric Corpn. Ltd., Toronto, in charge of all phases of operation of this plant, including engrg. design of switchboards; 1930 to date, sales engr., Amalgamated Electric Corpn, Ltd., Toronto, in charge of illumination design and sales, and consultant to engrg. dept. on design of all products. (*St. 1921, Jr. 1926.*)
References: A. L. Birrell, F. R. Ewart, W. R. Bunting, D. M. Fraser, B. S. McKenzie, J. M. Walker.

EVANS—CHARLES DURWARD, of Montreal, Que., Born at Brownsburg. Que., Apr. 2nd, 1902; Educ., B.Sc. (Mech.), McGill Univ., 1924; 1921, tracing, Public Service Corpn., rodman, Walter J. Francis, Ltd.; 1922, rodman, Pringle & Sons, Montreal; 1924-25, asst. supt. of gas divn., Quebec Power Co.; 1925-26, private enterprise; 1926-29, dfting, designing and estimating, Fraser Brace Engrg. Co., Montreal, and 1929-30, constrn. of copper refinery at Copper Cliff, Ont., for same company; 1930-31, estimator, constrn. dept., Gypsum, Lime & Alabastine Canada Ltd.; 1931-35, salesman, and 1935 to date, sales mgr., Canadian Gypsum Co., Montreal (District—Quebec and Maritimes). Work engaged in embodies responsibility for gen. sales; gypsum products concerned with (*a*) as bldg. material, (*b*) industrial; specialized sales work concerned with (*a*) insulation of bldgs., (*b*) acoustical treatments of bldgs., (*c*) roof deck constrn. (*Jr. 1930.*)
References: T. W. W. Parker, J. B. D'Aeth, F. S. Keith, A. T. E. Smith, P. C. Kirkpatrick.

HAGERMAN—BERNARD HARRISON, of Fredericton, N.B., Born at Fredericton, Oct. 19th, 1901; Educ., B.Sc. (Civil), Univ. of N.B., 1923; 1919-23 (summers), with N.B. Highways Dept.; 1923-27, rodman and instr'man., engrg. dept., Illinois Central R.R.; 1927 (Feb.-Apr.), instr'man., Chesapeake & Ohio R.R.; 1927 to date, 3rd asst. bridge engr., bridge dept., Dept. of Public Works of New Brunswick, directly responsible for design and constrn. of various bridges. (*Jr. 1925.*)
References: E. O. Turner, J. Stephens, A. F. Baird, M. W. Black.

HAYES—ROLAND EARLE, of 267 Powell Ave., Ottawa, Ont., Born at Ottawa, May 21st, 1900; Educ., B.Sc., McGill Univ., 1924; 1921, instr'man., Geodetic Survey of Canada; 1922, Hollinger Gold Mines, Mining Summer School of McGill; 1923, Geological Survey in B.C.; 1919-20, dfting room, metallurgical lab. and sampling, British America Nickel Co.; One year after graduation, sales engr., Peacock Bros., Montreal; 1925 to date, with General Supply Co. of Canada Ltd., Ottawa. At present, manager, engrg. dept., Sales of technical equipment, design of filtration and water purification plants; waterworks plants, etc. (*Jr. 1928.*)
References: W. E. MacDonald, R. M. Prendergast, G. E. Booker.

PHILLIPS—EDWARD KENT, of Saskatoon, Sask., Born at Ottawa, Ont., July 31st, 1903; Educ., B.E., 1925, M.Sc., 1927, Univ. of Sask. D.L.S., S.L.S.; Summer work 1922-27, instr'man. in charge of field party, gen. land surveying; 1928-32, land surveyor, D. & S.L.S., gen. land survey practice as member of firm Phillips, Stewart & Phillips; 1934, gravel inspr., Sask. Govt., Dept. Highways; 1935, dftsman. and checker on bridge design, for C. J. Mackenzie, M.E.I.C.; 1925-27 (8 mos. sessions) demonstrator, and 1927 to date, lecturer in civil engrg., Univ. of Saskatchewan, Saskatoon. Also junior partner, Phillips, Stewart & Phillips, Land Surveyors and Munic. Engrs., Saskatoon, Sask. (*Jr. 1929.*)
References: C. J. Mackenzie, J. J. White, H. R. MacKenzie, R. A. Spencer, A. M. Macgillivray.

SHIELDS—STANLEY, of 582 Bolivar St., Peterborough, Ont., Born at Belfast, Ireland, Aug. 17th, 1899; Educ., B.A.Sc., Univ. of Toronto, 1924. 1918, R.A.F.; With Can. Gen. Elec. Co. Ltd., Peterborough, as follows: 1924-25, test course, 1925-29, designing engr., 1929 to date, supervisor winding and insulation. (*St. 1920, Jr. 1927.*)
References: W. E. Ross, A. B. Gates, B. L. Barns, R. L. Dobbin, B. Ottewell, V. S. Foster.

FOR TRANSFER FROM THE CLASS OF STUDENT

AKERLEY—WILLIAM BURPEE, of 8 Barker St., Saint John, N.B., Born at Saint John, Jan. 6th, 1907; Educ., B.Sc. (C.E.), Univ. of N.B., 1932; 1930 (summer), chainman, Erie R.R.; 1930-32, instructor of undergraduate engrs. on topographical survey of campus of Univ. of N.B.; 1934-35 (intermittently), asst. engr., mining, surveying and land surveying, Miramichi Lumber Co.; 1935 to date, instr'man., N.B. Public Works, Dept. of Highways. (*St. 1932.*)
References: E. O. Turner, J. Stephens, J. T. Turnbull, A. R. Crookshank.

BAUMAN—BERT ERIC, of Arvida, Que., Born at Arnprior, Ont., May 19th, 1906; Educ., B.Sc. (C.E.), McGill Univ., 1927; 1925-26, rodman and instr'man., Dept. Rlys. and Canals; 1927-29, instr'man. and dftsman., Aluminum Co. of Canada, Arvida, Que.; 1929 (Apr.-Dec.), dftsman., Laurentide Constrn. Co. of Montreal; 1930-32, asst. constrn. engr., Aluminum Co. of Canada, Arvida, and 1933, engr. on bituminous concrete paving work for Arvida, Que.; 1933-34, supt. on highway constrn., Prov. of Quebec, Arvida to Kenogami; 1934 (April), inventory work for Price Bros. & Co., Riverbend, Que.; 1934-35, dftsman., Duke-Price Power Co., Arvida; May 1935 to date, constrn. engr., Aluminum Co. of Canada, Arvida, Que. (*St. 1927.*)
References: H. R. Wake, A. W. Whitaker, Jr., A. I. Cunningham, M. G. Saunders, F. L. Lawton, N. F. McCaghey.

BENNETT—GEORGE FRANCIS, of Halifax, N.S., Born at Ottawa, Ont., Oct. 26th, 1907; Educ., B.Sc., McGill Univ., 1931; 1928-30 (summers), C.N.R. and topog'l. surveys; With the Canadian Westinghouse Co. Ltd., as follows: 1931-34, ap'tice course, 1934 to date, engrg., apparatus and merchandise sales, Halifax, N.S. (*St. 1929.*)
References: W. M. Bristol, C. V. Christie, H. Fellows, J. R. Kaye, P. A. Lovett.

GIRDWOOD—ARTHUR JAMES, of Peterborough, Ont., Born at North Bay, Ont., June 22nd, 1911; Educ., B.A.Sc., Univ. of Toronto, 1934; 1928-29, survey party; 1929-30 and 1934-35, test course, and at present on A.C. design, Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*St. 1931.*)
References: B. Ottewell, W. M. Cruthers, A. L. Dickieson, L. DeW. Magie.

HAY—EDWARD CAMPBELL, of 163 Jackson St. W., Hamilton, Ont., Born at Peebles, Scotland, Dec. 7th, 1906; Educ., B.A.Sc., Univ. of B.C., 1930; 1925-26, dfting., Can. Westinghouse Co. Ltd.; Summers, 1927-28, field asst., Dom. Geol. Survey; 1929, substation helper, B.C. Elec. Rly. Co.; 1930-31, student course, Westinghouse Electric & Mfg. Co. Ltd., East Pittsburgh; 1931-33, student course, and 1933 to date, sales correspondent, merchandise divn., Can. Westinghouse Co. Ltd., Hamilton, Ont. (*St. 1928.*)
References: D. W. Callander, W. F. McLaren, J. R. Dunbar, W. J. W. Reid, H. U. Hart.

LINGLEY—HAROLD PERCIVAL, of Saint John, N.B., Born at Saint John, Nov. 8th, 1906; Educ., B.Sc. (Civil), Univ. of N.B., 1930; Summer work—1925-27, topog'l. surveys; Prov. Pilot Officer, Camp Borden; 1929-30, dftsman., C.N.R., also 1930-31; 1931 to date, with Dom. Public Works Dept., Saint John, at present junior engr. (temp. appointment) in Saint John office. (*St. 1930.*)
References: E. O. Turner, J. Stephens, G. Stead, J. R. Freeman, A. R. Crookshank.

MARTIN—COLIN HECTOR, of Selkirk, Man., Born at Prince Albert, Sask., Oct. 25th, 1912; Educ., B.Sc. (C.E.), Univ. of Man., 1934; Summers: 1928-29, rodman, Man. Good Roads; 1930-34, hydrographic survey party on Lake Winnipeg, summer 1935, also acted as 1st asst.; Fall 1935, gravel inspr., Man. Good Roads Board. (*St. 1935.*)
References: J. N. Finlayson, E. P. Fetherstonhaugh, G. H. Herriot, A. E. MacDonald, N. M. Hall, J. L. Foreman.

McDOUGALL—JOHN FREDERICK, of Edmonton, Alta., Born at Edmonton, Nov. 16th, 1907; Educ., B.Sc., Univ. of Alta., 1930. M.Sc., McGill Univ., 1931; 1929 (summer), rodman on highway constrn., Alta. Dept. of Public Works; 1930-32 (19 mos.), instr'man. on location, constrn. and surfacing of main highways throughout the Prov. of Alta.; 1933 (July-Oct.), asst. engr. on gravel surfacing; 1933-34, instr'man. on highway location and constrn.; 1934-35, asst. engr. on location and constrn., and from April 1935 to date, engr. on location and constrn. of highways in Prov. of Alta., in charge of grading, gravelling, and hard surfacing. (*St. 1928.*)
References: W. J. Dick, R. S. L. Wilson, J. W. S. Chappelle, C. A. Robb, L. C. Charlesworth, E. W. Bowness.

PAINTER—GILBERT WALTER, of Peterborough, Ont., Born at Montreal, Que., Oct. 13th, 1909; Educ., B.Eng., McGill Univ., 1933; 1928-31, student engr., Bell Telephone Co. of Canada; 1933, survey with Shawinigan Engrg. Co.; 1934-35, test course, and at present, switchboard engrg. dept., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*St. 1933.*)
References: B. Ottewell, V. S. Foster, T. E. Gilchrist, A. B. Gates, A. L. Dickieson.

ROBERTSON—GORDON GERRARD DICKSON, of 205-2nd St. W., Calgary, Alta., Born at Winnipeg, Man., Dec. 30th, 1902; Educ., 1925-32 (not continuous) Univ. of Alta. 1 year to complete B.Sc. (Mining); 1918-19, Reclam. Service, Dept. Interior, topog. for irrigation; 1920-28, field and office work, Topog'l. Surveys, Dept. of the Interior; 1929, International Boundary Comm., Dept. Interior; 1930, asst. on subdivn., Topog'l. Surveys; 1934, D.N.D., Calgary Barracks site; 1935, Geol. Survey, Dept. of Mines, instr'man. (*St. 1928.*)

References: F. H. Peters, F. M. Steel, J. Dow, M. P. Bridgland, C. A. Robb.

SMITH—EUGENE LLOYD, of 9844-103rd St., Edmonton, Alta., Born at Wentworth, N.S., Dec. 17th, 1901; Educ., B.Sc (Chem.), Univ. of Alta., 1930. 1st Class Alta. Teacher's Cert. 1 year post-graduate in Physical Chemistry; 1926-27-28 (summers), asst. chemist, 1929-30-31 (summers), chief chemist, Marlboro Cement Co.; Aug. 1935 to date, chem. engr., City of Edmonton power plant, water purification dept. (*St. 1930.*)

References: R. S. L. Wilson, C. A. Robb, D. A. Hansen, A. Ritchie, H. R. Webb, W. E. Cornish.

STRATTON—WILLIAM DONALD GEORGE, of 28 Exmouth St., Saint John, N.B., Born at Saint John, Dec. 20th, 1906; Educ., B.Sc. (C.E.), Univ. of N.B., 1929; 1926 (summer), Dom. Topographic Survey; 1927-28 (summers), field and office work, instr'man., with Dept. of Highways of N.B.; 1929-33, engrg. dept., Bell Telephone Co., toll lines, field work, design, estimates, etc.; 1934-35, Dept. of Public Works of N.B., inspr. of drilling and dredging, Saint John Harbour main channel widening and deepening; At present, instr'man., Dept. of Highways of N.B., asphaltic concrete pavement contracts (field and office work). (*St. 1929.*)

References: J. Stephens, E. O. Turner, J. A. Loy, A. R. Crookshank, J. T. Turnbull.

TAPLEY—DONALD GORDON, of 489 King St., Peterborough, Ont., Born at Pointe du Chene, N.B., Aug. 7th, 1911; Educ., B.Sc. (E.E.), N.S. Tech. Coll., 1934; 1929-31, summer works including tracing, Halifax Harbour Commn., timekpr. and checker, grain elevator constrn., flying, aeronautics, shop work at R.A.C.F., Camp Borden; With Can. Gen. Elec. Co. Ltd., as follows: 1934-35, student tester, Peterborough; student engr., contract service dept., Toronto; and at present, student engr., switchboard dept., Peterborough. (*St. 1934.*)

References: W. P. Copp, E. R. Shirley, W. M. Cruthers, V. S. Foster.

THORN—RICHARD, of 11 Mackay St., Dartmouth, N.S., Born at Norwich, England, Dec. 3rd, 1905; Educ., Grad. (by exam.), Inst. M.E. (Great Britain), 1931; 1925-29, indentured ap'tice, Marshall Sons & Co. Ltd., Gainsborough, Lincs., England; 1929, dftsman., Can. Vickers, Ltd., Montreal; 1929-31, dftsman., Messrs. E. A. Ryan and F. A. Combe, Montreal; 1932-33, sales, Heating Equipment Co., Halifax; 1933-34, sales, F. S. Coombs & Co., Halifax; March 1934 to date, asst. meter engr., Imperial Oil Ltd., Imperoyal, N.S. (*St. 1930.*)

References: E. A. Ryan, F. A. Combe, R. L. Dunsmore, C. Scrymgeour, W. B. MacKay.

WALKER—ROBERT SAMUEL, of Kapuskasing, Ont., Born at Inglewood, Ont., Aug. 6th, 1900; B.Sc., Queen's Univ., 1930; 1927, surveyor, Toronto Harbour Commission; 1928, clerk on steel gang; 1929, designing and drawing plans for bleach sulphite plant at Athollville, N.B.; 1930-32, designing dftsman for Provincial Paper Ltd., Port Arthur, Ont., revised bleach plant, designed and engineered bldg. of two large groundwood storage tanks; 1932-33, designing engr., Filmer Ltd., a mining research syndicate. Complete charge of design of several special machines of experimental plant size; 1933 to date, designing engr., Spruce Falls Power & Paper Co. Ltd., Kapuskasing, Ont. (*St. 1929.*)

References: F. O. White, C. W. Boast, A. Macphail, W. L. Malcolm, L. T. Rutledge, W. P. Wilgar

---

Two Famous Instrument Makers

Among the branches of practical mechanics which made great progress during the eighteenth century, none has a more interesting history than that of instrument making. This was a sphere in which British mechanicians excelled, and it is worth recalling that both Smeaton and Watt began their life's work in the shops of London instrument makers and had they not turned their attention to engineering they might well have become famous as makers of telescopes. The spread of scientific investigation during the eighteenth century was constantly making demands on the constructors of philosophical apparatus, but it was the advance of navigation, practical astronomy, and geodesy which led to the improvements in sextants, telescopes, theodolites, and the rest. The instrument makers of London alone would make a goodly list, and observatories both at home and abroad owed much to the labours of such men as Abraham Sharp, George Graham, John Bird, James Short, Jesse Ramsden, and Edward Troughton.

The work of Ramsden and Troughton began more than a century and a half ago, and from it sprang a host of improvements of benefit to the whole art of instrument making. Ramsden was born in Halifax in 1735, while Troughton was born in 1753 at Coner, Cumberland. The one was the son of an innkeeper, the other the son of a farmer. From the shop of a cloth-worker at Halifax, Ramsden, in 1755—the year Watt entered the shop of Morgan in Finch-lane, in the City of London—found employment in London, and three years later bound himself to a maker of barometers and thermometers. By 1762 he was able to set up as an engraver, and in 1766 opened a shop in the Haymarket, whence he afterwards removed to Piccadilly. Attacking the same problem which had attracted Graham and Bird, he brought to perfection his dividing machine, and for this in 1777 the Board of Longitude awarded him £615. He had already taken out a patent for a new universal equatorial and made improvements in sextants, and during the last twenty years of his life he constructed some of the most famous surveying instruments ever made. The steel chain used by General Roy in 1784 for measuring a base line on Hounslow Heath was made by him, and at the Science Museum and the Royal Society are preserved the fine 3-foot theodolites with which the main angles in the Principal Triangulation of Great Britain were measured. These instruments were in constant use from 1792 to 1862. Of his astronomical instruments mention may be made of the 5-foot vertical circle with which Piazzi at Palermo made the observations for his Star Catalogue.

While Ramsden was busy in his shop in Piccadilly, Troughton entered the workshop of his brother John in London, and later on the two became partners as mechanicians. The death of John, two years afterwards, left Edward in sole charge of the business, which he carried on alone until over seventy years of age. He too turned his attention to the dividing of arcs of circles and was no unworthy successor to Ramsden. His most important astronomical instruments were made after Ramsden's death in 1800. Among these was the mural circle erected in Greenwich in 1812, which it has been said, "effected the greatest revolution in observing since the time of Bradley." Designed when Maskelyne was Astronomer Royal, it was used by both Pond and Airy, and is now preserved at Greenwich with other historical instruments.—*Engineering.*

Erratum

In the List of Members (November Journal page 551) the name of *Mr. E. M. Rensaa* (A.M. 1932) should have been followed by the notation *B.Sc.* (*Man. '33.*)

Air Hygiene Foundation of America Inc.

Air Hygiene Foundation of America Inc. has been formed by a large group representing various industries, with headquarters at Pittsburgh, Pa. The purposes of this organization are to conduct investigations of and to stimulate research on problems in the field of air hygiene and to gather and disseminate factual information relating thereto. It will also co-operate with and assist other agencies active in this field and will collaborate in the co-ordination of such research efforts. A comprehensive investigation has been begun at Mellon Institute of Industrial Research, Pittsburgh, under support of Air Hygiene Foundation of America, in which the hygienic, technologic and economic aspects of air contamination, especially by dust in the industries, will be studied.

The Tatsfield Air Disaster

Shortly before five o'clock in the evening of Tuesday, December 10th, a Belgian air liner flying from Brussels to Croydon crashed on a wooded hill near Tatsfield, Caterham, Surrey. All the passengers, numbering seven, and all the crew, numbering four, were killed. The weather at the time of the disaster was cold and it is stated that the machine was flying low as the result of the formation of ice on the wings. If this explanation of the disaster is substantiated, the accident will have to be added to a lengthening list of mishaps arising from the same cause. It should be noted that the actual weight of the ice which forms on the wings and other parts is quite small and is not in itself sufficient to overload the machine. The real explanation lies in the fact that the ice builds up on the leading edge of the wings giving that edge a new and highly inefficient aerodynamic profile. As a result, the lift of the wing is seriously reduced and its drag greatly increased. Ice also builds up on the front edge of the struts, stay wires, and other parts and, although its total weight is quite small, materially increases the resistance of those parts. Among the victims of the Tatsfield disaster we regret to have to include the name of Sir John Carde, a technical director of Vickers-Armstrongs, Ltd., and well known for his work on the Carden-Lloyd tractor and light tank.—*The Engineer.*

Agreement on common standards and specifications for hydrologic data arrived at among representatives of different government agencies and prominent hydrologists outside of government service is shown in a 45-page Report of recommendations of the National Resources Committee. The report was made by a Special Advisory Committee to the Water Resource Committee of the National Resources organization, and brings into agreement the viewpoints of the producer and the user of such data.

The Special Committee was appointed in April 1935 under the chairmanship of Thorndike Saville, Professor of Hydraulic and Sanitary Engineering and Associate Dean, New York University.

The recommendations relate chiefly to the minimum standards regarded as compatible with the reliability and accuracy necessary for safe and economic design. The publication insists that mere enunciation of standards is insufficient to insure satisfactory collection and publication of basic data, and that it can be developed only under the supervision of experienced technicians.

The recommendations range from specifications for personnel and terminology, through standards for collection and compilation of data on precipitation, snow surveys, surface waters, ground water, evaporation, quality of water, and suggestions with respect to special projects, to recommendations for procedure surveys under the Works Progress Administration.

EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada
2050 Mansfield Street, Montreal

Situations Vacant

MECHANICAL ENGINEER, graduate, 30 to 35 years of age with six to eight years practical experience including machine design, layouts and estimates in engineering or works office. Special knowledge of machine shop practice, routing of materials, time studies on machines, etc. Familiarity with routine repairs and maintenance of some type of industrial plant of fair size. Working knowledge of steam and electricity. Apply to Box No. 1235-V.

WANTED—Man fully experienced in the production of various types of brake linings for responsible position. Apply to Box No. 1242-V.

ELECTRICAL ENGINEER, capable of designing power transformers of all capacities and voltages. Applicants should state experience and qualifications, giving particulars of age, salary expected, etc. to Box No. 1245-V.

CONTROL ENGINEER, experienced in pulp and paper problems. Duties would include investigation of problems in connection with groundwood and sulphite pulps, etc. Apply giving full particulars of experience to Box No. 1253-V.

YOUNG MECHANICAL ENGINEER, capable of preparing layouts and familiar with details of mechanical equipment used in pulp and paper mills. Man with about five years experience preferred. Apply to Box No. 1255-V.

ENGINEER SALESMAN. A large oil company operating in the Maritime provinces requires a live wire engineer salesman not over thirty-five years of age, preferably a native or resident in the Maritimes. Must have personality and organizing ability. Work will consist of general sales work common to the oil industry, plus contact with certain industrial plants where thorough mechanical knowledge is necessary. Apply to Box No. 1257-V.

Situations Wanted

PURCHASING AGENT. Graduate mechanical engineer, Canadian, married, age 36, with fourteen years experience in industrial field, including design, construction and operation, eight years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on sale of surplus construction equipment. Full details on request. At present employed. Apply to Box No. 161-W.

SALES ENGINEER, E.E.I.C.; B.Sc. C.E., 1930 (Univ. N.B.), P.E.N.B. Age 28. Experience includes building inspection, structural detailing, road construction, and chemical operation. Interested in sales work on the sales staff of some manufacturing or wholesale concern. Apply to Box No. 225-W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power houee equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

ENGINEER AND ACCOUNTANT, Jr.E.I.C., (Capt. Can. Engrs., reserve). Age 35, Canadian. Experienced in mechanical and civil engineering, Diploma; general office, draughting and instrument work; assistant engineer erection Royal York hotel; assistant resident engineer T. & N.O. Ry. const. Desires position in Toronto where combination of technical and business experience will be of value, as have been director and accountant last three years. Apply to Box No. 377-W.

ENGINEER, A.M.E.I.C. Age 30. Single. Employed. Civil and mining experience, capable of designing and superintending construction of timber, concrete and steel structures, rock crushing and ore plants. Would consider position with mining or engineering company designing and building mills. Apply to Box No. 431-W.

Situations Wanted

CIVIL ENGINEER, B.A.Sc. and C.E.; A.M.E.I.C., A.M.A.S.C.E., age 32, married. Experience over twelve years as assistant and resident engineer on the construction of hydro-electric, railway, and aerodrome works. Also office and teaching work on hydraulic designs and investigations, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

MECHANICAL ENGINEER, B.Sc. Age 31. Married. Last ten yeare includes:—Mechanical structural and reinforced concrete design in pulp and paper mills, industrial plants, hydro-electric, mine, sewers and sewage disposal plant construction. My experience also includes shop production, steam plant combustion, fuel analysing, inspecting, supervising and instrument work on industrial construction. Permanent position preferred. Apply to Box No. 521-W.

CONSTRUCTION ENGINEER, age 26, unmarried, graduate C.E. Experience includes hydro-electric, railroad, highway, and industrial plant construction, both field and office, including cost accounting, estimating, stores, layout, general engineering and supervision, as well as practical work in mechanical trades. Apply to Box No. 567-W.

MECHANICAL ENGINEER, experienced in mechanical and structural design, and plant maintenance. Apply to Box No. 571-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aero-photographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

During the past month there have been a number of requests for engineers with pulp and paper mill experience. Designers, mechanical engineers, and draughtsmen, particularly.

IF YOU ARE INTERESTED—REGISTER

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

ELECTRICAL ENGINEER, McGill '31, desires permanent position in engineering field. Experience includes draughting, designing and testing of induction motors, radio supervision and test, and some construction. Available immediately. Apply to Box No. 626-W.

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office experience including general design and plant layout. Also two years general shop work including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer, estimator. Available on short notice. Apply to Box No. 676-W.

ELECTRICAL AND RADIO ENGINEER, B.Sc. '30. Variously engaged on receiver development work, testing, and transformer development, under direction. More recent experience includes transmitter test room procedure and short wave beam transmission engineering. For further information apply to Box No. 680-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

Situations Wanted

ELECTRICAL AND CIVIL ENGINEER, B.Sc., Elec., '29, B.Sc., Civil '33. Age 27. Jr.E.I.C. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.Sc., '27, Jr.E.I.C. Four years maintenance of high speed Diesel engine units, 200 to 1,300 h.p. Also maintenance of d.c. and a.c. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels Expert designer and draughtsman on modern steam power plants Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenanee, and concrete bridge designing. Nature of work and location immaterial Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.Sc (Univ of N.B '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No 728-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30 Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps Location immaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER, M.Sc., A.M.E.I.C., R.P.E (Ont.), ten years experience in municipal and highway engineering. Read, write and talk French Married. Served in France Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

RADIO AND ELECTRICAL ENGINEER, B.Sc '31, S.E.I.C. Age 27 Experience in installation of power and lighting equipment. Temporary operator in radio station; studio experience with part time announcing Two summers in switchboard and installation department of telephone company, eight months on extensive survey layouts. Interested in sales work of electrical or radio equipment. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, B.Sc. '29, A.M.E.I.C. Married. One year building construction. One year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

MANAFACTURERS' REPRESENTATIVE at present doing business with leading industrial organizations in Canada, wishes to represent manufacturers of mechanical equipment. Such work as would involve technical data, and the preparation of plans where necessary, would be handled by an engineer whose experience with outstanding firms and projects, would be valuable to those seeking representation. Apply to Box No. 764-W

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ. '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E.Q., married Desires position, preferably with construction firm Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No 781-W.

PLANT ENGINEER or SUPERINTENDENT, capable of supervising all phases of industrial plant operation, graduate electrical, eleven years diversified industrial experience including test course, four years on large Quebec industrial development, on construction and operation, also six years with prominent consulting firm supervising electrical and mechanical engineering projects. Age 31, single. Apply to Box No. 795-W.

Situations Wanted

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. '32 (Univ. of N.B.). Age 25. Married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.Sc. '32, E.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

SALES ENGINEER, A.M.E.I.C., graduate engineer, age 34, practical experience in the manufacture of power plant equipment, thoroughly conversant with Canadian power plant practice and equipment for the metal working industries. Available on short notice. Apply to Box No. 860-W.

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

AGENCIES WANTED. Young engineer, B.A.Sc. in C.E., with business and sales experiences, speaking fluent French, would consider representing a firm as agent for Montreal or the province of Quebec. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

CIVIL ENGINEER, B.Sc., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

Situations Wanted

CIVIL ENGINEER, B.Sc. (Univ. of Sask. '33), E.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, S.E.I.C., B.Sc., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No. 1010-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.Sc. (Queen's, '14), A.M.E.I.C., Dominion Land Surveyor, 5 months special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply to Box No. 1035-W.

ENGINEER, Jr.E.I.C., E.E. '29, is very interested in applying electrical methods to cement testing and research work. Apply to Box No. 1062-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.A.Sc. Univ. Toronto '28. Experience includes Can. Gen. Elec. Co. Test Course. Also more than two years in the engineering dept. of the same company. Available on short notice. Preferred location central or eastern Canada. Apply to Box No. 1075-W.

ELECTRICAL ENGINEER, B.Sc. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

CIVIL ENGINEER, B.Sc., Sask. '30. S.E.I.C. Age 24 years. Experience in municipal engineering, including sewer and water construction, sidewalk construction, paving, storm sewer design, draughting, precise levelling, and reinforced concrete bridge construction. Unmarried. Available at once. Will go anywhere. Apply to Box No. 1115-W.

ELECTRICAL ENGINEER, B.Sc.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

MECHANICAL ENGINEER, B.A.Sc. (Univ. of B.C. '29); M.S. Age 27. Single. Four years experience in research work in applied mechanics and materials testing. Desires position involving analytical work in design, development or testing. Available on short notice. Apply to Box No. 1023-W.

PETROLEUM CHEMIST, B.Sc. in Chem. Eng. Age 25. Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

ELECTRICAL ENGINEER, B.Sc., Queen's '33. Single, age 23. Anxious to gain experience. Present experience installing small private hydro-electric plant. Location immaterial. Available at once. Apply to Box No. 1137-W.

Situations Wanted

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

CIVIL ENGINEER, B.A.Sc., S.E.I.C., age 26, single. Experience includes one year in bridge construction, plain and reinforced concrete, pneumatic caissons and surveying. Available at once. Any location. Apply to Box No. 1204-W.

PHYSICIST ENGINEER, B.Sc.Mech. (Queen's 1913), M.Sc., Ph.D.Physics (McGill 1929, '30). Experience in municipal engineering, producer gas installation and operation, university plant maintenance. Experienced teacher of college physics. Industrial and pure physical research experience. Age 42. Married. Apply to Box No. 1207-W.

MECHANICAL ENGINEER, B.Sc. (Queen's Univ. '28), age 36, married, desires position of trust and responsibility. Experience includes fitting and assembly of machine tools, production, draughting, and maintenance. Five years teaching draughting and mathematics. Available on reasonable notice. Location immaterial. Apply to Box No. 1210-W.

CIVIL ENGINEER, B.A., B.A.Sc., S.E.I.C., Canadian, age 27, single. Experience includes eighteen months in general building construction. Writes and speaks both French and English fluently. Available at once for any suitable position in general engineering. Apply to Box No. 1211-W.

CIVIL ENGINEER, B.Sc. '34 (Univ. of N.B.), age 24. Experience includes construction and highway engineering. Desires position with contracting or manufacturing firm. Interested in design. References. Will consider any location. Apply to Box No. 1214-W.

ENGINEER, with twenty years experience in industrial, pulp and paper mill, and general engineering and design. Age 41. Last five years chief engineer of paper mill making newsprint specialties and toilet tissues. Apply to Box No. 1246-W.

ELECTRICAL ENGINEER, B.Sc. '34 (Univ. of N.B.), E.E.I.C. Age 21, single. Desires any kind of electrical work. Will consider any location. Apply to Box No. 1262-W.

CIVIL ENGINEER, Univ. Toronto '33, age 24, married. One year as instrumentman with provincial department of highways. Experience in concrete and retread construction grading, culverts, etc. Also draughting, estimating and general office practice. Apply to Box No. 1265-W.

ELECTRICAL GRADUATE, E.E.I.C., B.Sc. '32, M.Sc. '34. Experience includes four years as part time operator and announcer for a radio broadcast station. At present employed in radio repair dept. of a large wholesale firm. Apply to Box No. 1283-W.

ELECTRICAL ENGINEER, B.Sc., E.E., A.M.E.I.C. University of Manitoba '28. Age 32. Married. Experience one year power line construction, five years resident and assistant district engineer on highway construction; two years highway traffic regulation in charge of district office. Good connections in Manitoba and Saskatchewan. Excellent references. Available at once and will go anywhere. Located in Winnipeg. Apply to Box No. 1316-W.

ENGINEER AND DRAUGHTSMAN, Jr.E.I.C., age 33, married. Diplomas from Mtl Tech. Inst. in R.C. and Structural Design. 11½ years experience in civil engineering, draughting and instrument work. This includes 7 years with M.L.H. & P. Cons. as field engineer on construction and maintenance of gas mains. Present location Montreal. Available at once. Apply to Box No. 1326-W.

GRADUATE ENGINEER, (McGill), in responsible charge of design, construction and operation of hydro-electric plants. Also power design and mechanical maintenance of industrial plants. Apply to Box No. 1328-W.

MECHANICAL ENGINEER, recent grad. University of Toronto, B.A.Sc. in mech. engrg, 24 years old, S.E.I.C., now managing a chain store, desires engineering work. Present location So. Ontario. Location immaterial. Best of references. Apply to Box No. 1348-W.

CIVIL ENGINEER, A.M.E.I.C. Married. Age 38. Twenty years experience in organization, design and estimating, and cost accounting. Active service in France. Apply to Box No. 1367-W.

THE ENGINEERING JOURNAL

THE JOURNAL OF THE ENGINEERING INSTITUTE OF CANADA

Published monthly at 2050 Mansfield Street, Montreal, by The Engineering Institute of Canada, Incorporated in 1887 as The Canadian Society of Civil Engineers.

Entered at the Post Office, Montreal, as Second Class Matter.

"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."

February, 1936 Volume XIX, No. 2

CONTENTS

Price 50 cents a copy, $3.00 a year, in Canada, British Possessions, United States and Mexico. $4.50 a year in Foreign Countries.
To Members and Affiliates, 25 cents a copy, $2.00 a year.

Published Monthly at 2050 Mansfield St., Montreal

THE ENGINEERING INSTITUTE OF CANADA

Incorporated in 1887 as The Canadian Society of Civil Engineers

BRANCHES:

Halifax Branch, Halifax, N.S.
Cape Breton Branch, Sydney, Cape Breton.
Moncton, Branch, Moncton, N.B.
Saint John Branch, Saint John, N.B.
Saguenay Branch, Kenogami, Que.
Quebec Branch, Quebec, Que.
St. Maurice Valley Branch, Three Rivers, Que.
Montreal Branch, Montreal, Que.
Ottawa Branch, Ottawa, Ont.
Kingston Branch, Kingston, Ont.
Peterborough Branch, Peterborough, Ont.
Toronto Branch, Toronto, Ont.
Hamilton Branch, Hamilton, Ont.
Niagara Peninsula Branch, Niagara Falls, Ont.
London Branch, London, Ont.
Border Cities Branch, Windsor, Ont.
Sault Ste. Marie Branch, Sault Ste. Marie, Ont.
Lakehead Branch, Port Arthur, Ont.
Winnipeg Branch, Winnipeg, Man.
Saskatchewan Branch, Regina, Sask.
Lethbridge Branch, Lethbridge, Alta.
Edmonton Branch, Edmonton, Alta.
Calgary Branch, Calgary, Alta.
Vancouver Branch, Vancouver, B.C.
Victoria Branch, Victoria, B.C.

Members of Council 1935

PRESIDENT
F. A. GABY, Montreal, Que.

VICE-PRESIDENTS
†E. V. CATON, Winnipeg, Man.
†P. L. PRATLEY, Montreal, Que.
*E. G. CAMERON, St. Catharines, Ont.
*A. B. NORMANDIN, Quebec, Que.
*A. GRAY, Saint John, N.B.

PAST-PRESIDENTS
CHAS. CAMSELL, Ottawa, Ont.
O. O. LEFEBVRE, Montreal, Que.
F. P. SHEARWOOD, Montreal Que.

COUNCILLORS
†C. G. R. ARMSTRONG, Windsor, Ont.
†C. B. BROWN, Montreal, Que.
†G. H. BURBIDGE, Port Arthur, Ont.
*J. L. BUSFIELD, Montreal, Que.
*C. S. CLENDENING, Diamond City, Alta.
*H. CIMON, Quebec, Que.
†J. R. COCKBURN, Toronto, Ont.
†A. COUSINEAU, Montreal, Que.
‡A. B. CREALOCK, Toronto, Ont.
*H. J. CRUDGE, Moncton, N.B.
*R. L. DOBBIN, Peterborough, Ont.
‡A. FRIGON, Montreal, Que.
*F. G. GOODSPEED, Winnipeg, Man.
†L. F. GOODWIN, Kingston, Ont.
†B. GRANDMONT, Three Rivers, Que.
*C. S. L. HERTZBERG, Toronto, Ont.
*W. JACKSON, Niagara Falls, Ont.
†G. H. KIRBY, Riverbend, Que.
†H. S. JOHNSTON, Halifax, N.S.
*J. A. McCRORY, Montreal, Que.
*F. W. PAULIN, Hamilton, Ont.
*A. E. PICKERING, Sault Ste. Marie, Ont
*C. M. PITTS, Ottawa, Ont.
‡E. A. RYAN, Montreal, Que.
*C. M. SMYTH, Sydney, N.S.
†E. W. STEDMAN, Ottawa, Ont.
*F. M. STEEL, Calgary, Alta.
*H. L. SWAN, Victoria, B.C.
†J. A. VANCE, Woodstock, Ont.
†G. A. VANDERVOORT, Saint John, N.B.
†H. R. WEBB, Edmonton, Alta.
†A. S. WOOTTON, Vancouver, B.C.
†S. YOUNG, Regina, Sask.

*For 1935 †For 1935-36 ‡For 1935-36-37

TREASURER
J. B. CHALLIES, Montreal, Que.

SECRETARY
R. J. DURLEY, Montreal, Que.

OFFICERS OF BRANCHES

HALIFAX
Chairman, C. S. BENNETT
Vice-Chair., C. SCRYMGEOUR
Sec.-Treas., R. R. MURRAY, 87 Cambridge St., Halifax, N.S.
Executive, J. R. KAYE, I. P. MACNAB, J. D. FRASER, J. F. F. MACKENZIE, W. H. NOONAN, J. W. McLEOD, J. B. HAYES
(Ex-Officio) H. FELLOWS, H. S. JOHNSTON

CAPE BRETON
Chairman, W. E. BOWN
Sec.-Treas., SYDNEY C. MIFFLEN, 60 Whitney Ave., Sydney, N.S.
Executive, M. R. CHAPPELL, W. S. WILSON, C. M. ANSON, W. E. CLARKE
(Ex-Officio) C. M. SMYTH

SAINT JOHN
Chairman, V. S. CHESNUT
Vice-Chair., J. R. FREEMAN
Sec.-Treas., F. A. PATRIQUEN, 19 Horsfield St., Saint John, N.B.
Executive, S. HOGG, C. S. MACLEAN, G. H. THURBER
(Ex-Officio) E. J. OWENS, A. GRAY, G. A. VANDERVOORT

MONCTON
Chairman, H. B. TITUS
Vice-Chair., G. L. DICKSON
Sec.-Treas., V. C. BLACKETT, Engrg. Dept., C.N.R., Moncton, N.B.
Executive, F. O. CONDON, JAS. PULLAR, T. H. DICKSON, C. S. G. ROGERS, A. S. GUNN, G. C. TORRENS
(Ex-Officio) H. J. CRUDGE, J. G. MACKINNON

SAGUENAY
Chairman, J. SHANLY
Vice-Chair., S. J. FISHER
Sec.-Treas., L. R. BEATH, P.O. Box 211, Kenogami, Que.
Executive, W. L. YACK, E. LAVOIE, H. B. PELLETIER, M. G. SAUNDERS
(Ex-Officio) G. E. LAMOTHE, J. W. WARD, G. H. KIRBY

QUEBEC
Hon. Chair., A. R. DECARY
Chairman, ALEX. LARIVIERE
Vice-Chair., J. T. F. KING
Sec.-Treas., J. JOYAL, Quebec Public Service Comm., Court House, Quebec, Que.
Executive, R. B. McDUNNOUGH, L. P. METHE, L. BEAUDRY, A. G. SABOURIN, J. G. O'DONNELL, A. ROBERGE
(Ex-Officio) A. B. NORMANDIN, HECTOR CIMON

ST. MAURICE VALLEY
Chairman, B. GRANDMONT
Vice-Chair., J. E. FLEURY
Sec.-Treas., J. A. HAMEL, 642 Notre Dame St., Three Rivers, Que.
Executive, F. W. BRADSHAW, C. L. ARCAND, H. J. WARD

MONTREAL
Chairman, J. B. D'AETH
Vice-Chair., H. MASSUE
Sec.-Treas., C. K. McLEOD, 1440 St. Catherine St. W., Montreal, Que.
Executive, R. H. FINDLAY, C. C. LINDSAY, B. R. PERRY, T. C. THOMPSON, J. A. LALONDE, J. A. GOHIER
(Ex-Officio) F. S. B. HEWARD, A. COUSINEAU, C. B. BROWN, F. A. GABY, O. O. LEFEBVRE, P. L. PRATLEY, J. A. McCRORY, E. A. RYAN, J. L. BUSFIELD, F. P. SHEARWOOD, A. FRIGON

OTTAWA
Chairman, E. VIENS
Sec.-Treas., F. C. C. LYNCH, Dept. of Mines, Victoria Memorial Museum, Ottawa, Ont.
Executive, E. M. DENNIS, T. A. McELHANNEY, N. B. MACROSTIE, G. R. TURNER, B. F. HAANEL
(Ex-Officio) E. W. STEDMAN, C. M. PITTS, R. W. BOYLE, C. CAMSELL

PETERBOROUGH
Chairman, A. L. DICKIESON
Sec.-Treas., W. T. FANJOY, 223 Crescent St., Peterborough, Ont.
Executive, V. R. CURRIE, A. L. KILLALY, E. J. DAVIES, E. R. SHIRLEY
(Ex-Officio) J. W. PIERCE, H. R. SILLS, R. L. DOBBIN

KINGSTON
Chairman, R. A. LOW
Vice-Chair., Lt.-Col. N. C. SHERMAN
Sec.-Treas., Major L. F. GRANT, Royal Military College, Kingston, Ont.
Executive, G. G. CARR-HARRIS, S. STEPHENSON, J. E. GOODMAN
(Ex-Officio) W. CASEY, L. F. GOODWIN

TORONTO
Chairman, W. E. BONN
Vice-Chair., O. HOLDEN
Sec.-Treas., W. S. WILSON, Mining Bldg., University of Toronto, Toronto, Ont.
Executive, N MACNICOL, W. G. CHACE, A. M. REID, J. M OXLEY, C. E. SISSON, A. U. SANDERSON
(Ex-Officio) R. E. SMYTHE, A. B. CREALOCK, J. ROY COCKBURN, C. S. L. HERTZBERG

HAMILTON
Chairman, W. HOLLINGWORTH
Vice-Chair., E. G. MACKAY
Sec.-Treas., A. LOVE, 40 Paisley Ave. S., Hamilton, Ont.
Executive, W. J. W. REID, A. R. HANNAFORD, V. S. THOMPSON, D. W. CALLANDER
(Ex-Officio) F. W. PAULIN

LONDON
Chairman, S. W. ARCHIBALD
Vice-Chair., J. FERGUSON
Sec.-Treas., S. G. JOHRE, 153 Kent St., London, Ont.
Executive, V. A. McKILLIP, E. V. BUCHANAN, W. C. MILLER, H. A. BRAZIER, J. R. ROSTRON
(Ex-Officio) F. C. BALL, H. A. McKAY, J. A. VANCE

NIAGARA PENINSULA
Chairman, P. E. BUSS
Vice-Chair., G. H. WOOD
Sec.-Treas., P. A. DEWEY, 1224 Ontario Ave., Niagara Falls, Ont.
Executive, C. G. MOON, E. P. MURPHY, C. W. WEST, C. S. BOYD, S. HAIRSINE, J. H. JACKSON, J. C. STREET, L. C. McMURTRY, H. WELLWOOD
(Ex-Officio) E. G. CAMERON, W. JACKSON, W. R. MANOCK

BORDER CITIES
Chairman, T. H. JENKINS
Vice-Chair., C. F. DAVISON
Sec.-Treas., BOYD CANDLISH, 170 Rankin Blvd., Sandwich, Ont.
Executive, E. M. KREBSER, D. T. ALEXANDER, C. G. WALTON
(Ex-Officio) C. G. R. ARMSTRONG, H. J. COULTER

SAULT STE. MARIE
Chairman, J. L. LANG
Vice-Chair., H. F. BENNETT
Sec.-Treas., N. C. COWIE, 15 Hearst St., Sault Ste. Marie, Ont.
Executive, H. O. BROWN, C. W. HOLMAN, T. FOULKES, H. W. SUTCLIFFE
(Ex-Officio) E. A. PICKERING

LAKEHEAD
Chairman, R. J. ASKIN
Vice-Chair., F. C. GRAHAM
Sec.-Treas., G. R. McLENNAN, 80 High St., North, Port Arthur, Ont.
Executive, H. G. O'LEARY, K. A. DUNPHY, G. R. DUNCAN, G. ERICKSEN
(Ex-Officio) G. H. BURBIDGE, GEO. P. BROPHY

WINNIPEG
Chairman, F. V. SEIBERT
Vice-Chair., G. E. COLE
Sec.-Treas., J. F. CUNNINGHAM, 918 Somerset Ave., Fort Garry, Man.
Executive, A. CAMPBELL, H. L. BRIGGS, A. E. MACDONALD, R. W. McKINNON, WM. WALKDEN
(Ex-Officio) A. J. TAUNTON, F. G. GOODSPEED, E. W. M. JAMES, E. V. CATON

SASKATCHEWAN
Chairman, A. P. LINTON
Vice-Chair., W. E. LOVELL
Sec.-Treas., R. J. FYFE, 618 Broder Bldg., Regina, Sask.
Executive, J. W. D. FARRELL, W. E. LOVELL, H. S. CARPENTER, J. J. WHITE, S. R. MUIRHEAD, H. C. RITCHIE
(Ex-Officio) R. A. SPENCER, S. YOUNG

LETHBRIDGE
Chairman, W. L. McKENZIE
Vice-Chair., J. M. CAMPBELL
Sec.-Treas., E. A. LAWRENCE, 207-7th St. S., Lethbridge, Alta.
Executive, G. S. BROWN, R. F. P. BOWMAN, J. HAIMES
(Ex-Officio) C. S. CLENDENING, C. S. DONALDSON, J. B. DEHART

EDMONTON
Chairman, F. K. BEACH
Vice-Chair., E. STANSFIELD
Sec.-Treas., R. M. HARDY, University of Alberta, Edmonton, Alta.
Executive, C. E. GARNETT, A. J. GAYFER, R. J. GIBB, H. P. KEITH, C. A. ROBB
(Ex-Officio) H. R. WEBB

CALGARY
Chairman, J. HADDIN
Vice-Chair., J. DOW
Sec.-Treas., JAS. McMILLAN, Calgary Power Co. Ltd., Insurance Exchange Bldg., Calgary, Alta.
Executive, F. J. HEUPERMAN, H. W. TOOKER, J. R. WOOD
(Ex-Officio) G. P. F. BOESE, F. M. STEEL

VANCOUVER
Chairman, JAS. ROBERTSON
Vice-Chair., H. N. MACPHERSON
Sec.-Treas., G. M. GILBERT, 930 Birks Bldg., Vancouver, B.C.
Executive, C. T. HAMILTON, J. P. McKENZIE, P. SANDWELL, E. C. THRUPP, G. L. TOOKER, F. O. MILLS
(Ex-Officio) A. S. WOOTTON, P. H. BUCHAN, A. E. GORDON

VICTORIA
Chairman, I. C. BARLTROP
Vice-Chair., J. C. MACDONALD
Sec.-Treas., KENNETH REID, 1336 Carnsew St., Victoria, B.C.
Executive, G. M. DUNCAN, G. M. IRWIN, G. M. TRIPP, C. D. SCHULTZ
(Ex-Officio) D. MACBRIDE, H. L. SWAN

THE
ENGINEERING JOURNAL

The Institute as a body is not responsible either for the statements made or for the opinions expressed in the following pages.

Volume XIX | Montreal, February, 1936 | Number 2

The World's Airway System

J. A. Wilson, A.M.E.I.C.,
Controller of Civil Aviation, Civil Aviation Branch, Department of National Defence, Ottawa, Ontario.

Paper to be presented before the General Professional Meeting of The Engineering Institute of Canada, at Hamilton, Ontario, on February 6th and 7th, 1936.

SUMMARY.—Commencing with an historical review of the development of commercial aviation with heavier-than-air machines, and the necessary international control, the paper surveys the achievements of the principal European airway systems, their traffic and financial positions. British overseas air services to India, Australia and South Africa are described. The extent and organization of air traffic and the aids to air navigation in the United States are sketched. The course of events preparatory to a trans-Canada airway and trans-Atlantic communication is outlined, and attention is drawn to the self-sustained air services which have aided in the development of our northern areas.

History will mark the third decade of the twentieth century as a period of amazing progress in transportation. At its opening a journey round the world by the main centres of commerce and including London, New York, San Francisco, Hongkong, Singapore and Calcutta required about seventy days travel. In 1936 the same journey will be possible in fourteen days and before the close of the decade probably in ten.

The purpose of this paper is to give some account of the airway system which has made this revolution possible. It deals with transport by heavier-than-air types of aircraft, i.e., aeroplanes and seaplanes. The air commerce of the world is borne today on these and as yet lighter-than-air types play little part in it. The world's air services may be conveniently dealt with under three headings—European, British Commonwealth and United States. Canadian activities, being of special interest here, and having a somewhat different background, will receive more detailed attention.

A knowledge of the history of aviation is necessary to an understanding of its present position. The influence of two factors, neither of which played any part in the early development of the railway, steamship or automobile, has been abnormal and has disturbed the natural growth of aviation.

One factor is psychological, arising out of the conquest of a new element. Mankind had always travelled on the face of the earth and water and new inventions for doing so came gradually. Their adoption required little mental readjustment. Human flight, though throughout the ages the dream of the poet and scientist, was something entirely new. Even now, after a generation, it still inspires instinctive distrust and hesitation on the part of many, if not an actual majority, of mankind.

It is equally true that the "Conquest of the Air" fired the imagination and generated an enthusiasm on the part of aviation's pioneers which could not be gainsaid. By their devotion, courage and industry every obstacle has been surmounted and the success already achieved justifies their inspiration. It is none the less true, however, that aviation has suffered more from its enthusiasts than from its enemies. Many far too optimistic views have been broadcast of its potentialities. This undue optimism reacted unfavourably and has hindered, rather than helped progress. This phase is now passing and aviation has already taken its place as an essential part of the world's transportation system, administered by business men and operated by skilled staffs with a background of sound technical training and long experience.

The other factor was the conjunction of the Great War with the initial stages of rapid development in aviation. The war was, in fact, the cause of this rapid development and during the adolescence of the aeroplane military requirements alone ruled design and construction. Imagine what might have happened to automobile development had all design been concentrated for a number of years about the beginning of this century on the production of tanks and artillery tractors, or, if for a generation, from 1860, marine engineering had been confined to the production of destroyers and battleships. The effect of this stoppage of all development of civil aviation went even deeper, for, in the case of the automobile and the steamship, the roads and harbours necessary for their movement already existed, whereas in 1914 no airway systems for civil use had even been considered.

Development during the period between December, 1903, the date of the Wright Brothers' first successful power-driven flight, and the outbreak of war in August, 1914, falls naturally into two stages. In the early experimental years, when flying was the hobby of a few enthusiasts, aircraft and engines were unreliable and the technique of flight was being mastered. Funds were lacking for rapid development and the public sceptical that any practical result would be achieved.

On July 25th, 1909, Bleriot flew the English Channel. This flight marked the beginning of more rapid progress. Governments could no longer ignore the potentialities of flight and the fundamental changes it might bring; its influence in future warfare was manifest to the younger generation of military and naval officers and the public crowded to watch exhibitions of flying everywhere. Rapid progress followed, funds for development were forthcoming, and by 1914 aircraft had reached the stage when they were fairly stable in the air and could be used for observation purposes and limited transport. It is significant, in view of the events of the past few months, that in August, 1914, plans were well advanced for a transatlantic flight.

During the war, civil aviation ceased entirely. There was an immense development of military aviation and a constantly increasing demand for aircraft of higher speed and manœuvrability and greater carrying capacity. There was but little time for research, so that war time progress was more in the production of engines of greater horse power and larger aircraft than in any fundamental improvement in design.

After the armistice, the world found itself with thousands of aircraft and a great body of trained pilots and air engineers for whom absolutely no peace time outlet had been developed. Every nation realized the importance of maintaining its air power. It was impossible to maintain the war strength of the Air Forces and everywhere there was a search for civil work in aviation, not only on its own merits, but as a means of building up a reserve of national air power.

The only outlet in most countries was the carriage of passengers, mail and express between the main centres of population and industry and in Europe a feverish activity ensued in the establishment of such services. This growth was governed more by nationalistic aspirations than by traffic requirements or considerations of sound commercial operation.

Fortunately, at the Peace Conference, the representatives of the allied and associated powers had the vision to foresee the rapid development of air transport and to realize that chaos would result unless there was some agreement among the nations as to the principles which should govern international flying. A sub-committee of the Peace Conference was, therefore, established to study the subject and draft a convention which would provide a basis for development on common standards.

The International Convention for Air Navigation then agreed on lays down certain general principles. Under Article 1, it recognizes that every Power has complete and exclusive sovereignty over the air space above its territory, but under Article 2 accords freedom of innocent passage above its territory to the aircraft of the other contracting states. Under Article 3, each state may forbid its own private aircraft and those of other contracting states from flying over certain areas and under Article 16, each contracting state has the right to establish reservations and restrictions in favour of its national aircraft in connection with the carriage of persons and goods for hire between two points in its territory. The Convention further provides for the registration of all aircraft by contracting states under certain conditions, for their certification of airworthiness, for interstate flying and for the licensing of personnel and other details. It also creates, under Article 34, the International Commission for Air Navigation and defines the method of representation of the contracting parties on that Commission. The duties of the Commission are to receive or make proposals for the modification or amendment of the present Convention, for the interchange of information, for the definition of certificates of airworthiness, the conditions under which pilots' licences shall be issued and to collect and disseminate information of every kind relating to air navigation. Provision was later made under the Convention for member states to enter into agreements with non-member states covering international traffic by air, provided the terms of the original convention are not infringed.

Under this Convention and the International Agreements permitted between member and non-member states, a world-wide system of air lines has been gradually developed. In Europe practically every country has its national Air Service and the British, French, German, Italian, Belgian and Netherlands governments have been specially active. These national air transport companies compete strenuously for traffic and parallel each other's services on many airways. The activities of the International Air Traffic Association, which has been formed by the aircraft operating companies of the different countries for the advancement of their interests, have modified this competition to some extent and by agreements for the exchange of traffic, the issue of through tickets and co-operation in the compilation of time-tables, so as to give convenient connections between one line and another, better co-operation and a more efficient transport system have resulted. Political, strategic rivalry and economic nationalism have, of course, retarded the progress of aviation in Europe very materially. It is only recently that Imperial Airways, for instance, have been able to secure the right to fly across France and Italy on the way to the Far East and South Africa.

The European System

The European airway system only exists by reason of the generous subsidies paid the airway operators by their governments. The exact amount of the contributions made by the different governments is difficult to obtain. Much of it is camouflaged and no two governments pay on the same basis. The following figures, published by the Air Transport Co-operation Committee of the League of Nations, however, show approximately the position in 1933.

Country	Receipts from Customers	Official Subsidies	Financial Autonomy	Load factor* or Coefficient of Utilization
			per cent	per cent
Germany........	9,569,399	17,311,071 Reichmarks	35.4	
Austria..........	454,474	1,486,500 Schillings	23	46
Belgium.........	5,563,880	16,549,392 Belgian Frcs.	25.2	32
Finland..........	3,464,982	2,118,900 Finmarks	70	52
France...........	29,300,000	109,583,000 French Frcs.	21	53
Greece..........	7,076,354	14,752,667 Drachmas	32	70
Italy............	6,889,255	72,377,644 Lire	8.7	42.5
Netherlands.....	1,241,777	404,268 Florins	76	54.1
Poland..........	447,993	5,603,215 Zloty	7.4	40.4
Sweden.........	889,453	970,500 Kroners	48	70
Switzerland......	563,733	1,120,702 Swiss Francs	33	47
Czecho-Slovakia	2,415,819	13,860,000 C. Crowns	15	43

The same report, after a paragraph on Imperial Airways, in commenting on the financial position of the European airway system makes an interesting comparison between the Netherlands (K.L.M.) and the Italian systems:—

"Imperial Airways are possibly second to no other European line as regards economic working. It is, however, difficult, in the case of a concern whose main justification lies in Imperial communications, to see what advantage the European lines only have over the rest. Moreover, the British government does not supply separate figures for the revenue earned by each line of Imperial Airways.

"To get an idea, therefore, of the best achievements of air transport in Europe, the proper way is to analyse the returns of the Netherlands K.L.M. for its European network (omitting the Indies line, even as regards its Amsterdam-Athens-Cairo section).

"In 1933, for the whole of its European network, the

*Every aircraft is licensed by its Certificate of Airworthiness to carry a maximum weight which must not be exceeded in flight. The pay load of the aircraft is what is left after deducting from this maximum permissible weight the weight of the aircraft, complete with engines, fittings, etc., crew, fuel and oil. The "co-efficient of utilization" or "load factor" is the ratio between this pay load and the amount of cargo actually carried.

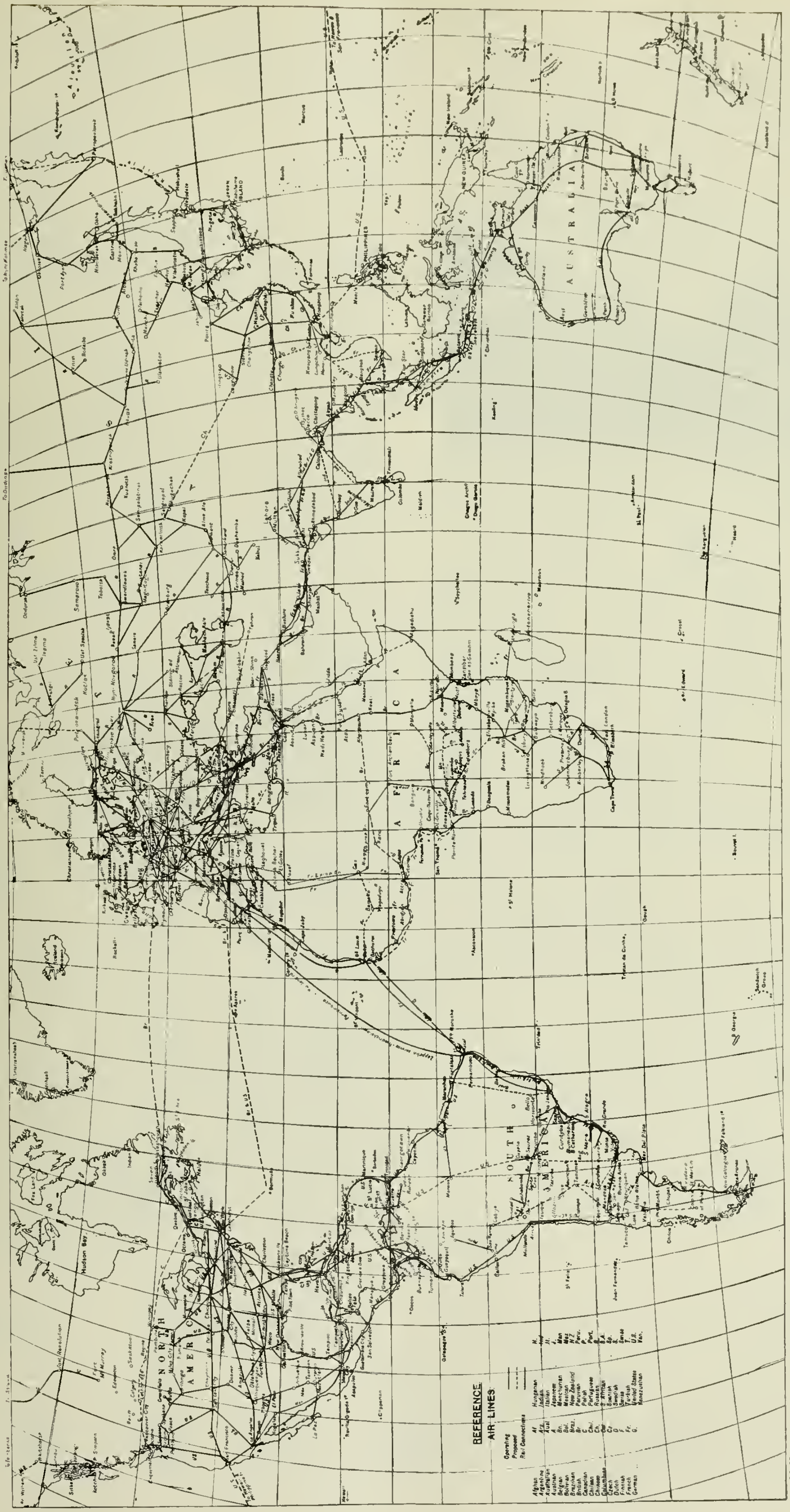


Fig. 1—Principal Air Routes of the World, 1934.

K.L.M. received a subsidy of 404,268 florins. At the same time it earned:

825,182 florins in passenger revenue
305,406 florins in goods revenue
35,309 florins in luggage charges
75,880 florins in mail charges

or 1,241,777 florins total revenue.

Fig. 2—Douglas Monoplane, used by American Services, K.L.M. in Europe and on East Indies Service. Two 720-h.p. motors. Pay-load 2,555 pounds. Max. speed 213 m.p.h.

"The revenue from traffic therefore amounted to 13 million francs, as compared with 4,100,000 francs government subsidy. The financial autonomy of the line was therefore 76 per cent, and the company is only 24 per cent away from its assumed goal—economic independence.

"This splendid result is mainly due to the comparatively small size of the system served; to the fortunate position occupied by the Netherlands, at the intersection of the most important trade routes for the whole of northern and north-western Europe, which is economically the most active; and to the proportion maintained between the resources employed and the results that can be expected. Additional advantages are the Free Trade system traditional in the Netherlands, and the determination of those in control of the company to have the requisite machines built or purchased, at the proper time and in the proper place.

"In spite of the difficulties of 1934, the K.L.M. would appear to have even bettered during that year the results of 1933. According to press statements, traffic receipts for the whole system covered 82 per cent of total expenses; what is certain is that the traffic figures show a fresh and very striking increase.

"Taking the question from the standpoint of financial return, commercial air lines such as those in Italy seem to be badly handicapped as compared with the K.L.M. As there can be no question of the quality of the personnel and machines, and as such widely different results must be primarily attributed to insuperable differences in economic geography, the author has no hesitation in pointing to the following facts. In 1933, the Italian air services — all covering the territory dealt with in my report — produced 4,360,000 ton-kilometres (or 40 per cent more than the K.L.M.), 1,880,000 of which were utilized. Yet, the Italian revenue from customers does not exceed 9,000,000 francs, as compared with 94,000,000 francs in subsidies. The following table shows the comparison between the two national concerns:

	Per ton-kilometre carried	
	Receipts from customers Francs	Government subsidy Francs
Netherlands	9.60	3.00
Italy	4.75	50.00

"Thus, for each ton-kilometre carried, the Italian lines require receipts totalling 54.75 francs, whereas the K.L.M. can manage with 12.60 francs. This striking difference is only to a small extent due to the utilization of the tonnage afforded (54 per cent by the K.L.M., 43 per cent by the Italian lines). It is due more to the difference in the rates actually charged: the K.L.M. earns twice as much on every ton-kilometre. Finally, it may be suspected that the machines operated on the Italian lines are expensive to run, and that a great proportion of the ton-kilometres carried pays no, or merely nominal charges. In these circumstances, if transport is the real objective of commercial aviation in Europe, it will be seen that the Italian government pays seventeen times as much as the Netherlands government per unit of actual transport."

The author, Mr. Henri Bouché, concludes his report as follows:—"The European network is still waiting, however, for the most valuable gift that it could receive: a doctrine of collective action calculated on a European scale to meet European needs, and based on strictly economic lines."

A glance at the map showing the European airway systems shows the multiplication of national services, the inevitable result of post-war rivalries and fears. However unsound the economics of the position, from the users' point of view, travel by air is safe, convenient and relatively cheap and the growth of the traffic indicates that air travel and transport has come to stay.

Particulars of five great European systems may be of interest:—

Germany

Germany was prohibited by the terms of peace from maintaining an Air Force. Her whole energy was, therefore, released and devoted to the building up of an internal civil airway system which soon served every considerable town and city in the Reich and spread far afield, till today it operates services to Amsterdam and London; Paris, Marseilles and Barcelona; Copenhagen, Gothenburg and Oslo; Tilsit, Riga and Leningrad; Kovno and Moscow; Vienna, Budapest, Belgrade, Sofia and Salonica; Venice and Rome. Further, the German airway extends to South America via Seville and Bathurst, thence by seaplane and mothership across the South Atlantic to Brazil. On this service the seaplane lands beside the mothership in mid-Atlantic and is hoisted on board, refuelled and launched by catapult to continue its flight.

This method of overcoming the long ocean passage is unique. It has worked successfully for three years now and rumour has it that it may be used to make possible

Traffic Returns German Regular Air Services

Year	Route Mileage	Miles Flown	Passengers		Mail (Including Printed Matter and Parcels)		Goods (Including Newspapers and Excess Baggage)	
			Number Carried	Passenger-Miles	Tons	Tons-Miles	Tons	Tons-Miles
1931	17,900	6,424,012	98,167	15,945,407	399.52	110,028	2,195.52	548,490
1932	16,975	5,758,326	98,489	17,529,948	378.14	96,724	2,085.20	538,034
1933	17,228	6,551,728	123,036	23,828,298	459.92	126,037	2,479.71	650,446
1934	23,442	8,862,766	165,846	38,950,181	759.51	276,687	3,167.17	883,913

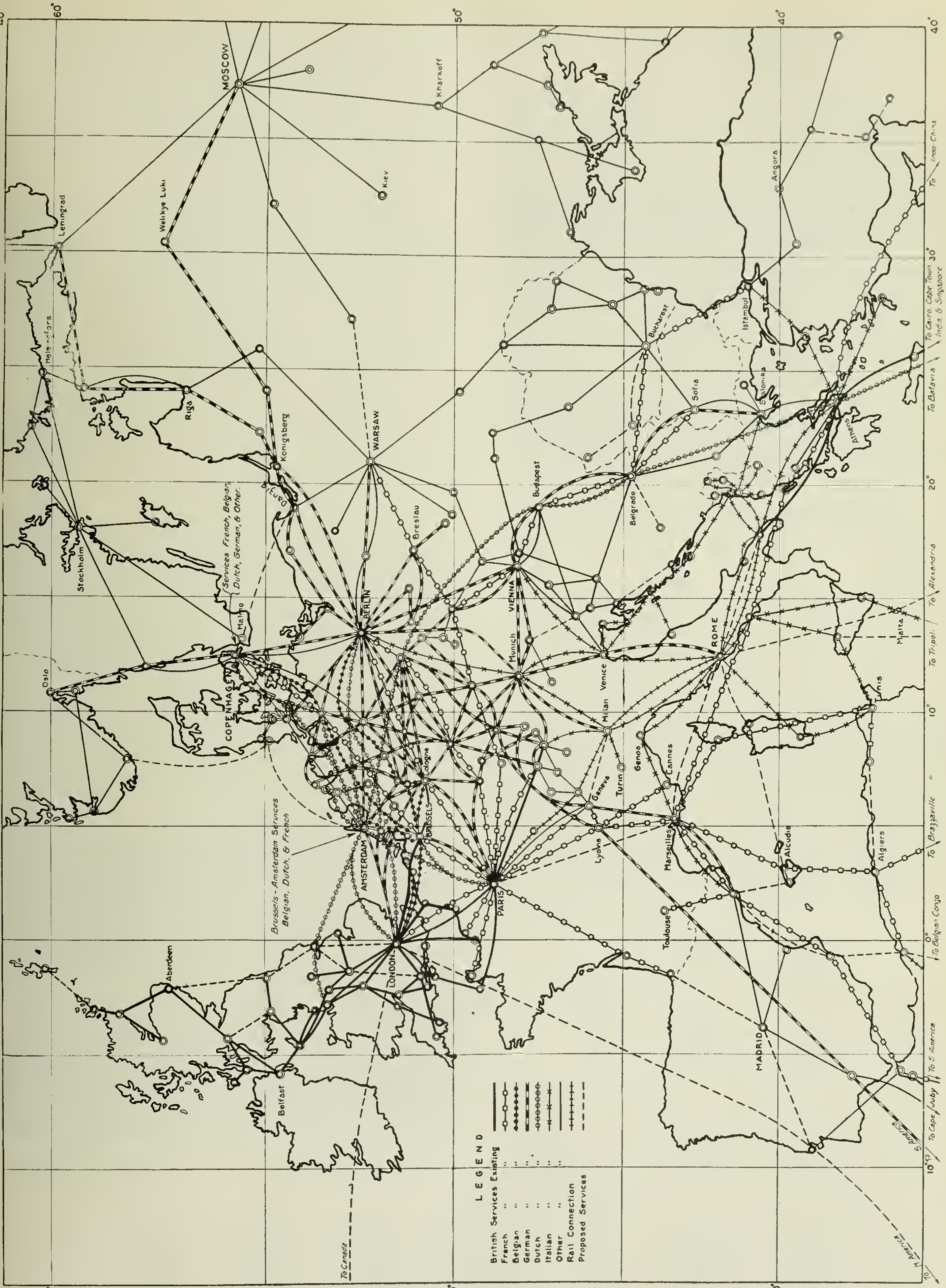


Fig. 3—European Air Routes and Extensions, 1934.

a Germany-United States service. Whether it will prove practical in the stormier North Atlantic waters remains to be seen. If so, it opens great possibilities.

The Russian System

Soviet Russia's area and her inadequate railway and road systems present an opportunity for a remarkable development of air transport which her rulers have been quick to realize. Till 1932 German influence was supreme. "Deruluft," the German-Russian operating company, which still operated the Berlin-Leningrad and Berlin-Moscow lines, was formed in 1921. In 1932 all commercial aviation was unified in "Aeroflot." This organization is really a division of the Soviet Air Force and a system of airways is gradually being built up all along the frontiers of Soviet Russia so as to permit of the easy concentration of her air power at any point from the Baltic along her western and southern boundaries past the Black and Caspian seas to Central Asia and finally to the Pacific coast. On many of these airways the service is as yet only occasional. The trans-Siberian and Afghanistan services are stated to be six times a month each way and other services even less frequent. As in northern Canada, much use has been made of the aeroplane for exploration and reconnaissance and for transportation in the more remote districts. Little up-to-date information is available on Russian progress.

Statistics

Year	Route Mileage	Passengers carried	Mails (tons)
1923	260	2,267	1.82
1925	2,022	5,282	7.78
1928	5,795	8,089	63.80
1930	16,458	12,000	114.81
1931	17,241	19,000	345.89
1932	18,811	27,226	454.00
1933	27,926	41,000	1,673.15

France

The French European network, though not so intensive at home as the German, is even more wide spread, serving London; Rotterdam and Amsterdam; Brussels; Hamburg, Copenhagen and Malmo-Cologne and Berlin; Strasburg, Nuremberg, Prague, Breslau and Warsaw; with an extension from Prague to Vienna, Budapest, Belgrade, Sofia, Bucharest and Constantinople. The French service to Asia traverses the route Paris, Marseilles, Naples, Corfu, Athens, Beirut, Iraq, Persia, India, Burmah to Bangkok and Saigon, while its African lines serve the French possessions in North, West and Equatorial Africa and extend from Natal, paralleling the German service across the South Atlantic to Brazil and the Argentine.

The financial statement of "Air France," the national operating company, for 1934 shows the total cost of operations to have been $14,125,486 and the revenue $14,457,830. Of the revenue $12,838,554 was from state and other subsidies and mail contracts and $1,427,171 passenger and express revenue.

Netherlands

K.L.M., the Netherlands national operating company, is, as has been seen above, one of the most economical and efficient operating companies in the world. It has wisely limited its European operations but serves Holland and the neighbouring countries to great advantage with lines to Berlin; Hamburg, Copenhagen and Malmo; London; Brussels and Paris. Its famous line from Amsterdam to Batavia runs via Leipzig, Prague, Budapest, Belgrade, Athens and Egypt, thence paralleling the British service through Palestine, Iraq, India and Burmah to Sumatra and Java.

On June 1st, 1935, K.L.M. reduced the former eight-day schedule for the Amsterdam-Batavia flight, 8,000 miles, to five and a half days and on July 1st increased the frequency to twice a week, as the traffic justified this. The load factors on this service were, in 1934:—East bound 82.8 per cent; west bound 77.8 per cent.

The British Airway System

The British Isles, because of their changeable climate and limited area and the excellence of the road and railway systems, are not a favourable environment for an airway system. The past two years, however, have seen quite an intensive development of internal unsubsidized air services. This development has only been made possible by the production of multi-engined aeroplanes of comparatively low horse power, capable of carrying a good passenger load in comfort at a comparatively high speed with remarkable reliability and at a low cost per mile.

The British postal authorities too have adopted a very helpful attitude towards air mails and now use air transport wherever the mails can be expedited by so doing. No surcharge is made for such letters and the certainty of a regular revenue from this source has helped the operators materially.

Regular scheduled services are now maintained from London to the Channel Islands; south coast towns as far as Plymouth; Bristol and Cardiff; Birmingham, Liverpool,

Traffic Returns French Regular Air Services

Year	Route Mileage	Miles Flown	Passengers		Mail (Including Printed Matter and Parcels)		Goods (Including Newspapers and Excess Baggage)	
			Number Carried	Passenger-Miles	Tons	Tons-Miles	Tons	Tons-Miles
1931	22,600	5,544,052	32,700	11,447,407	183.66	243,896	1,580.21	495,108
1932	22,845	5,487,512	36,892	13,398,644	170.22	270,338	1,143.93	370,146
1933	21,450	5,986,011	52,179	18,563,243	219.07	326,749	1,487.49	507,743
1934	21,295	6,041,236	50,019	18,482,905	216.01	318,387	1,322.21	462,947

Traffic Returns Holland Regular Air Services

Year	Route Mileage	Miles Flown	Passengers		Mail (Including Printed Matter and Parcels)		Goods (Including Newspapers and Excess Baggage)	
			Number Carried	Passenger-Miles	Tons	Tons-Miles	Tons	Tons-Miles
1931	10,310	1,375,100	11,628	3,133,500	79.43	147,927	704.46	224,863
1932	10,559	1,776,396	14,659	4,342,302	133.75	260,797	578.71	180,025
1933	11,360	2,071,433	32,054	8,587,916	155.89	330,261	891.09	265,466
1934	11,816	2,711,647	57,339	14,245,694	200.45	353,277	785.98	235,641

Isle of Man, Belfast and Glasgow; Manchester and Blackpool, Nottingham and Leeds; Hull, Newcastle, Edinburgh, Aberdeen, Inverness, Wick and Lerwick, and so form a network of internal airlines connecting the main centres of industry and commerce.

The major British effort in civil aviation, however, is that organized during the past eleven years by the government in conjunction with Imperial Airways. Shortly after the armistice the British government subsidized four companies to operate services, three across the Channel to Europe and one to the Channel Islands. In 1924 this arrangement was terminated and a new company, Imperial Airways, was formed to undertake all external air services. The remarkable and almost continuous growth of Imperial Airways is, perhaps, most simply illustrated by the increase in their traffic in ton miles.

Year (ending March 31st)	Traffic Ton Miles
1925	391,032
1926	393,937
1927	512,967
1928	583,668
1929	803,192
1930	1,017,773
1931	900,793
1932	1,251,753
1933	2,196,722
1934	2,733,603
1935	3,511,528

Imperial Airways' services form an important part in the European system. Regular lines are operated—London-Paris; London, Paris, Basle and Zurich; and London-Brussels, Cologne, Leipzig, Prague and Budapest. The relative importance and efficiency of the British service is shown in the returns of the cross-channel traffic. In 1934, 14,682 flights were made, on which 102,667 passengers were carried by British, French, German, Dutch and Belgian regular services. Forty-six per cent of these flights were made by British aircraft and they carried 57 per cent of the traffic.

The Indian and Australian Service

Important as these European services are, the major part of Imperial Airways' work is on the Empire services to India and Australia and to South Africa. These have

Fig. 4—Junkers 52 Monoplane. Three 700-h.p. motors. All-up Weight 20,900 pounds. Max. Speed 180 m.p.h.

been built up since 1929, when the service to India was inaugurated. It was extended first across India to Calcutta, then to Rangoon, next to Singapore, and finally, during 1935, linked up there with "Quantas" Empire Airways, an associated Australian company who operate the Singapore-Brisbane service. This is the longest continuous airway in the world—12,750 miles. Traffic on the Indian section has quadrupled in the five years since its inauguration and the frequency was increased in 1935 from once a week in each direction to twice a week. Traffic on the Australian section has so far surpassed expectations that negotiations are now in hand to place this section on a twice a week basis as well.

The Australian government has assisted the development of a wide spread system of domestic services linking

Fig. 5—D.R. Draco used by British and Australian Services. Four 205-h.p. motors. Pay-load 2,480 pounds. Max. Speed 170 m.p.h.

the principal cities of the Commonwealth and also serving many isolated communities. A regular service to Tasmania has been established and an extension to New Zealand is now under consideration so that the all-British communities in the antipodes may have the benefit of the improved system of communication and transport.

The South African Service

The London-Cape Town weekly service—7,900 miles long—was opened for service in 1932 and has been equally successful. The traffic on it doubled during the first two years and the increase in traffic has been so great as to necessitate the inauguration of a twice a week service from January 1st, 1935.

Under the Empire Air Mail Scheme which has been under consideration during recent months by the Dominion and Colonial governments concerned and which is now agreed to by all, all first class mails will be carried without surcharge. The advance proposed under this scheme is clearly seen from the following table:—

Empire Air Mail Scheme

Provisional Journey Schedules and Frequencies

A = With present day equipment. B = Medium night flying equipment. C = Extensive night flying equipment.

Route	Times taken by Services in July, 1934		Estimated times to be taken under new Scheme			Number of Air Services per week (July, 1934)	
	Air	Surface	A	B	C	Existing	Proposed
	Days	Days	Days	Days	Days		
1. London-Sydney	14	31	10¼	8½	7¼	None	Two
2. Sydney-London	13	31	9½	7¾	6¼	None	Two
3. London-Singapore	10	23	6¼	5½	4¾	One	Three
4. Singapore-London	10	23	6¼	4¾	4¼	One	Three
5. London-Karachi	6¼	16	3¼	2¾	2½	One	Four
6. Karachi-London	6¼	16	2½	2¼	2¼	One	Four
7. London-Capetown	10¼	17	7	5	4¼	One	Two
8. Capetown-London	10¼	17	6¼	5	4½	One	Two
9. London-Kisumu	6¼	22	4¼	2½	2½	One	Three
10. Kisumu-London	7¼	22	3¾	3¼	2¾	One	Three

The cost is estimated to be as follows:—

	United Kingdom Payment	Other Governments	Total
	£	£	£
1st year............	463,000	287,000	750,000
2nd "	388,000	287,000	675,000
3rd "	313,000	287,000	600,000
4th "	238,000	287,000	525,000
5th "	163,000	287,000	450,000

In 1934 Imperial Airways aircraft flew more than 3,500,000 miles and in 1935 the total will exceed 6,000,000

Fig. 6—Bristol Monoplane. Latest British Transport Type. Two 775-h.p. motors. Max. Speed 260 m.p.h.

miles. Taking the cost per ton mile in 1925 as 100 the cost is today 40. This reduction has been achieved principally by the intensive use of each aircraft in their service. The number of these is very small as compared with many other services but each machine is kept as many hours in the air as possible. Each of the four-engined Handley Page type, which is one of the mainstays of the service, averaged eighteen hundred and ten hours in the air during 1934.

Imperial Airways have now under consideration a service to Nigeria and other West African colonies, a trans-Atlantic service and other extensions. The company have always adopted a forward policy. It believes in large units with the best speed the traffic will bear, but considers safety, regularity, comfort and low rates of more importance than speed. They were the first to introduce the three-engined and then the four-engined aircraft. The new aircraft now under construction to enable the Empire Air Mail Scheme to be inaugurated in a year's time include 29 four-engined flying boats of a carrying capacity of from 3½ to 5 tons pay load, depending on the fuel required, and 11 four-engined monoplanes, all fitted to carry, with the utmost comfort, which is very necessary on such lengthy journeys, 27 passengers by day and with sleeping berths for 20 by night. Meals will be prepared and served in flight, just as in a dining car.

To sum up Imperial Airways' operations:—

(1) Its aircraft have now flown over 18,500,000 miles;
(2) It serves 24 countries in four continents;
(3) It employs over 1,800 people;
(4) The staff is spread over 50 stations;
(5) It has dealings in more than 20 currencies;
(6) The salaries and wages bill exceeds £350,000 per annum;
(7) Its aircraft used over 2,500,000 gallons of fuel last year.
(8) It carried over 15,000,000 letters last year.

Further, Imperial Airways and subsidiary and associated companies:—

(*a*) Are flying an average of 17,000 miles per day;
(*b*) Operate daily services in Great Britain and to France, Switzerland, Belgium, Germany, Austria and Hungary with connections to all parts of Europe;
(*c*) Operate four services a week to Greece and Egypt;
(*d*) Operate twice weekly to Palestine, Iraq, India, Burma, Siam and Malaya and once weekly to Australia;
(*e*) Operate twice weekly to Anglo-Egyptian Sudan, Uganda, Kenya Colony, Tanganyika Territory, Northern and Southern Rhodesia and the Union of South Africa;
(*f*) Operate ancillary and special services in Africa, Asia, Australia and Newfoundland.

The company received subsidies of £561,000 and earned a profit of £133,769 during the year ending March 31st, 1935, and paid a dividend of 7 per cent on its issued share capital of £624,080.

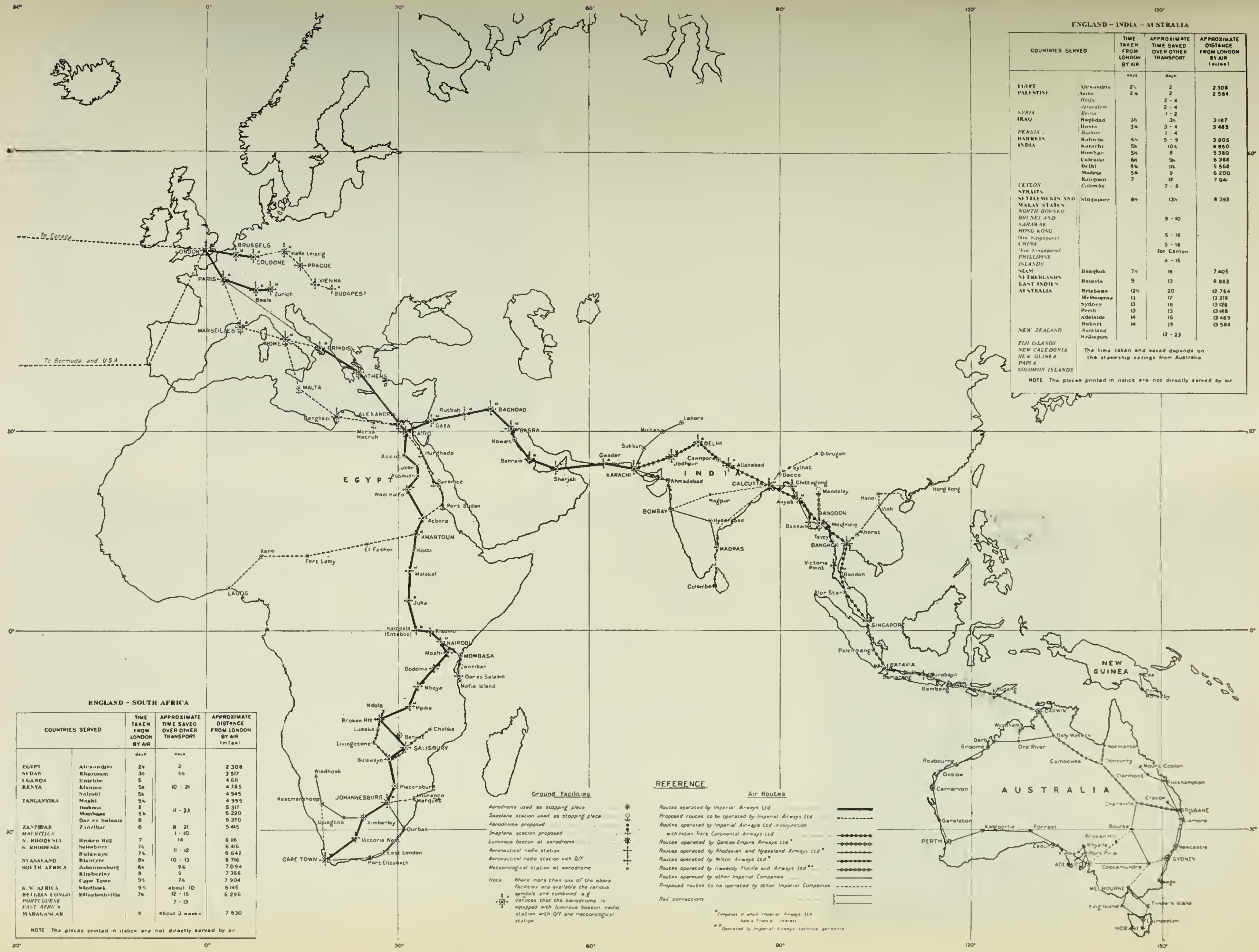
The United States Airway System

Nowhere are circumstances so favourable for the development of air transport as in the United States. A large continental area in a temperate climate, under a common government, with no customs or language barriers,

Imperial Airways Ltd.
Total Traffic Statistics for all Regular Services
(Total route mileage, 1934: 14,823)

Period	Aircraft miles flown	Passengers carried (individual)	Passenger miles flown	TON		MILES		Average load (tons)	Average engine horse power per aircraft flight
				Freight	Mails	Passenger	Total		
1924 (vi)	699,900	(viii)	2,482,000	129,100 (vii)		221,600	350,700	0.5	500
1925	805,300	11,027	2,645,000	147,600 (vii)		236,200	383,800	0.5	500
1926 (v)	733,000	16,621	3,746,000	159,000 (vii)		334,500	493,500	0.7	800
1927 (v)	719,000	19,005	4,296,000	153,100 (vii)		386,500	539,600	0.7	900
1928	911,300	27,303	6,477,000	178,600	36,900	583,300	798,800	0.9	1,000
1929 (iv)	1,166,000	28,484	7,147,000	218,600	126,800	648,900	994,300	0.9	1,200
1930	1,104,900	24,027	6,003,000	196,200	180,000	545,500	921,700	0.8	1,200
1931 (iii)	1,276,900	23,817	7,009,000	200,500	214,900	645,400	1,060,800	0.8	1,400
1932 (ii)	1,733,700	45,844	15,954,000	252,700	277,200	1,483,900	2,013,800	1.2	1,700
1933 (i)	1,926,000	54,768	20,228,000	326,200	406,200	1,891,700	2,624,100	1.4	1,800
1934 (i)	2,315,100	54,875	22,411,000	378,500	663,000	2,110,900	3,152,400	1.4	1,700

(i) Egypt-India service extended to Singapore in July, 1933. Traffic includes the service east of Karachi which is operated by Imperial Airways Ltd., and India Trans-Continental Airways Ltd.
(ii) Egypt-South Africa service extended from Kisumu to Cape Town in January, 1932.
(iii) Egypt-South Africa service commenced as far as Kisumu in March, 1931.
(iv) London-Egypt service commenced April, 1929. Egypt-Basra service extended to Karachi (India) in April, 1929.
(v) Egypt-Basra service commenced 27th December, 1926; flights in 1926 included in total for 1927.
(vi) April-December.
(vii) Separate figures for mails and freight not available.
(viii) Records not available.



ENGLAND – INDIA – AUSTRALIA

COUNTRIES SERVED		TIME TAKEN FROM LONDON BY AIR	APPROXIMATE TIME SAVED OVER OTHER TRANSPORT	APPROXIMATE DISTANCE FROM LONDON BY AIR (miles)
		days	days	
EGYPT	Alexandria	2½	2	2 308
PALESTINE	Gaza	2¾	2	2 584
	Haifa		2 - 4	
	Jerusalem		2 - 4	
SYRIA	*Beirut*		1 - 2	
IRAQ	Baghdad	3½	3½	3 187
	Basra	3¾	3 - 4	3 485
PERSIA	*Bushire*		1 - 4	
BAHREIN	Bahrein	4½	5 - 9	3 805
INDIA	Karachi	5½	10½	4 860
	Bombay	5½	8	5 380
	Calcutta	6½	9½	6 388
	Delhi	5¾	11½	5 568
	Madras	5¾	9	6 200
	Rangoon	7	12	7 041
CEYLON	*Colombo*		7 - 8	
STRAITS SETTLEMENTS AND MALAY STATES	Singapore	8½	13½	8 393
NORTH BORNEO BRUNEI AND SARAWAK			9 - 10	
HONG KONG (via Singapore)			5 - 18	
CHINA (via Singapore)			5 - 18 for Canton	
PHILLIPINE ISLANDS			4 - 16	
SIAM	Bangkok	7½	16	7 405
NETHERLANDS EAST INDIES	Batavia	9	13	8 883
AUSTRALIA	Brisbane	12½	20	12 754
	Melbourne	13	17	13 218
	Sydney	13	18	13 128
	Perth	13	13	13 148
	Adelaide	14	15	13 489
	Hobart	14	19	13 584
NEW ZEALAND	*Auckland* *Wellington*		12 - 23	
FIJI ISLANDS *NEW CALEDONIA* *NEW GUINEA* *PAPUA* *SOLOMON ISLANDS*	The time taken and saved depends on the steamship sailings from Australia			

NOTE The places printed in italics are not directly served by air

ENGLAND – SOUTH AFRICA

COUNTRIES SERVED		TIME TAKEN FROM LONDON BY AIR	APPROXIMATE TIME SAVED OVER OTHER TRANSPORT	APPROXIMATE DISTANCE FROM LONDON BY AIR (miles)
		days	days	
EGYPT	Alexandria	2½	2	2 308
SUDAN	Khartoum	3½	6½	3 517
UGANDA	Entebbe	5	10 - 21	4 611
KENYA	Kisumu	5½		4 785
	Nairobi	5½		4 945
TANGANYIKA	Moshi	5¾	11 - 23	4 995
	Dodoma	8		5 317
	Mombasa	5¾		6 220
	Dar es Salaam	6		6 370
ZANZIBAR	Zanzibar	6	8 - 21	5 415
MAURITIUS			1 - 10	
N. RHODESIA	Broken Hill	7	14	6 116
S. RHODESIA	Salisbury	7½	11 - 12	6 416
	Bulawayo	7¾		6 642
NYASALAND	Blantyre	8½	10 - 13	6 716
SOUTH AFRICA	Johannesburg	6½	9½	7 094
	Kimberley	8	9	7 366
	Cape Town	9½	7½	7 904
S. W. AFRICA	Windhoek	9¾	about 10	6 145
BELGIAN CONGO	Elizabethville	7½	12 - 15	6 296
PORTUGUESE EAST AFRICA			7 - 13	
MADAGASCAR		9	about 3 weeks	7 630

NOTE The places printed in italics are not directly served by air

Fig. 7—Imperial Air Routes, 1934.

with a high standard of living and intelligence, many populous cities and industrial areas well distributed over the country, and a mechanically minded population accustomed to travel and already used to long journeys on business or pleasure by road and rail. Under these conditions it is natural that aviation has made giant strides in the United States and that there has been built up during the past nine years an airway system unrivalled elsewhere.

Fig. 8—Glenn Martin Clipper. Four 800-h.p. Motors. All-up Weight 51,000 pounds. Max. Speed 180 m.p.h. with Fuel for 3,200 Miles.

The United States was slower in starting its airway system than other countries, because there was no Federal Air Law till 1926 and no co-ordinated and State-assisted system was possible in advance of legislation. Between 1918 and 1926, however, the U.S. Post Office had built up its own transcontinental air mail system from Hadley Field, N.J., 30 miles from New York, to Oakland, California, a distance of some 2,600 miles, and had lighted it for night flying as far west as Salt Lake City, 2,041 miles. In 1927 the Bureau of Air Commerce was formed and given power to build and equip a national airway system to be operated under licence by commercial firms who contract for the carrying of mails by air with the Post Office. On July 1st, 1935, the system included 20,769 miles of fully lighted and radio-equipped airways. There are four transcontinental systems:—

(1) Boston, Albany, Buffalo, Detroit, Chicago, St. Paul, Spokane and Seattle.
(2) New York, Cleveland, Chicago, Salt Lake and San Francisco.
(3) New York, St. Louis, Kansas City, Albuquerque, Los Angeles.
(4) Washington, Atlanta, Fort Worth, El Paso, San Diego.

and many north and south connections.

The outstanding features of the federal airway system are its lighting, meteorological service, radio beam and two-way services. There are 185 first order meteorological stations and 335 airway weather stations, all interconnected by radio and teletypewriter. Airway forecasts are broadcast every six hours based on the data collected from all over the continent. A recent report* of a flight made on November 13th, 1935, over the Pacific Coast airway may be of interest:—

"Prior to the aircraft's departure the pilot obtains from the despatcher a concise report giving him the heights at which he is to fly over different legs of the journey, the weather conditions at the airports and intermediate stations over which he will pass or land; the ceiling, the direction of winds, the type of clouds and temperature. Should the pilot receive instructions to proceed and not deem the weather suitable, he can reject the despatcher's instructions—on the other hand, should the pilot wish to proceed the despatcher can retain the aircraft on the ground until he deems the weather is suitable. This procedure is carried out on the instructions of the United States Department of Commerce and no flight may be undertaken unless the weather conditions are deemed suitable by both the despatcher and the pilot.

The pilot then leaves the ground, climbing immediately to the ceiling height at which he is to fly, and must fly at that altitude and on the course designated. This is very strictly adhered to. During the flight the pilot or co-pilot, as the case may be, must make out a detailed report of the weather as found at that height. Should he run into adverse weather conditions which were previously unforeseen, he must immediately report same to the ground station and state the nature of the conditions he has encountered, then he will be instructed how to proceed.

On the invitation of the pilot the writer changed places with the co-pilot and received some instruction on the use of the Sperry Artificial Horizon instrument, and also on the Directional Gyro Compass. The gyro compass is apparently very necessary in conjunction with the ordinary magnetic compass, as the magnetic compass fluctuates considerably and in the four or five different aircraft in which the writer acted as co-pilot, they all seemed to function the same.

The majority of United Air Lines' aircraft are now equipped with self-adjusting, three-bladed propellers and once the engines are opened up to their cruising rate of approximately 2,000 r.p.m., with an intake manifold pressure of twenty-eight pounds, whether climbing or diving the propeller adjusts itself accordingly and eliminates excessive strain on the engine while giving a maximum of performance.

The advantage over the old type of adjustable propeller is that the old type had only two settings—one for take-offs and the other for cruising—at the same time the engine had to be throttled down in order to adjust from one setting to another. Now the engines are opened up with the propellers adjusted at the correct position for giving the maximum performance at take-off. When the aircraft has reached the desired altitude the pilot moves two levers which throw in the automatic operating mechanism.

The system of radio communication is a most desirable asset, as the pilot can, while wearing his headphones, receive his beam signal, which is a steady monotone combination of signal "A" and "N," and at intervals of about every three minutes the designated signal of the beam station is repeated three times in quick succession. This signal is one of the letters of the Morse code. Should the pilot deviate to the left from his beam path he is immediately notified by the station sending out the letter in Morse code—"A." Should he deviate to the right he immediately receives in Morse code the letter "N." This system is commonly known as the "A" and "N" system.

Every fifteen minutes on the Pacific run the pilot calls the aerodrome to which he is heading, giving his weather report, as he finds it, the type of cloud formation, direction of the wind, the height at which he is flying and the atmospheric temperature. The operator at the airport immediately replies by saying "O.K." and repeats to the pilot the message received and in turn notifies the pilot of the weather conditions at the airport, direction of wind, height of clouds, type of clouds, visibility, whether hazy, foggy or clear, and

*By the District Inspector, Civil Aviation, Vancouver.

the barometric pressure of the airport. This barometric pressure is necessary in order that the pilot may adjust one of his two sensitive altimeters to be used in landing.

On approaching the aerodrome the pilot advises the operator his approximate location and approximate time of arrival. The operator then proceeds out on the field and by a system of remote control notifies the pilot whether or not he can hear the engine, again repeating the weather conditions. Should the operator be able to hear the aircraft he notifies the pilot to lower his wheels. This is more or less routine procedure and is carried out on all flights irrespective of weather conditions, visibility and whether it is daylight or dark.

Should the visibility be such that it is necessary to come in to the beam station with a very low ceiling at the airport, then the beam directs the aircraft to and over the beam station, which is usually located approximately a mile to two miles from the airport proper—then by a definitely planned routine the aircraft is turned to the right or left, no turns being made with over a 10-degree bank, and allowing ten seconds for entering the turn. The turn is continued until the boundary lights are visible.

In case it is necessary to make a blind landing, which is never done except in dire emergency, the pilot, by means of a two-way switch, changes his wave length to locate the landing beam and continues his turn until he picks up the new signal, flying on this course away from the centre of the airport until he picks up the first and second vertical beams, which are located at the boundary and about fifteen hundred feet from the boundary along the flight path towards the landing strip, then by a wide turn he relocates the landing beam and proceeds down this flight path until the boundary signal is received, and by this time he is in a position to flatten out for his landing."

Should anyone have doubts about the organization of this system let him listen in any evening on a good short wave radio set and hear for himself the pilots reporting

Fig. 9—Interior of Glenn Martin Clipper. Pay-load 4,824 pounds.

their positions and weather every fifteen minutes and receiving from the ground their weather reports and orders as to altitude and landing instructions. It is a fascinating amusement.

The volume of air mail increased from 800,000 pounds in 1926 to 9,500,000 pounds in the peak year, 1931, and has since remained nearly constant at a little less than 8,000,000 pounds. The ton mileage of mail in 1934 was 2,461,411.

Including all domestic and foreign connections, the U.S. air mail system on July 1st, 1935, extended over 46,629 miles. The daily average of miles flown under mail contracts was 129,654, including 16 domestic routes and 13 foreign routes, serving Canada, the West Indies, Mexico, Central and South America. Coast to coast service in fifteen hours is now the rule on the major services and cruising speeds have doubled in eight years from 90 to 180 miles per hour on such lines. Passenger traffic has increased from 5,782 in 1926 to 561,370 in 1934, while the passenger rates have fallen from an average of twelve cents per mile till they are no more than first class rail fare plus Pullman and meals, or an average, on July 1st, 1935, of 5.9 cents per mile. The air express business in the United States has great possibilities and its real exploitation has as yet hardly begun. It has increased, however, from 3,555 pounds in 1926 to 3,449,675 pounds in 1934.

Space does not permit of a fuller description of the advances made in air transport in the United States at this time. The full story may be seen in a bulletin issued by the United States Department of Commerce entitled "Civil Aeronautics in the United States," dated August 1st, 1935, from which the following figures are taken:—

Statistics of Civil Aviation in the United States

	1931	1932	1933	1934
Airways (all)				
Total mileage:				
Domestic	30,450	28,550	27,812	28,084
Foreign extensions	19,948	19,980	19,875	22,717
Accidents:				
Number of passenger fatalities	26	25	8	21
Passenger miles flown per passenger fatality	4,770,876	5,862,103	24,850,010	10,727,026
Express and freight carried (pounds):				
Domestic	788,059	1,033,970	1,510,215	2,133,191
Foreign	363,289	566,851	942,597	1,316,484
Mail:				
Carried by contractors:				
Domestic (pounds)	9,097,411	7,393,257	7,362,180	....
Foreign (pounds)	545,800	515,466	454,352	....
Mail income to contractors:				
Domestic	$19,900,251	$19,294,332	$16,467,216	$8,813,542
Foreign	6,983,792	6,939,989	6,946,475	....
Mail income average per contract mile flown (domestic)	$0.70	$0.56	$0.43	$0.37
Miles flown:				
Domestic routes	42,755,417	45,606,354	48,771,553	40,955,396
Foreign routes	4,630,570	5,326,613	5,870,992	7,831,155
Passenger-miles flown:				
Domestic	106,442,375	127,038,798	173,492,119	187,858,629
Foreign	13,526,202	19,513,789	25,307,960	37,408,930
Passengers carried:				
Domestic	469,981	474,279	493,141	461,743
Foreign	52,364	66,402	75,799	99,627
Airports:				
Total airports in operation	2,093	2,117	2,184	2,297
Communications:				
Radio broadcast stations	56	61	68	71
Radio range beacon stations	47	68	94	112
Radio marker beacons	46	74	77	84
Weather reporting, airway and airport stations—				
Weather Bureau and Department of Commerce operated, long line teletypewriter equipped	234	234	205	206
Miles of teletypewriter service	13,186	13,500	12,064	11,631
Airway lighting:				
Beacons: Revolving	1,460	1,623	1,510	1,324
Intermediate landing fields, lighted by Department of Commerce	385	337	246	259

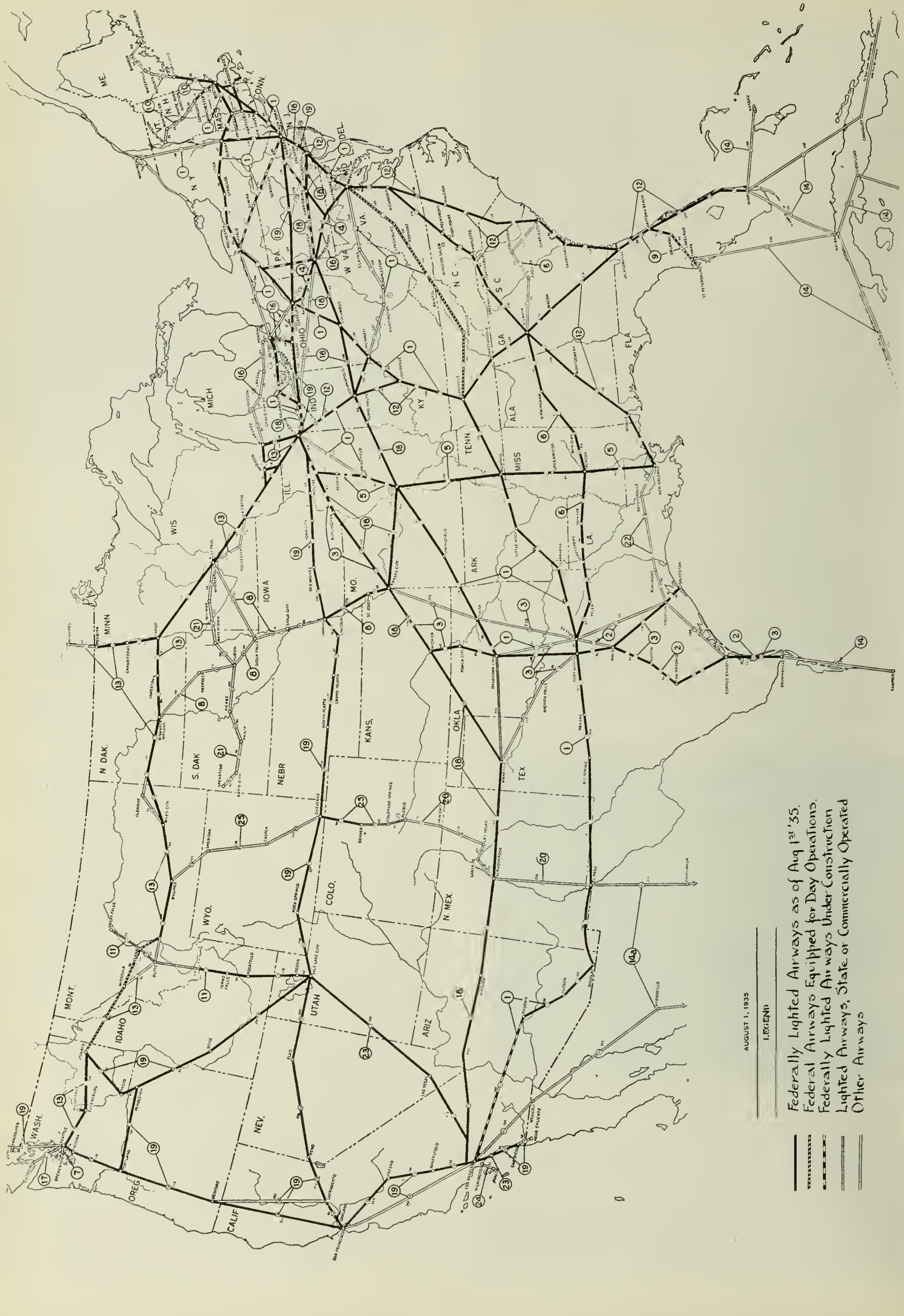


Fig. 10—Air Routes of United States 1935.

Scheduled Airway Operators

Route No.	Operator	Routes Operated	Route Mileage	Class of Service
(1)	American Airlines, Inc.	New York to Fort Worth (via Washington and Nashville)	1466	MPE
		Fort Worth to Los Angeles	1293	MPE
		New York to Chicago (via Buffalo and Detroit)	754	MPE
		Detroit to Chicago (via Kalamazoo)	263	MPE
		Chicago to St. Louis	257	MPE
		Chicago to Fort Worth (via Peoria, St. Louis, Tulsa and Oklahoma City)	950	MPE
		New York to Boston (via Springfield, Mass.)	206	MPE
		New York to Boston (via Hartford and New Haven)	209	MPE
		Boston to Cleveland (via Albany and Buffalo)	637	MPE
		Cleveland to Nashville (via Columbus and Louisville)	469	MPE
		Washington to Chicago (via Cincinnati and Indianapolis)	684	MPE
		New York to Montreal	332	MPE
(2)	Bowen Air Lines, Inc.	Fort Worth-Dallas to Brownsville	551	PE
		Fort Worth-Dallas to Houston	255	PE
(3)	Braniff Airways, Inc.	Chicago to Kansas City	410	MPE
		Chicago to Dallas (via Kansas City, Wichita and Oklahoma City)	964	ME
		Amarillo to Fort Worth	315	MPE
		Dallas to Brownsville	546	MPE
		Waco to Galveston	206	MPE
		Kansas City to Dallas (via Tulsa)	254	PE
		Houston to Corpus Christi	186	PE
(4)	Central Airlines, Inc.	Washington to Detroit	469	MPE
(5)	Chicago & Southern Air Lines Inc.	Chicago to New Orleans (via Peoria)	872	MPE
(6)	Delta Air Corporation	Charleston, S.C. to Dallas	1065	MPE
(7)	Gorst Air Transport, Inc.	Seattle to Bremerton	15	PE
(8)	Hanford Tri-State Air Lines, Inc.	St. Paul to Omaha (via Sioux Falls)	369	MPE
		Omaha to Kansas City	168	MPE
		Bismarck to Sioux Falls	315	MPE
(9)	National Air Line System	St. Petersburg to Jacksonville (via Daytona Beach)	237	MPE
(10)	National Airways, Inc.	Boston to Bar Harbor	253	MPE
		Boston to Burlington	193	MPE
(11)	National Parks Airways, Inc.	Salt Lake City to Great Falls	489	MPE
(12)	North American Aviation, Inc.	New York to New Orleans (via Atlanta)	1296	MPE
	(Eastern Air Lines Division)	New York to Miami (via Charleston, S.C.)	1144	MPE
		Chicago to Miami (via Jacksonville, Louisville and Nashville)	1267	MPE
(13)	Northwest Airlines, Inc.	Chicago to St. Paul (via Rochester)	356	MPE
		Chicago to Pembina (via Milwaukee)	769	MPE
		Fargo to Seattle	1267	MPE
		Pembina to Winnipeg	65	PE
(14)	Pan American Airways, Inc.	Miami to Havana	229	MPE
		Miami to San Juan	1180	MPE
		San Juan to Paramaribo	1378	MPE
		Paramaribo to Buenos Aires	4840	MPE
		Miami to Cristobal (via San Salvador)	2228	MPE
		Miami to Cristobal (via Kingston and Barranquilla)	1810	MPE
		Barranquilla to Port of Spain	1021	MPE
		Miami to Nassau	188	MPE
		Tampa to Havana	339	PE
		Brownsville to Mexico City (via Tampico)	496	MPE
		Mexico City to San Salvador	951	MPE
		Kingston to Port au Prince	304	PE
		Port au Prince to Santo Domingo	161	PE
		Belem (Para) to Manaos	852	PE
		Vera Cruz to Merida	530	PE
(14a)	Pan American Airways, Inc.	Los Angeles to Mexico City	1684	PE
	(Aerovias Centrales)	El Paso to Durango	663	PE
(15)	Pan American-Grace Airways, Inc.	Cristobal, Canal Zone to Montevideo, Uruguay (via Santiago, Chile)	4552	MPE
(16)	Pennsylvania Airlines & Transport, Inc.	Washington to Detroit	410	PE
		Detroit to Milwaukee	265	MPE
(17)	Seattle-Victoria Air Mail, Inc.	Seattle to Victoria	74	M
(18)	Transcontinental & Western Air, Inc.	New York to Los Angeles (via Chicago, Kansas City and Amarillo)	2583	PE
		New York to Los Angeles (via Columbus, Indianapolis and Kansas City)	2555	MPE
(19)	United Air Lines Transport Corp.	New York to San Francisco (via Chicago)	2647	MPE
		San Diego to Seattle	1161	MPE
		Agua Caliente to San Diego	14	PE
		Seattle to Vancouver	119	PE
		Salt Lake City to Seattle (via Portland)	816	MPE
		Pendleton to Spokane	169	MPE
(20)	Varney Air Transport, Inc.	Pueblo to El Paso	519	MPE
(21)	Watertown Airways, Inc.	St. Paul to Spearfish	559	PE
(22)	Wedell-Williams Air Service Corporation	Houston to New Orleans	329	MPE
(23)	Western Air Express Corp.	San Diego to Salt Lake City	702	MPE
(24)	Wilmington Catalina Airline, Ltd.	Wilmington to Avalon	31	PE
(25)	Wyoming Air Service, Inc.	Cheyenne to Pueblo	199	MPE
		Billings to Cheyenne	380	MPE

M—Mail. P—Passenger. E—Express.

Between 1927 and 1933 generous mail contracts helped to place the principal airway operators in a sound financial position. Early in 1934 all domestic air mail contracts were suddenly cancelled and for three months no air mail revenue was obtained. When the contract system was renewed the prices were materially reduced and many companies have since been operating with a deficit. The serious effect of this reduction is shown in the following returns, from the two largest operators. American Airlines showed an operating loss of $888,504 in 1934 and United Airlines a loss of $2,283,525. Economies in operation and the increase of other revenue has now restored the position in large measure, as in the first nine months of 1935 American Airways' deficit has been reduced to less than $400,000, while United Airlines show a profit for the quarter ending 30th September of $304,565.

Pan American Airways System

With the exception of the Canadian connections at Montreal, Winnipeg and Victoria, the foreign air operations under the United States flag are conducted by Pan American Airways and its associated companies. Beginning in 1928 with a single route—Key West to Havana—251 miles long, its route mileage today is about 45,000 miles. In 1929 the terminal was moved to Miami and a series of extensions commenced, which, by 1931, served the West Indies Islands, Mexico and all Central American Republics, the Panama Canal zone and both coasts of South America as far south as Buenos Aires and Santiago.

In 1932 the local Alaskan services were unified in Pacific Alaska Airways, a subsidiary company, and in 1933 49 per cent of the capital stock of Chinese National Airways was acquired, giving the company access to important centres in the Far East. These were extended in 1934 and in 1935 the trans-Pacific service—San Francisco, Honolulu, Midway, Wake, Guam, Manila—was successfully inaugurated. This trans-Pacific service will be extended to New Zealand in the near future. An agreement was reached in November, 1935, with that government providing for a regular service from Honolulu to Auckland, New Zealand. This will give New Zealand and Australia direct connection by air with the United States and Canada. When the trans-Atlantic services are inaugurated a girdle will have been thrown completely round the world by Imperial and Pan American Airways. The summer of 1936 will see the aircraft of both companies co-operating in experimental trans-Atlantic air services through agreements reached in Ottawa and Washington last November.

Pan American Airways is certainly second to no company in the world in the efficiency and thoroughness of its organization. Its record speaks for itself. Its plans are carefully matured and its safety and reliability are proverbial. Its aircraft are the finest available and its ground organization of the highest type.

These results have been made possible by the timely assistance of the United States government through mail contracts at generous rates and in other ways. The company's operations have been profitable. In 1932 the company is stated to have had a net income of $512,581 and in 1933 of $631,640 or earnings per share of $1.36 and $1.42 respectively.

Canada

Canada played an important part in the early experimental stages of aviation through the efforts of Dr. Graham Bell and his associates. The scene of their activities was Baddeck, Cape Breton, and the first flights in the British Empire were made from the ice there by Messrs. Baldwin and McCurdy on February 23rd, 1909. There was little flying in Canada, however, before the war.

During the war there was great activity in training pilots for the overseas forces and several large training camps were established in Ontario, while thousands of young Canadian transferred from active service units overseas to the Air Forces, both Naval and Military. All these activities were, however, directly under the United Kingdom government and no distinctively Canadian units were established until immediately prior to the armistice. These units were demobilized after the armistice and Canada entered the post-war period with no air organization, either military or civil.

The important part aviation could play in the development of the Dominion was recognized, however, and in 1919 the Air Board Act was passed establishing a Board for the administration of aeronautics. Air Regulations based on the International Convention for Air Navigation became law on January 1st, 1920, and orderly development was, therefore, possible from the outset. This country was far removed from the rivalries which have interfered with economic development in Europe and elsewhere and the problem could thus be considered strictly on its merits. Enquiries were made with a view to determining where aircraft could be used to the best advantage. In our vast northern areas better means of transport were urgently required. It was to this field that our aims and energy were directed after the war. There aircraft could play an immediately useful part in work of the greatest importance to the Dominion.

Experimental work in forest patrols was begun in August, 1919, at Grand'Mere through the co-operation of the Provincial Forest Service, one of the large pulp and paper companies, and the Dominion government. The success attending these experiments quickly led to the establishment of air units for forest fire patrol, mapping and exploration work, in conjunction with the provinces of British Columbia, Ontario, and Quebec, and the Dominion Forest Service in Manitoba, Saskatchewan and Alberta.

The surveyor, geologist, and prospector were not slow to follow the example of the forester and use aircraft as a better means of transportation and observation throughout the unsettled areas of Canada.

The result of this policy has been that today there exist generally throughout northern Canada efficient commercial air services which have been self-sustaining, have required no subsidy, and which give access to the remotest districts of the country. More has been learned of northern Canada during the past ten years than in the preceding three hundred. The forester, surveyor, geologist, prospector, mining engineer; the clergy, the doctors, the nurses, the police; in fact, all whose activities lie in northern Canada find their task greatly lightened, their range of action multiplied many times and their efficiency increased

Statistics Operations of Pan American Airways

	1928	1929	1930	1931	1932	1933	1934
Airway route mileage	251	12,265	17,861	20,664	26,652	30,982	32,552
Aeroplanes	7	64	98	102	107	124	139
Radio weather	—	—	—	—	—	—	—
Stations	3	25	44	51	59	94	99
Personnel	118	987	1,593	1,667	1,918	2,292	2,801
Passenger miles flown	297,000	5,360,000	8,980,000	12,479,000	19,571,000	27,511,000	35,000,000
Mail and express carried	270,155	485,140	731,187	819,657	1,279,130	1,562,361	1,884,000

by the use of aircraft. Journeys which a few years ago meant weeks or months, and sometimes even years of toil and hardship, are now performed in ease and comfort in a few hours. The expansion of Canada's mining industry has greatly helped to tide Canada over the dark days of the depression and this development has been immensely assisted and hastened by aviation. Many of our most promising new mining fields owe their discovery and their opportunity of present development entirely to aircraft. The extent of this development is shown in the following statistics:—

	1930	1931	1932	1933	1934
Aircraft miles	7,547,420	7,046,276	4,569,131	4,538,315	6,497,637
Flights	156,574	144,080	102,219	106,252	128,031
Hours	92,993	73,645	56,170	53,299	75,871
Passengers	124,875	100,128	76,800	85,006	105,306
Passenger miles	5,408,676	4,073,552	2,869,799	3,816,862	6,266,475
Freight and express (pounds)	1,759,259	2,372,467	3,129,974	4,205,901	14,441,179
Mail (pounds)	474,199	470,461	413,687	539,358	625,040

(In 1935 the poundage of mail carried will exceed 1,125,000.)

	1930	1931	1932	1933	1934
Private air pilots	311	292	356	405	427
Commercial air pilots	402	366	419	474	405
Air engineers	370	346	341	403	461
Private aircraft	48	66	45	49	38
Commercial aircraft	445	495	303	296	330
Air harbours	70	78	91	105	101

The best proof of the soundness of our northern services is their continuation throughout the depression without any form of subsidy. Canadian development is unique in this respect. No country has spent less on civil aviation and no country has had greater returns from the money spent. The results achieved are due wholly to the enterprise and efficiency of the private operator, who has expanded his activities throughout the length and breadth of northern Canada and today is providing efficient service through all parts of the north. Operating conditions are strenuous, the work is carried on summer and winter with only short intermissions during the freeze-up and break-up

Fig. 11—Intermediate Landing Field at Caddy Lake, Man.

periods in fall and spring. The single-engined general purpose monoplane is the most popular type. Flying is on floats in summer and skis in winter and the average pay load is about 1,200 pounds.

The development of inter-city services was not ignored but enquiry in 1920 had shown that in the circumstances existing in the early post-war years there was no immediate necessity for the inauguration of such services. The cost would be great and the physical difficulties of winter flying had not yet been overcome. In addition, the war type aircraft were not particularly suited to this class of work nor was public opinion ripe. It was decided, therefore, that an inter-city system could well wait for some years.

In 1927, however, it was realized that the time had come when Canada could no longer neglect this field and surveys were then commenced to determine the best route for the trans-Canada airway. In Europe, a complete airway system had been organized and the United States' services were beginning to tap Canadian traffic at strategic points along the frontier. The danger that through these points of contact high speed traffic now passing through Canadian channels might be diverted southward to the United States was clearly realized. By 1929 construction on the trans-Canada airway was sufficiently far advanced to permit of a daylight service from Windsor to Moncton in the east and a night service between Edmonton, Calgary and Winnipeg in the west. This latter airway was lighted for night flying and was equipped with the latest radio beam and communication services. At the same time, surveys through the difficult mountain section enabling the Prairie system to be extended to the Pacific coast were in hand, while the problem of bridging northern Ontario, which two generations before had presented immense difficulties to the railroad constructor, was being carefully examined.

This was the situation when the financial crisis made economies in all government services essential. The operation of the airway ceased, for the time being, on March 31st, 1932. Fortunately, construction work has been continued as a measure of unemployment relief. The airway through the mountain section has been practically completed, while much work has been done in the northern Ontario section, and in Quebec, New Brunswick and Nova Scotia so as to complete the system from Vancouver to Halifax.

The trans-Canada airway crosses the Rocky Mountains from Vancouver by the Crow's Nest Pass to Lethbridge. Exhaustive surveys have shown that this route is not only the shortest and most direct, but is preferable from a climatic and flying point of view. It also serves a more densely populated area in which several airports had already been constructed. From Lethbridge a north and south branch has been built to serve Calgary and Edmonton as well as the main line to Regina and Winnipeg.

The path chosen from Winnipeg through northern Ontario follows approximately the line of the National Transcontinental Railway as far as Cochrane, whence it passes south-east to Emsdale, dividing there for Toronto to the south and Montreal to the east. From Montreal the airway continues through the eastern townships of Quebec, the state of Maine and New Brunswick to Moncton with connections to Halifax, Charlottetown and Sydney.

The trans-Canada airway is a co-operative effort in which the municipalities served have provided a chain of twenty-one airports from coast to coast. The extent to which they have contributed in this way is often forgotten. Not less than $4,000,000 has been spent on such airports. The aids to air navigation on the airway, such as intermediate aerodromes, airway lighting, meteorological and radio services have been constructed by the Dominion government following the precedent of marine navigation.

The Prairie section, which was built in 1929 and 1930, includes twenty-seven intermediate fields, fifty-nine airway beacons and five radio beam stations. The Mountain, Central and Maritime sections now under construction comprise a total of sixty-six intermediate aerodromes, of which five are completed and nineteen are so far advanced that their use in daylight is now possible. Construction has commenced on twenty-six others and the sites for an additional ten are under option or have been purchased, leaving six still to be purchased.

The most serious effect of the stoppage of scheduled airway flying in March, 1932, is not the delay in construction and operation but the loss of experience in modern airway operation. Progress in this phase of flying operations has been extraordinarily rapid during the past four years and a highly skilled and experienced personnel, both air and ground, is essential to the successful operation and co-ordination of the flying, meteorology, radio and communication services. Such services cannot be improvised in a day but must be built up gradually over a period of years. The opportunities for so doing are entirely absent in Canada today and our personnel, who have shown a natural aptitude in aviation since its beginning, are without the facilities to keep them in touch with modern flying practice.

The trans-Canada airway is not only of value as a national project, but is an important part of the airway system of the world, which has been assuming shape during the past few years. As has been seen, all continents are now spanned by airways over which a constantly increasing stream of traffic is passing. This country is one of the great trading nations of the world and we only maintain this position and our high standard of living because of our external trade. The means of communication which serve this trade are, therefore, of great concern to Canada. The shortest routes from the North American continent to both Europe and Asia lie through Canadian territory. The transatlantic and transpacific airways are, therefore, of vital importance to us. These routes, together with the trans-Canada airway, are the three great links still awaiting organization in the world airway system.

The Trans-Atlantic Airway

Recent conversations in Ottawa between representatives of the United Kingdom, the Irish Free State, Newfoundland and Canada, and subsequently in Washington with the United States authorities, foreshadow the early development of a transatlantic service. The North Atlantic is the greatest trade route in the world and on it, if anywhere, will be found traffic of sufficient volume, urgency and value to justify the addition to the present highly organized means of transport and communication of an express service for mails, passengers and freight by air.

Three transatlantic routes have received much attention of recent years; the northern route, via Baffin Land, Greenland and Iceland; the direct route, via Newfoundland and the Irish Free State; and the southern route, via Bermuda and the Azores. The direct interest of Canada in the first two is manifest and careful study of conditions on both have been made for many years. The inaccessibility during the greater part of the year of the bases on the northern route and the inhospitable climate have led to the conclusion that the northern route is not a practical one under present conditions. In addition, while it provides a short route from points in eastern Europe, such as Berlin, Leningrad and Scandinavia, to western Canada and the United States, it does not provide a direct or short route from London and Paris to Montreal and New York. Attention has, therefore, been directed to the establishment of a service by the direct route. As a preliminary step the first regular air mail service in Canada was established in 1927 from Montreal to Rimouski to hasten the delivery of outgoing and incoming transatlantic mail. This ship-to-shore service has been operated successfully during the summer season of navigation since that date without the loss or damage of a single packet of the many millions carried. In 1930 and 1932 experimental flights were made with a view to further expediting the mail by making the transfer from the ship to the aircraft in the Straits of Belle Isle and so making one-third of the trans-Atlantic passage by air.

The increase in the range, speed and carrying capacity of aircraft now makes it possible to consider an all air service across the Atlantic, and experimental flights may be expected during 1936 by Imperial Airways and Pan American Airways, who are co-operating in the establishment of the service with the support of the British Commonwealth governments concerned and the United States. The operating difficulties on this route are obvious. High westerly winds, fog on the Atlantic coast and the prevalence of critical temperatures which lead to ice formation on the planes, render it, perhaps, the most arduous of the world's airways. Only a resolute and determined effort, using the highest type of equipment and a thorough ground organization will suffice to master the difficulties. Sufficient is known, however, of the conditions to justify confidence that in a very few years the regular operation of a trans-Atlantic service by this route will be feasible during the summer months at least.

On the southern route the climate is better, and though the route is much longer, yet the operating difficulties are less and for some years it is probable that, just as trans-Atlantic liners use northern and southern courses during the summer and winter months, the trans-Atlantic air service may pass by alternative routes.

Comparison of Trans-Atlantic Air Routes

Distance	Arctic	Direct	Southern
From London, England to			
Montreal	4357	3330	5767
New York	4687	3660	5437
Number of intermediate bases	8	2	4 (to Lisbon)

The Trans-Pacific Airway

A trans-Pacific route has now been established by Pan American Airways from San Francisco via Honolulu, Midway, Wake and Guam Islands, to Manila, there connecting with existing and proposed airways in the Far East. This route is much longer than the direct route, which revives the old question of "the north west passage" to China. The great circle course from Chicago to Shanghai passes through Winnipeg, Chippewyan, Simpson, Dawson, Fairbanks and Nome, Alaska, thence across the Bering Straits by a short sea passage of only a few miles, and down the coasts of eastern Siberia, Manchuria and China. That part of this airway which lies on the American continent is well known and a large part of it is regularly flown over in both summer and in winter by northern operators. Present information justifies the statement that its operation is feasible and that a service from Edmonton via the Peace, Liard and Yukon river valleys, which all lie adjacent to the direct line of flight, could be operated with ease and safety. Political conditions in the Far East, however, have militated against its consideration up to the present and until more settled conditions prevail there it is unlikely that any active steps will be taken to develop this route. Its great advantage is that stops for refuelling can be made at economic intervals, whereas on the longer sea route via Honolulu the pay load is bound to be restricted by the long distances which must be traversed without refuelling.

It will thus be seen that Canada's northern position on the American continent is most important to the world's airway system and that the trans-Canada airway is a vital link between the Old World and the New.

This brief and incomplete survey of the world's airway system shows that during the depression, in a time of falling trade and traffic returns, aviation has not only held its own but grown by leaps and bounds. No country, except Canada, has materially reduced its expenditures on civil aviation during the past five years, but, on the contrary, expansion has been rapid and widespread. The world's airway system is the growth of the last six years and the only remaining major links still to be developed are in Canada or pass through her territory.

Aeronautical science is still young and the future will see great progress in the design of aircraft for long distance services at still higher speeds and with greater economy. The present generation is witnessing a shrinkage of the world similar to that which followed the introduction of the railway and steamship. Distance is best measured by the time taken to traverse it. Instantaneous communication is today possible throughout the civilized world by radio and cable. Tomorrow, personal contact throughout the world will be possible by air transport with little loss of time.

The philosopher may ask—Why all this speed? and the economist may question its cost. Such questions apply equally to the radio and telephone, the automobile and, in fact, to all appurtenances of our modern civilization. Fortunately for our Institute and its members, man is not a wholly reasonable or economic animal. The desire for achievement, imagination, the exercise of ingenuity, the love of invention, gifts of particular interest to engineers, play an important part in his being and motives. Quite apart from its very real practical uses in the modern world, aviation appeals to these higher qualities in man. The past ten years have witnessed a generous and enthusiastic outpouring of them in aeronautical science unparalleled in the history of mechanical invention. Its first fruits are our present airway system, thrown round the world in a few short years.

The Columbia Basin Project

In the State of Washington, U.S.A.

C. E. Webb, M.E.I.C.,
District Chief Engineer, Dominion Water Power and Hydrometric Bureau, Department of the Interior, Vancouver, B.C.

Paper presented before the Vancouver Branch of The Engineering Institute of Canada, on November 20th, 1935, and before the Victoria Branch on November 25th, 1935.

Under the Public Works Act the United States Government authorized the construction of a power project in 1933 in the Columbia river at Grand Coulee along with several other major projects scattered at different points throughout the United States, the dominant objective being the immediate re-employment of people in the particular districts involved. At that time $63,000,000 were provided for the construction of a "low" dam on the river.

About the same time that the authorization for the construction of the low dam at Grand Coulee for power purposes was given, it was decided to build a dam at Bonneville near Portland on the Columbia river, for which originally $31,000,000 was appropriated. The Bonneville project provides for a gate control spillway dam across the main river channel creating a head of 67 feet at low water; a power plant with two complete units of 43,000 kw. capacity each, with skeleton structure for four additional units; a barge lock having a width of 76 feet and a clear length of 360 feet, and a minimum depth of 10 feet on the sills. An elaborate system of fishways in both the dam and power house channels, is included in the project.

The Bonneville dam is designed to be of assistance to navigation as well as for power purposes, and is being constructed under the supervision of the United States Army Engineers.

The possibilities of irrigating the area in Eastern Washington embraced in the Columbia Basin Project have been receiving the attention of various interests for many years. As early as 1904 the Bureau of Reclamation had under investigation a gravity project from considerably higher levels on the Pend d'Oreille, Spokane and Palouse rivers. This scheme included large storage reservoirs in adjoining states, extensive canals, tunnels and viaducts, the cost of which was at that time considered beyond the economic limit. Studies were made in subsequent years of both the gravity supply and a pumping project with a dam at Grand Coulee on the Columbia river to impound the water as well as provide the necessary power for pumping.

Following intensive hydrometric studies inaugurated by the United States Geological Survey in 1925 a comprehensive investigation of the Columbia and its tributaries was made during 1928 to 1931 by the United States Army Engineers. Their report of 1931, containing a wealth of general and engineering data, forms the basis of the present Columbia Basin Project which is being developed by the United States Bureau of Reclamation.

The original authorization of $63,000,000 for the Grand Coulee so-called "low dam" was to have been utilized for power purposes only. The project has recently been changed to a "high" dam for irrigation and flood control involving two principal stages of construction. For the first stage of construction the same moneys as originally arranged for will be provided. The structure now being built, which is in effect, nothing more than a dam foundation, will generate no power, but it is planned to complete at some future date the "high" dam on the present foundation, to supply irrigation in the Columbia Basin.

Plans for the ultimate development include a concrete straight-gravity type dam about 550 feet in maximum height above the lowest point of foundation; with a crest length of about 4,200 feet and a top width of 30 feet where a 26-foot roadway will be provided; a 1,650-foot spillway in the river channel section; power plant of 2,520,000 h.p. capacity and irrigation system for 1,200,000 acres. The reservoir will be 150 miles in length and extend to the Canadian border.

This is the dam planned for the full joint service of river and land improvements and when built to its full height will serve the needs of river storage, irrigation, power generation for irrigation pumping and other services in the area. The base section now being built will have no present function except to assist regulation of the river's flow.

The change of present plan has not greatly altered the construction specifications or requirements which call for construction of a dam 177 feet in height with foundations of sufficient strength to permit economical construction of a higher dam when deemed advisable, without the necessity of extensive alterations of the original structure. Approximately the same amount of mass concrete will be placed as was called for in the low dam. All of the 18-foot diameter steel penstocks from the power house up to elevation 990 will be constructed while power house construction above the level of the turbine floor will be eliminated. It is anticipated the change of construction will be more satisfactory from an engineering standpoint because of the difficulties involved in the construction joint between the low dam and future concrete to be placed to raise the structure to its ultimate height. The principal items of work involved in the Mason-Walsh-Atkinson-Kier Company contract amounting to just under thirty million dollars, are the excavation of 14,500,000 cubic yards of material, and the placing of 3,600,000 cubic yards of concrete. It is estimated that the work now planned will be completed in the fall of 1937.

As the Grand Coulee site was isolated from rail transportation and electrical power it was necessary to construct a 30½-mile branch railroad from Coulee City and a 31-mile 110,000-volt transmission line from the same place. The transmission line was built on a rush schedule of forty-two days.

Preliminary plans for the ultimate Columbia Basin project as worked out by the Bureau of Reclamation call for a total investment of $404,633,000 to put the entire project in operation. This is made up of $113,676,000 for the high dam, $67,425,000 for the power plant, $15,000,000 for interest during their construction and $208,532,000 for the irrigation development. The total cost is slightly more than was expended in the construction of the Panama Canal. In drawing up these plans it is contemplated that the irrigation development of 1,200,000 acres will not start until the dam is completed and will take place gradually, the suggested rate being 20,000 acres per year. Thus it may be seen that the whole area may be under irrigation within sixty years after the dam is built.

The developments at Grand Coulee have been rapid and stupendous. Just over two years ago, in 1933, the author visited the site in company with Mr G. L. Parker, district engineer of the United States Geological Survey, to inspect the gauging station at Grand Coulee. At that time only the ferry man and his family were living in the area. At the time of a subsequent visit in the summer of 1935 there were probably fifteen thousand people living on the banks of the Columbia. A permanent townsite is being developed by the United States Bureau of Reclamation on the left bank with paved streets, lighting, water supply, sewage and all modern municipal services installed. On the right bank is Mason City, the contractor's temporary city, housing over three thousand employees. There are scattered outside of these two places, several communities with theatres, real estate offices and other activities which go with a new town.

Picture the extraordinary character of the Grand Coulee site with its dry gorge, the floor of which is 600 feet above river level and extends southwestward from the present course of the Columbia river for more than 30 miles. This freak of nature resulted from a blockade of the Columbia river by the Okanagan glacier, which generations ago flowed into the Columbia river many miles to the west. The Grand Coulee was created when the Columbia river was dammed in this way and overflowed into the Grand Coulee channel. The river flowed through this channel for a considerable period until the Okanagan glacier retreated and allowed the river to resume its earlier course. The Grand Coulee was then left a dry gorge with its magnificent "dry falls" at the lower end. The placing of the dam at the upper end of the Grand Coulee and damming its lower valley makes possible the creation of a lake some 30 miles in length at an elevation some 600 feet above the present

Fig. 1—Topographic Perspective, Geographic Location of Dam and Irrigation Areas affected by the Columbia Basin Project.

river, it is proposed to pump water into this lake to serve by gravity the irrigation requirements of the 1,200,000 acres of now arid lands in the Columbia Basin which extend as far south as Pasco, Washington. The irrigation projects extend some 85 miles north from Pasco with a maximum longitudinal dimension of 66 miles. We are told that the development of this area will be equivalent to adding another state the size of Delaware to the Union.

Fig. 2—Dry Falls of the Grand Coulee. Five Miles in Length and 400 Feet in Height, located at the Lower End of the Grand Coulee.

The construction problems at Grand Coulee have been met in an extraordinary way, volume being surprisingly large and conditions unusual. For size and method of attack this project is outstanding in the world today. The Grand Coulee dam when completed to its full size will be three times as big as Boulder dam, now the largest concrete dam in the world.

The combined irrigation and power project as now conceived consists of the dam across the Columbia river where it passes the northeasterly end of the Grand Coulee. A 1,890,000 kw. power plant in two power houses, one at each end of the downstream toe of the dam; a 20-unit pumping plant in a 100 by 640 foot building which is upstream of the left abutment and below reservoir level, each pumping unit of which will have a capacity of 800 second-feet when operating under a total head of 370 feet; plate steel discharge pipes, one from each pumping unit through which the water is raised from a supply canal 1.7 miles in length; an earth and rock fill dam nearly 100 feet in height at each end of the Grand Coulee to form a regulating reservoir 24 miles in length with an area of 21,000 acres and a useful capacity of 340,000 acre-feet, the maximum water surface of which will be 280 feet above that in the Columbia river reservoir; an 11-mile main canal leading out of the southwesterly end of the Grand Coulee having a capacity of 15,000 second-feet which bifurcates into a main east and a main west canal, 156 and 101 miles long respectively (the entire main canal system requires the construction of numerous large tunnels, siphons, wasteways, headgate structures and bridges); a distribution and lateral system extended to each 160-acre farm; secondary power plants at feasible locations along the canals, and transmission lines; numerous motor-driven pumping plants for raising the water not exceeding 100 feet to various areas totalling 219,000 acres, and finally a drainage system to handle the seepage consequent to irrigation.

Hydrology and Soil Conditions

The climate in the area is very favourable for human habitation and with a fertile soil the land should be settled under favourable auspices. The drainage area of 74,000 square miles upstream from the Grand Coulee damsite embraces parts of British Columbia, Idaho, Montana and Washington. The drainage from British Columbia including the Pend d'Oreille river constitutes nearly two-thirds of the flow of the Columbia river at the dam.

The mean temperature of the area is 50.4 degrees F., and during the irrigation season, April to October, is 62.2 degrees F. The mean annual precipitation is 8.2 inches. However, the mean precipitation for the irrigation season is only 3.6 inches. The soil is generally deep and varies from fine silty to sandy loam and is reported to be extremely rich. The crops are expected to be any or all of those common to a temperate zone, such as hay, grain, beans, peas, other vegetables and fruits. The land at one time was quite well settled having been nearly all homesteaded in the nineties. Therefore, the project can hardly be considered as bringing new land into cultivation although the farms and towns have been largely abandoned due to lack of productivity of the land without water.

Grand Coulee Dam Site

The foundation and abutment bedrock is entirely granite which may be differentiated into a fine-grained much-jointed, somewhat porphyritic rock and a considerably coarser grained massive granite, both of which have been found sound and suitable for supporting a high concrete dam. The topography of the rock floor is generally of uniform elevation, from 2,800 to 3,000 feet in width, and the rock at each abutment rising on about a 1½:1 slope. However, there are three pronounced but comparatively narrow depressions in the foundation, one toward the right abutment being 100 feet below the general level.

The granite foundation is overlain with fine-grained compact deposits which have been referred to as the silt overburden. This has a thickness varying from about 20 to 150 feet and constitutes the main mass of the foundation excavation.

In the early field investigations some diamond drill holes were put down and are now being continued to solve various design and construction problems. One hole has been drilled 650 feet below the bottom of the river channel. Along the axis of the dam three-foot holes are being drilled at 200-foot intervals. These are being made to a depth of 50 to 60 feet by use of a core drill. It will be possible to lower the geologists into these holes to observe the rock foundation at close range while the excavated cores will form a permanent record of the nature of the foundation.

Fig. 3—View of Project, Rattlesnake Canyon Disposal Dump in Centre Foreground. Mason City on Right Bank below Dam Site Excavation.

Large Spillway Capacity

The spillway will be divided into eleven 135-foot openings by ten piers, and structural-steel drum gates 28 feet high will be mounted on the crest of these openings. The lip of the drum gates when fully raised to elevation 1288 (low water in the river is at present about elevation 940), will control the normal high water surface of the reservoir which, at this elevation, will have a capacity of 9,610,000 acre-feet in a lake extending to the Canadian border. The spillway capacity with gates down and a reservoir water surface elevation of 1290.5 will be about 1,000,000 second-feet, slightly more than twice the recorded flow. The river elevation at the international boundary under natural high water conditions is in the neighbourhood of 1,328 feet and the low water about 1,292 feet.

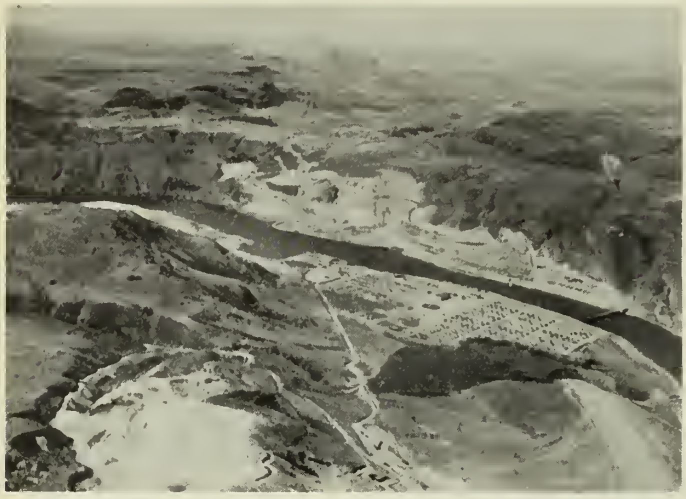


Fig. 4—View of Project Looking Upstream taken from East Bank, Mason City immediate Foreground. Coulee Dam Townsite on Left Bank.

Completion of the Grand Coulee "high" dam is a problem for the future and one that need not be given serious consideration until the work now under contract is nearing completion. Conditions and requirements at that time will no doubt govern the next step to be taken in the development of the Columbia Basin project.

Mason City, Washington

The Mason-Walsh-Atkinson-Kier organization has spent $1,000,000 in building a modern town of comfortable homes to house its three thousand employees. It is located on a gently sloping bench on the east side of the river, about one-half mile below (north of) the dam site. The main and central avenue, 80 feet in width, is in line with the new State highway bridge. Along this avenue are located a recreation hall, bus depot, theatre, town hall, bank, post-office, hotel and stores. The homes of men with families are on the north side of this main artery, and on the south side are bunkhouses for other workers and foremen, a "bachelor town" of one-room cottages, girls' dormitory, hospital, mess hall, and administration building. Water supply is from the Columbia river, water being pumped from the river about a mile above the dam and chlorinated at the pumps. Mason City is entirely without chimneys and smoke and, except for main floor areas in a few of the larger buildings, the entire city is electrically heated. There is an organized fire department and State highway patrolmen preserve law and order. The mess hall has a seating capacity of 1,344. A modern hospital of fifty-six beds has a well-stocked pharmacy, clinical laboratory, three operating rooms, a maternity department, and dental rooms. On the hospital staff are three doctors, nurses, laboratory technician, two dentists and a dietician. The hospital is completely air-conditioned.

Coulee Dam, Washington

The Government town, known as Coulee Dam, is on the west side of the river, and has a present population of about three hundred. Streets are paved and sidewalks and curbs have been built. The water supply is obtained from a spring of 40 gallons per minute capacity, except that river water is used for irrigation, fire protection and flushing. An administration building, two dormitories, school building, garage and fire station, warehouse and about one hundred residences have been constructed. The buildings are modern in every respect and of permanent construction.

Construction Features

The contractors have evolved several interesting devices for the carrying out of their contract, the most spectacular to the visitor at the present time being the conveyor belt system which is designed to move 2,500 cubic yards per hour, a distance of over one mile from behind the coffer dams at the dam-site to the dump in Rattlesnake Canyon with a gross lift of 543 feet. Both of these figures will be increased as the job progresses. The conveyor belt is 5 feet in width, ¾-inch thick and will be called upon to move probably a grand total of more than 17,000,000 cubic yards of material. The best twenty-one hour output to date is 50,700 cubic yards. The usual daily output is 43,000 cubic yards.

Making Aggregate at Grand Coulee

In planning the aggregate plant the quantity of material required made it necessary to reduce all handling charges to a minimum. Under the low dam contract, some 3,500,000 cubic yards of concrete were required and the high dam will increase this figure to 10,000,000 cubic yards. The poured concrete will be cooled artificially by pumping cold water through a system of one-inch pipes placed in the concrete on 5-foot centres.

All aggregate materials are to come from the Brett Banks, 1½ miles northeast of the dam, on a high mesa forming the eastern edge of the Columbia river valley. This deposit, some 700 feet above the general level of Mason City, is of glacial origin and contains all the aggregate sizes required in quantities far exceeding the needs of the job.

There are to be two concrete mixing plants, one on each side of the river, each plant to be equipped with four 4-cubic yard mixers, each with an automatic weighing batcher under octagonal bins whose eight compartments will afford two bins for each of three classes of material and one bin each for two other grades.

The suspension bridge immediately below the dam site will carry a conveyor system upon which the aggregate will be transported to the mixer plant on the north side of the river. The belt will be 36 inches wide with a speed of 400 feet per minute. In addition the suspension bridge will carry a pipe through which east-bound bulk cement will be delivered by pneumatic means from the blended cement silos on the west bank, for a maximum distance of about 6,000 feet.

As previously stated the present contract at the Grand Coulee dam is expected to be completed in 1937. The ultimate structure at Grand Coulee will contain nearly three times as much concrete as the now famous Boulder dam on the Colorado river and its cost also dwarfs the Colorado river project. It will be interesting for Canadians and especially those of British Columbia to watch the results of this stupendous undertaking.

Report of Council for the Year 1935

In reviewing the events of the past year, it is satisfactory to note the continued improvement in industrial conditions, which although not rapid, has been accompanied by a growth in engineering activities. All branches of engineering have not shared equally, since the construction industry has lagged somewhat behind other branches; thus our members concerned in construction work have been less favourably situated than others as regards employment. There has, however, been a marked reduction in the number of our members who are unemployed and an increase in the active roll of The Institute, the latter being due in part to the resumption of membership by a considerable proportion of those on the non-active list, and in part to the unremitting efforts of the various branch membership committees.

The revenue of The Institute has shown an increase over that anticipated in the budget of the Finance Committee, a budget which has been closely followed as regards expenditure. Our income has, however, not yet expanded to a point permitting the resumption of the many activities which have had to be curtailed in recent years through lack of funds. It is particularly desirable that when sufficient funds become available to permit the provision of expenses for speakers at outlying branches, and for regular visits to branches on the part of officers of The Institute, these most useful practices be resumed.

It has seemed desirable to Council that the entrance fee for all classes of membership, which for more than a year has been reduced to five dollars, should remain at that figure for the present. The Annual Meeting will be asked to approve Council's action in thus waiving the provisions of Section 32 of the by-laws.

Your Council would express appreciation of the manner in which the activities of the branches have been maintained during the year and in particular the successful efforts which have been made to interest younger members of the profession in The Institute's work.

The Council has pleasure in recording the generous foundation by Past-President G. H. Duggan, M.E.I.C., of a prize having a value of one hundred dollars, which will bear his name and which will be offered annually to members of The Institute for award to the author of the best paper on some phase of the branch of engineering work with which the donor has been connected. The thanks and appreciation of The Institute have been conveyed to Mr. Duggan by the Council.

Among the questions of public interest to which your Council has given attention during the year may be mentioned: The drought problem in the West; the procedure desirable in calling for tenders and letting contracts for public works; the St. Lawrence Ship Channel, and the technical aspect of low cost housing.

It has also been possible to co-operate with the National Construction Council, of which The Institute is one of the supporting organizations, and with the Canadian Chamber of Commerce, in regard to public matters under the consideration of these bodies.

Your Council has noted with appreciation a number of cases during the past year in which engineers have been appointed to important positions in the public service, particularly in the case of the Quebec Electricity Commission and important portfolios in the Federal and Provincial governments.

In all parts of the country, members of The Institute have followed with great interest the work of the Committee on Consolidation, which was appointed by the Annual Meeting at Toronto on February 7th, 1935. The activities of that committee have been reported from time to time in The Engineering Journal, and its recommendations will be placed before the membership for discussion at this Annual Meeting. It is noteworthy that in several provincial centres schemes of consolidation between the local associations of Professional Engineers and The Institute have been formulated. These proposals have received careful consideration, but Council was not able to implement any of them, pending the presentation of the report of the Committee on Consolidation to this Annual Meeting. Council is anxious to promote the cause of consolidation and ventures to express the hope that the furtherance of such proposals will not be found to conflict in any way with any more comprehensive organization that may be contemplated in, or may grow out of the report of the Committee on Consolidation, but will, on the contrary, be contributory thereto.

No changes in The Institute by-laws have been proposed this year pending the possible development of some scheme for consolidation.

Attention should be drawn to the fact that in February 1937 The Institute will complete its fiftieth year of continuous activity, some thirty years of which were under the name of The Canadian Society of Civil Engineers. It is felt that this semi-centennial of The Institute should be marked by an appropriate celebration and a special committee has been formed to suggest suitable plans for this occasion.

The anticipations expressed in last year's report as to the success of the 1935 E.I.C. Engineering Catalogue have been fulfilled. It is gratifying to note that many expressions of appreciation of this valuable publication have been received, and the catalogue would now appear to be on a self-sustaining basis.

After an interval of three years, during which funds were not available, it has been found possible to issue a List of Members, thus supplying long delayed information which has been urgently needed.

In the opinion of Council, attention should be called to the lack of interest shown by the younger members in the competitions for the various prizes of The Institute. Further, too many of our members do not appear to realize the benefits accruing to the author of a paper, whether entered for a prize, or presented for discussion at an Institute or branch meeting. He cannot fail to increase his own professional knowledge, he benefits by the quite legitimate publicity given to authors and discussors; he adds to his personal reputation, and renders a service to The Institute and his fellow members.

The Forty-Ninth Annual General Meeting commenced at Headquarters on Thursday, January 24th, 1935, in accordance with the by-laws, and was adjourned to the Royal York Hotel in Toronto on February 7th when it was continued, and followed by the Annual General Professional Meeting.

Following the custom of recent years, the Toronto meeting was limited to two days, but this did not prevent the transaction of important general business and the presentation of some notable technical papers. At the business session on February 6th the subject of the Consolidation of the Engineering Profession in Canada was brought up, as a result of a number of resolutions and messages which had been sent in by various branches of The Institute. The discussion on this question was opened by Gordon McL. Pitts, A.M.E.I.C., who first presented a resolution endorsing the principle of consolidation, which was carried unanimously. In view of the importance of the matter, it was decided to continue the discussion in the afternoon, at the time of the presentation of three papers on the Status of the Engineer, and at this adjourned discussion the meeting appointed a Committee on Consolidation under the chairmanship of Mr. Gordon Pitts, the Committee being directed to develop the possibilities of Consolidation of the Profession in Canada, and to report their findings to Council and through Council to the next Annual Meeting of The Institute, or to a special General Meeting called for the purpose.

The social functions began with a luncheon on February 7th, at which J. B. Carswell, M.E.I.C., addressed those present on the Status of the Engineer; in the evening the Annual Dinner of The Institute took place, at which the prizes and medals of The Institute were presented by the Hon. Grote Stirling, M.E.I.C., and an address was given by Dr. A. S. Eve, C.B.E., F.R.S., Dean of the Faculty of Graduate Studies, McGill University, the dinner being followed by a dance. One of the most interesting functions of the meeting was a tour of the Royal Ontario Museum which was organized for the ladies who were most kindly received by the curator, Professor C. T. Currelly.

All the members present at the meeting greatly appreciated the successful results of the preparatory work of the Branch Committee under the chairmanship of J. J. Traill, M.E.I.C., and, later, of A. B. Crealock, A.M.E.I.C.

The professional sessions were held on Friday, February 8th. Six papers were presented in the morning, and the afternoon was devoted to an important discussion on the Water Supply of the Prairie Provinces and its Bearing on their Economic Development, this session being held under the chairmanship of Past-President S. G. Porter, M.E.I.C. Eleven papers were presented covering the different engineering phases of this question, and an active discussion followed.

Following the activities of the first two days of the meeting, a considerable number of members remained for the morning of Saturday the 9th, and took part in inspection trips to engineering works of interest in the city and neighbourhood.

A considerable proportion of the time usually taken up by purely technical papers was devoted to the consideration of topics of more general interest to the public, an innovation which met with general approval.

Roll of The Institute

During the year 1935, two hundred and twenty-three candidates were elected to various grades in The Institute. These were classified as follows:—Twenty-one Members, thirty-seven Associate Members, fifteen Juniors, one hundred and forty-six Students, and four Affiliates. The elections during the year 1934 totalled one hundred and seventy candidates.

Transfers from one grade to another were as follows:—Associate Member to Member, twenty-nine; Junior to Associate Member, thirty-five; Student to Associate Member, thirty-two; Student to Junior, thirty; Affiliate to Associate Member, one; Junior to Member, one; a total of one hundred and twenty-eight.

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 1935, for non-payment of dues and by resignation, eight Members, twenty-five Associate Members, nine Juniors, twenty-five Students, and two Affiliates, a total of sixty-nine.

Two hundred and seventy-two reinstatements were effected, and twelve Life Memberships were granted.

During the year 1935 thirty-one names were placed on the Non-Active List, which now numbers three hundred and eighty-three.

Deceased Members

During the year 1935 the death of thirty members of The Institute have been reported as follows:—

Honorary Member

Byng, Julian Hedworth, First Viscount Byng of Vimy.

Members

Adams, William Charles	Hunter, Joseph
Angus, Robert	Larmonth, John Herbert
Armstrong, John Simeon	Lesage, Thomas W.
Brock, Reginald Walter	Lindenthal, Gustav
Davis, George H.	O'Meara, Alfred
DePencier, Henry P.	Pattenden, Albert Henry
Gutelius, Frederick Passmore	Pitcher, Frank Henry
Harcourt, Frederick Young	Wynne-Roberts, Robert Owen
Hodgson, Jos. Pollard	

Associate Members

Bonin, Joseph O.	Madgett, Clarke John
Cantley, Charles Lang	McCrady, Frank Welcome
Cauchon, J. E. Noulan	Macreath, Chas. Melville
Gauvin, Chas. Edward	Pigot, Charles John
Gardiner, Edward	Richardson, Geo. Henry
Lambe, Alfred Boydell	

Junior

Leverin, Harald Leicester

Total Membership

The membership of The Institute as at December 31st, 1935, totals four thousand, one hundred and thirty-three. The corresponding number for the year 1934 was, three thousand, seven hundred and sixty-four. These figures do not include those names which are on the Non-Active List.

1934		1935	
Honorary Members	8	Honorary Members	7
Members	914	Members	976
Associate Members	1,782	Associate Members	1,983
Juniors	299	Juniors	320
Students	727	Students	810
Affiliates	34	Affiliates	37
	3,764		4,133

Respectfully submitted on behalf of the Council,

F. A. Gaby, M.E.I.C., *President.*
R. J. Durley, M.E.I.C., *Secretary.*

Treasurer's Report

It is doubtful if in the entire forty-nine years of this organization's history the Treasurer has had greater cause for sounding a note of satisfaction and confidence than has the present incumbent. Satisfaction in the accomplishment of The Institute and confidence in its future was never more justified than it is to-day. Notwithstanding the drastic economies at Headquarters, and in spite of the extensive curtailment in activities forced upon Council by the depression, The Institute has continued to provide valuable service to its membership. While other reports will indicate the principal reasons therefor, the Treasurer feels it advisable to emphasize the following facts:—

1. During 1935 Revenue exceeded Expenditures.
2. The catalogue is now a proven asset with an increasingly promising future.
3. Fee collections are notably better than budget expectations.
4. Reinstatements to the active list have increased greatly.
5. The membership has resumed its growth.

With full knowledge of the above facts it is the considered opinion of the Treasurer that so far as finances are concerned, The Institute is in a sound and satisfactory position.

J. B. Challies, M.E.I.C., *Treasurer.*

Finance Committee

Your Finance Committee are again happy to be able to report definite evidence of recovery from the effects of the severe restriction in engineering activity during the "depression years." The principal encouraging features during 1935 have been the resumption of active membership by so many of those who were compelled by circumstances to temporarily seek the relief offered by the non-active list, the consequent additional income from over-due fees, and the continued increase in membership.

The budget expectations have been more than fulfilled with regard to current fees, advance and entrance fees, but the considerable increase in receipts from over-due fees bring the total revenue under the heading "Fees and Subscriptions" to $33,726.22 as compared with the estimate of $31,300.00, and the 1934 figure of $32,446.56.

From publications apart from Journal subscriptions, the income has just kept pace with expectations, The Journal advertising having fallen slightly short and the Catalogue advertising having shown rather better results than anticipated.

Other sources of income have also improved in yield, so that the total actual receipts, namely, $60,520.64, represent over $2,000.00 more than the budget drawn up in February last.

Your committee feel that the membership should be definitely gratified at these results, which, in addition to being tangible evidences of improving conditions, also demonstrate the country-wide loyalty of the membership toward The Institute. In view of certain scattered efforts to class The Institute as effete or moribund it is surely pertinent to observe that this loyalty can only be based on sincere regard for the organization itself, and a consciousness of services received.

On the expenditure side it must first be intimated that the obvious and proper policy of the Finance Committee has been to spend all revenue within a balanced budget on useful services, resuming wherever possible those that have been curtailed in recent years. Thus a new list of members has been published, not in the usual form, but in a form dictated by the amount of funds available. Some increase in library facilities has been permitted, more money has been allotted to Committees, and automatically the Branch rebates have been increased.

The actual cash expenditures during the calendar year have reached $60,005.85, whereas the budget allowed $58,500.00 exactly equal to the anticipated income. On this basis the operations for 1935 show a credit surplus of $514.79. The Auditors' Statement does not quite reflect this fact because of the Catalogue expenditures not being confined to the year of issue. The expenses on the 1935 Catalogue which were incurred in 1934 were brought into the statement, whilst those on the 1936 issue incurred in 1935 will be deferred until the next Annual Statement. As the cost of production is decreasing, the anomalous result of this arrangement is that our surplus is reduced from $514.79 to $18.28 after some allowance has been made for depreciation.

It is opportune to observe at this point that the 1935 issue of the Catalogue was definitely profitable. The total

STATEMENT OF REVENUE AND EXPENDITURE FOR YEAR ENDING 31st DECEMBER, 1935

Revenue

Membership Fees:		
Arrears	$ 3,399.50	
Current	22,450.84	
Advance	545.21	
Entrance	1,049.00	
		$27,444.55
Publications:		
Journal subscriptions and sales	6,281.67	
Journal advertising	11,940.64	
Catalogue advertising—1934-35 issue	13,596.24	
		31,818.55
Income from Investments		477.19
Refund of Expenses of Hall		625.00
Sundry Revenue		155.35
		$60,520.64

Expenditure

Building Expenses:			
Taxes—Property and water		$ 2,019.78	
Fuel		409.60	
Insurance		128.37	
Light		250.12	
Caretaker's wages and service		878.00	
Repairs and expenses		627.14	
			$ 4,313.01
Publications:			
Journal—Salaries	$ 5,637.06		
Expenses	13,209.33		
		18,846.39	
Catalogue—Salaries	3,756.38		
Expenses	9,134.94		
		12,891.32	
Sundry printing		476.37	
			32,214.08
Office Expenses:			
Salaries—Secretary and staff		10,659.09	
Telephone, telegrams and postage		1,426.52	
Office supplies and stationery		941.09	
Audit fees		250.00	
Messenger and express		116.42	
Miscellaneous		159.69	
			13,552.81
General Expenses:			
Annual and Professional Meetings		1,795.09	
Meetings of Council		107.13	
Travelling—Secretary		213.24	
Branch stationery		181.25	
Students' Prizes		50.61	
E-I-C Prizes		288.75	
Gzowski Medal		17.25	
Library—Salary	$ 519.72		
Expenses	452.87		
Depreciation, 10%	160.90		
		1,133.49	
Interest, discount and exchange		345.63	
Examinations—Cost less amount collected		20.00	
Committee expenses		632.47	
National Construction Council		100.00	
			4,884.91
Rebates to Branches			5,537.55
Total Expenditure			$60,502.36
Excess of Revenue over Expenditure for Year			18.28
			$60,520.64

expenditures amounted to $12,891.32, whilst revenue to date is about $13,220.00, in addition to which some $400.00 remains to be collected. The outlook for future issues is still brighter. The field is widening, the general advertising situation is bound to improve, and due to familiarity and efficiency the cost of production per unit of revenue is diminishing.

As in 1934, your Finance Committee has been continuously faced with the problem of discovering for each individual case the most reasonable treatment of members in arrears. Happily the pressure is now substantially reduced, and the policy of making it easy for those who have been really hard pressed to retain their affiliation and eventually to resume active membership has been successful in assisting many members back to full participation in Institute affairs. Similarly a generous consideration of the position of those members who felt compelled to resign during recent years, has enabled many of them to re-enter via the re-instatement path, while the efforts of the Membership Committee have been successfully directed to the securing of numerous new applications for admission.

The investments of The Institute have suffered little or no change during the year. Yields from interest and dividends naturally follow the general tendencies of the times, and the assets have been increased by the generous provision made by Past-President G. H. Duggan, M.E.I.C., for additional prizes or awards.

Whilst ordinary repairs have been made to the Headquarters building, there has been no need of further capital expenditure. The normal situation has been maintained at the bank, but it has naturally been found impracticable to increase to any extent the surplus on the asset side of the statement.

Your Committee expresses its appreciation of the continued excellent work of the Headquarters Staff, which has been abnormally heavy recently, in order to cope with Committee requirements, and sincerely trusts that the opportunity for some partial restoration of cuts in salary may be found in the not too distant future.

Respectfully submitted,

P. L. Pratley, M.E.I.C., *Chairman*

Nominating Committee—1936

Chairman: A. J. Taunton, M.E.I.C.

Branch	*Representative*
Cape Breton Branch	F. W. Gray, M.E.I.C.
Halifax Branch	R. L. Dunsmore, A.M.E.I.C.
Saint John Branch	A. Gray, M.E.I.C.
Moncton Branch	H. B. Titus, A.M.E.I.C.
Saguenay Branch	N. F. McCaghey, A.M.E.I.C.
Quebec Branch	L. P. Methé, A.M.E.I.C.
St. Maurice Valley Branch	Z. Lambert, M.E.I.C.
Montreal Branch	J. A. Lalonde, A.M.E.I.C.
Ottawa Branch	C. P. Edwards, A.M.E.I.C.
Peterborough Branch	A. L. Killaly, A.M.E.I.C.
Kingston Branch	L. M. Arkley, M.E.I.C.
Toronto Branch	J. W. Falkner, A.M.E.I.C.
Hamilton Branch	J. R. Dunbar, A.M.E.I.C.
London Branch	S. G. Johre, A.M.E.I.C.
Niagara Peninsula Branch	C. G. Moon, A.M.E.I.C.
Border Cities Branch	A. J. M. Bowman, A.M.E.I.C.
Sault Ste. Marie Branch	A. H. Russell, A.M.E.I.C.
Lakehead Branch	H. G. O'Leary, A.M.E.I.C.
Winnipeg Branch	F. V. Seibert, M.E.I.C.
Saskatchewan Branch	R. A. Spencer, A.M.E.I.C.
Lethbridge Branch	J. Haimes, A.M.E.I.C.
Edmonton Branch	R. S. L. Wilson, M.E.I.C.
Calgary Branch	J. J. Hanna, A.M.E.I.C.
Vancouver Branch	E. E. Carpenter, M.E.I.C.
Victoria Branch	E. C. G. Chambers, A.M.E.I.C.

STATEMENT OF ASSETS AND LIABILITIES AS AT 31st DECEMBER, 1935

Assets

Current:			
Cash on hand and in Savings Account			$ 113.89
Accounts receivable	$ 2,650.48		
Less: Reserve for uncollectible accounts	255.01		
			2,395.47
Arrears of fees—Estimated			2,500.00
			5,009.36
Special Funds—Per Statement attached:			
Investments		13,280.14	
Cash in Savings Bank		1,227.54	
Due by Current Funds		1,314.98	
			15,822.66
Investments—At cost:			
$100 Dominion of Canada 4½%, 1946		96.50	
$200 Dominion of Canada 4½%, 1958		180.00	
$4,000 Dominion of Canada 4½%, 1959		4,090.71	
$500 Province of Saskatchewan 5%, 1959		502.50	
$1,000 Montreal Tramways 5%, 1941		950.30	
$2,000 Montreal Tramways 5%, 1955		2,199.00	
$500 Title Guarantee and Trust Corp. Certificate, past due		500.00	
2 Shares Canada Permanent Mortgage Corp		215.00	
40 Shares Montreal Light, Heat & Power Cons. N.P.V.		324.50	
			9,058.51
Advances to Branches			150.00
Deposit—Postmaster			100.00
Prepaid and Deferred Expenses:			
Stationery		781.79	
Unexpired insurance		320.00	
Expenses of 1935-36 Catalogue		3,196.36	
			4,298.15
Gold Medal			45.00
Library—At cost, less amounts written off			1,448.13
Furniture—At cost, less amounts written off			4,496.61
Land and Buildings—At cost (Assessed Value $57,200)			89,041.64
			$129,470.06

Liabilities

Current:		
Bank Overdraft—Secured		$ 10,466.66
Accounts Payable		1,568.54
Rebates due to Branches		553.40
Library Deposits		5.00
Amount due to Past Presidents' Fund		1,314.98
		13,908.58
Special Funds:		
Leonard Medal	$ 643.45	
Plummer Medal	626.79	
Duggan Medal	2,351.82	
Fund in Aid of Members' families	2,189.60	
Past Presidents' and Prize Fund	5,553.91	
War Memorial Fund	4,457.09	
		15,822.66
Surplus:		
Balance as at 1st January, 1935	99,720.54	
Add—Excess of Revenue over Expenditure for year ending 31st December, 1935	18.28	
		99,738.82
		$129,470.06

Montreal, 11th January, 1936.

Audited and verified, subject to our report of this date.

Ritchie, Brown & Co.,
Chartered Accountants.

Past-Presidents' Prize Committee

The President and Council:—

Five candidates entered this competition by submitting a paper on the prescribed subject "The Co-ordination of the Activities of the Various Engineering Organizations in Canada." The competitors were Messrs. deHart, Gray, Kirby, Sills and Breakey.

After reading all papers and then re-reading for the first and second places, the examiners have reached a clear conclusion, by a majority of opinion, that the Past-Presidents' Prize for the year 1935 should be awarded to J. B. deHart, M.E.I.C.

The Committee wishes to add that the competition for the first two places in this award was very close.

Respectfully submitted,

R. W. Boyle, M.E.I.C., *Chairman.*

Gzowski Medal Committee

The President and Council:—

We recommend that the Gzowski Medal for 1934-35 be awarded to Mr. P. L. Pratley, M.E.I.C., for his paper entitled: "The Sub-structure of the Reconstructed Second Narrows Bridge."

The Committee are unanimous in making this recommendation.

Respectfully submitted,

R. S. L. Wilson, M.E.I.C., *Chairman.*

Plummer Medal Committee

No report received.

Leonard Medal Committee

The President and Council:—

The Leonard Medal Committee, consisting of Messrs. G. G. Ommanney, M.E.I.C., B. Stuart McKenzie, M.E.I.C., A. O. Dufresne, M.E.I.C., G. V. Douglas, A.M.E.I.C. and L. L. Bolton, M.E.I.C., chairman, have read the various papers eligible for the award of the Leonard Medal for the year 1934-1935, and are unanimously of the decision that the medal should be awarded to Mr. R. W. Diamond for his paper "The Trail Heavy Chemical Plants" published in the Canadian Mining and Metallurgical Bulletin for September, 1934.

Respectfully submitted,

L. L. Bolton, M.E.I.C., *Chairman.*

Students' and Juniors' Prizes

The report 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 24th, 1936, and the following awards were made:—

H. N. Ruttan Prize (Western Provinces)—To Z. Levinton, S.E.I.C., for his paper "Determination of Temperature Stresses in an Arch Bridge Model by Means of the Photoelastic Method."

SPECIAL FUNDS AS AT 31st DECEMBER, 1935

Leonard Medal Fund:		
Balance as at 1st January, 1935	$ 628.79	
Add: Bond interest	30.00	
Bank interest	1.91	
	660.70	
Deduct: Cost of Medals	17.25	
		$ 643.45
Plummer Medal Fund:		
Balance as at 1st January, 1935	619.78	
Add: Bond interest	22.50	
Bank interest	1.76	
	644.04	
Deduct: Cost of Medals	17.25	
		626.79
Duggan Medal:		
Value of Bonds donated during year	2,300.00	
Add: Bond interest	51.75	
Bank interest	.07	
		2,351.82
Fund in Aid of Members' Families:		
Balance as at 1st January, 1935	2,122.46	
Add: Bond interest	90.00	
Bank interest	2.14	
	2,214.60	
Deduct: Donation made to Member	25.00	
		2,189.60
Past Presidents' and Prize Fund:		
Balance as at 1st January, 1935	5,433.99	
Add: Bond interest	240.00	
Bank interest	2.92	
Interest on loan	12.00	
	5,688.91	
Deduct: Cost of Prizes	135.00	
		5,553.91
War Memorial Fund:		
Balance as at 1st January, 1935	4,263.91	
Add: Bond interest	190.00	
Bank interest	4.61	
	4,458.52	
Deduct: Sundry expense	1.43	
		4,457.09
		$15,822.66

Represented by:		
$500 Title Guarantee and Trust 6% 1933 Certificate	$ 500.00	
Cash in Savings Bank	143.45	
		$ 643.45
$500 Dominion of Canada 4½% 1959 Bonds	500.00	
Cash in Savings Bank	126.79	
		626.79
$2,300 Dominion of Canada 4½% 1959 Bonds	2,300.00	
Cash in Savings Bank	51.82	
		2,351.82
$1,000 Province of Ontario 4½% 1964 Bonds	1,022.17	
$1,000 Dominion of Canada 4½% 1959 Bonds	972.97	
Cash in Savings Bank	194.46	
		2,189 60
$3,000 Montreal Tramways 5% 1955 Bonds	2,490.00	
$1,500 Title Guarantee and Trust Corp. 6% 1933 Certificate	1,500.00	
Cash in Savings Bank	248.93	
Due by Current Funds	1,314.98	
		5,553.91
$2,000 Dominion of Canada 4½% 1959 Bonds	2,000.00	
$2,000 C.P.R. Collateral Trust Gold Bonds 5% 1954	1,995.00	
Cash in Savings Bank	462.09	
		4,457.09
		$15,822.66

John Galbraith Prize (Province of Ontario)—No papers received.

Phelps Johnson Prize (Province of Quebec, English)—To S. T. Fisher, Jr.E.I.C., for his paper on "Recent Developments in Sound Pictures."

Ernest Marceau Prize (Province of Quebec, French)—To Yvon-Roma Tassé, S.E.I.C., for his paper "Le Vent pour Electrifier nos Campagnes."

Martin Murphy Prize (Maritime Provinces)—To F. L. Black, Jr.E.I.C., for his paper "The Low Voltage Cathode-Ray Oscillograph and Several Applications in Radio Research."

Membership Committee

The President and Council:—

Early in the season practically every branch of The Institute had appointed a membership committee for the purpose of actively convassing prospects for new members and also encouraging non-active members to resume active membership. Furthermore, transfers of these members who were qualified for a higher grade were suggested.

In order to provide these local committees with the necessary knowledge of The Institute and its activities, your Committee prepared a "Manual," which contained a full account of The Institute, its activities, with comprehensive notes covering reasons why the Canadian engineer should be a member. Over one hundred copies of this manual were distributed. Your Committee believes that something of this sort should always be kept available as otherwise it is almost impossible for a member of a local committee to become sufficiently well acquainted with The Institute's affairs to be able to present a fair case to the prospective member.

As a "side line" to membership activities, some branches have obtained desirable publicity for Institute members, by supplying the local press with announcements of new admissions and transfers. It is gratifying to find that in some cities the transfer from Associate Member to Member has been looked upon as "news" and has resulted in very satisfactory publicity dealing with the "honour conferred."

Conditions cannot be said to be ideal for obtaining new members owing to several causes among which may be mentioned: (1) Some lack of employment and low remunerations; (2) Some confusion of thought regarding the future status of The Institute; (3) Competition from other organizations. However many branches have definitely shown that they can overcome adverse conditions, and while it is inadvisable to make any invidious distinctions your committee feels warranted in especially commenting on the fact that in British Columbia the backing of the Association of Professional Engineers of that province has been instrumental to a large degree in the success that has been obtained by the local committee.

It is gratifying to be able to report that, as a result of these branch activities, the corporate membership shows an increase of 9.8% as compared with last year—the total active membership being 4,133 as compared with 3,764 in 1935. Further, improved conditions have enabled some 226 members on the non-active list to resume their active connection with The Institute; thus reducing the non-active list from 609 to 383 members.

In order that The Institute may maintain its numerical strength, and preferably improve upon the present figures, branch executives are urged to take every step possible to encourage any kind of activity which will help to make The Institute attractive to Canadian engineers, and to actively support their own membership committees.

One of the difficulties of membership committees is the locating of "prospects," notwithstanding the fact that there are many of them. This is where every member of The Institute can play his part, by submitting names of those engineers who are not members to any local officer, and furthermore not overlooking the fact that he himself can do a great deal by putting in a good word for The Institute on every possible occasion.

Theoretically it should not be necessary to seek members, but rather the function of a membership committee should be more in the nature of passing upon applicants, standardizing qualifications and so forth. The facts, however, must be faced, this is a competitive world, and some means must be maintained of acquainting engineers with the advantages of membership in The Engineering Institute of Canada.

Respectfully submitted,

J. L. Busfield, M.E.I.C., *Chairman.*

Papers Committee

The President and Council:—

In the opinion of your Committee, it has two main functions. The first is to help outlying branches, whose membership is limited in number, to get competent men to present papers at their branch meetings. To accomplish this, all members of the committee were asked to send in names of members from their district who contemplated trips that would permit of their calling on other branches. In addition to this a letter was inserted in The Journal asking members to notify the General Secretary if they could make such visits. So far as is known there have been no results.

We desire to call Council's attention to the urgency of this matter. In many cases some expenditure is necessary to cover the travelling expenses of speakers for such branches, and this, those branches cannot afford. It is felt that if this difficulty can be provided for, the benefit to the many members in our smaller branches and the increases in the prestige of The Institute will be greater than can be obtained in any other way.

The second function of the committee is to help the General Secretary, and the branch executive concerned, to get papers for the Annual Meeting. Some assistance was given by the committee this year in obtaining papers for the Annual Meeting and the Chairman held several discussions with the Hamilton Branch with whom he offered to co-operate. Last year the Chairman of the committee was also Chairman of the Annual Meeting Papers Committee as he was on the executive of the Branch holding the Annual Meeting. This worked very well. Normally, however, this is not the case and it is considered that the proper body to assist the General Secretary in arranging for papers at the Annual Meeting is the local papers committee formed for that purpose. Only confusion can result from an attempt to bring the General Papers Committee into the picture.

Each branch has its own local papers committee and it is suggested that the chairmen of these committees should be, automatically, the members of the general Papers Committee. The chairman would, as at present, be appointed by Council. This would add considerably to the size of the committee but its personnel would be of men interested in papers and conversant with the type of papers available within each branch. More co-operation in the exchange of papers between branches could be expected from these men than can be got from a committee, picked at random and composed of men who, in some cases, are not sufficiently active in branch affairs to appreciate the requirements or to be interested in papers.

It is also recommended that the General Papers Committee, as such, have no responsibility for the presentation of papers at Annual Meetings, and that its energies be devoted to helping the outlying branches by making it possible for them to arrange for a paper or a short address from any outstanding member of the profession who may happen to be in their vicinity.

Respectfully submitted,

C. S. L. Hertzberg, M.E.I.C., *Chairman.*

Library and House Committee

The President and Council:—

In accordance with the policies laid down by Council to reduce expenses to a minimum, consistent however with reasonable service, very few additions have been made to the library and only essential repairs have been made to our building. The demand, as would be expected, for services afforded through the library has been well maintained as will be evident from the following comparison which indicates the relative use made of The Institute's facilities during 1934 as compared with 1935.

	1935	*1934*
Requests for information	673	617
Requests for text books, periodicals, reprints, etc.	472	487
Technical books borrowed by members	89	102
Bibliographies compiled for members	21	32
Accessions to library, (largely reports, etc.)	589	597
Requests for photoprints	17	30
Total pages of photoprints furnished to members	110	169
Books presented for review by publishers	27	22

The expenditure this year for repairs is slightly in excess of what it was in 1934 chiefly due to what might be termed a major repair to the roof. The respective outlays for building maintenance are as follows:—

	1934	*1935*
Building maintenance	$490.00	$520.00

The cost of operating the library has remained the same as in the previous year in so far as salaries are concerned—the work being performed by one of the staff giving part time. The net cost of books and periodicals together with salary costs for each of the years, after deducting revenues secured from sale of photostats, etc., is as follows:—

	1934	*1935*
Salaries	$433.00	$433.00
Net cost books, etc.	178.00	239.00
	$611.00	$672.00

Due to yearly additions to the library, the present stack facilities have reached the limit of their capacity and your Committee, having looked into the matter, would recommend that additional sections be purchased for which a price of $72.00 has been obtained.

Through the generosity of several members, The Institute library has benefited by the acquisition of a number of volumes.

Your Committee has given considerable thought to the idea of making, if possible, the facilities afforded the members more valuable, and to this end wishes to recommend consideration of the suggestions as follows:—

1. That new corporate members or those elected to this rank (Members and Associate Members) shall within a period of two years from date of their election undertake to do one of the alternatives (*a*) or (*b*).
   (*a*) Submit a paper prepared by him on some branch of engineering work with which he is particularly familiar or on a subject of general interest, which paper is to be placed at the disposal of The Institute for publication or delivery at one of its meetings.
   (*b*) Donate a book or its equivalent to the library.
2. In order that the members may know more fully of the privileges and facilities which are at their disposal, through their membership in The Institute, greater publicity should be given the services available. It is urged that through the pages of The Journal, at different points, foot-notes or card size announcements indicating pertinent facts, such as costs of subscription to journals of other societies afforded through reciprocal privileges, costs of reprints and excerpting technical articles, etc., should be featured.
3. That in addition to the existing card catalogue, a catalogue be compiled of the books and publications which are in the library and that this catalogue be made available to those of our members who desire to have it, at the cost of its preparation. It is further intended that this catalogue be kept up to date by yearly revision. It is suggested that a questionnaire be sent out before this compilation is undertaken to determine those who would desire to avail themselves of this catalogue so that an equitable basis of charge for the service might be reached beforehand.

Respectfully submitted,
E. A. Ryan, M.E.I.C., *Chairman.*

Report of the E.I.C. Members of the Main Committee of the Canadian Engineering Standards Association

The President and Council:—

The Institute nominees on the Main Committee of the Canadian Engineering Standards Association are now as follows:—

Mr. J. Morrow Oxley, M.E.I.C., retires March, 1936.
Mr. P. L. Pratley, M.E.I.C., retires March, 1937.
Dean C. J. Mackenzie, M.E.I.C., retires March, 1938.

Industrial conditions have shown a slight improvement during the past year and this has had a favourable effect on the income of the Association. There have been only two resignations from sustaining membership and no reductions. One sustaining member has resumed his subscription and two new sustaining members have been secured. The total number of sustaining members and subscribers for the year remains at sixty-eight, the total amount received for the year being $5,350.00, which is an increase of $170 over the sum received in 1934.

The Association continues to occupy quarters in Room 3064 of the National Research Building, through the courtesy of the National Research Council, and with other economies which have been effected the Association has thus been able to carry on for the year.

The Secretary attended the annual meeting of The Engineering Institute of Canada and the Canadian Purchasing Agents Association, and at the latter meeting was given an opportunity of addressing the members with reference to the work of the Association.

A meeting of the Main Committee was held in October to discuss mainly the proposed reorganization of the Main Committee, and general approval was given of the proposed reorganization. A report will shortly be sent out to the members of the Main Committee for their preliminary approval. At this meeting the financial situation of the Association was discussed and assurance was given of continued support from the National Research Council and possibly increased support from industry.

The C.E.S.A. Bulletin has been continued during the year, but it has not been found possible as yet to resume publication of the Year Book.

Work in Progress

A — Civil Engineering and Construction

Brick Sizes.—The Association has now published under designation A 36—1935, a standard covering Dimensions for Building Brick, which it is believed fairly represents Canadian practice. An effort will be made through the technical associations and manufacturers to secure adoption of the standard, and thereafter consideration will be given to other types of building materials. The size adopted is 8⅜ by 2⅜ by 4 inches, for both face and common brick.

Structural Timber.—A committee has been organized to deal with timber specifications and a first draft has been issued, on which comments have now been received. It is planned to discuss this draft at an early meeting of the committee.

Wood Poles and Piling.—As reported last year it is proposed to merge the committees on wood poles and to discuss standards for all types of Canadian timber. A special request has been received from the Canadian Electrical Association that all available types of Canadian timber be recognized. It is hoped also to resume work on the specification for piling.

B — Mechanical Engineering

Screw Products.—Nothing further has been done on this work, but specifications for wood screws and small rivets are under consideration.

Safety Code for Passenger and Freight Elevators.—A report from the panel which is reviewing the comments on the first draft has not yet been received but is expected shortly.

Safety Code for Mechanical Refrigeration.—Nothing further has been done on this code during the year, awaiting a decision as to the final disposition of the code.

Oil Burners.—The Association was finally advised that this work would be taken over by the National Research Council, and the C.E.S.A. committee has been discharged.

C — Electrical Work

Canadian Electrical Code, Part I.—The third edition of the Code was issued in December 1934 and has been widely distributed. Special provincial editions have been prepared for those provinces who have provincial inspection acts.

Canadian Electrical Code, Part II.—Work in connection with Part II, covering approval specifications, has continued to be very active. Specifications for Enclosed Switches, Transformers for Luminous-tube Signs and Oil-burner Ignition Equipment; Industrial Control Equipment in Ordinary Locations, Insulated Conductors for Power-operated Radio Devices, Cable for Luminous-tube Signs and for Oil-burner Ignition Equipment, Soldering Lugs, Motor-operated Blowers and Stokers, Cord Sets, Measuring and Discharge Devices for Explosive or Flammable Liquids, Automatic Motor-control Devices of Small Capacity, and Auxiliary Gutters, Junction-boxes and Pull-boxes, have been published. Specifications for Electrically-heated Warming Pads, Oil Circuit-breakers, Dust-tight Enclosures, Wireways and Busways, Asbestos-insulated Stove Wire, Panelboards, Enclosed Branch-circuit Cutouts, Switchboards and Switching Equipment, Electrically-operated Refrigerating Machines, Electric Cranes and Hoists, Electrode Receptacles for Luminous-tube Signs, Low-voltage Control-circuit Wire and Cable, and Electrical Appliances for Hair Dressing, are still in draft form, but many of them have been discussed at meetings of the special Panel dealing with this subject. First drafts of Specifications for Christmas-tree and other Decorative Lighting Outfits, Rubber-covered Wires and Cables, Cutout Bases, Cabinets and Cutout Boxes, Ground Clamps, Receptacles, Plugs and Similar Devices, Lamp Holders having Socket Screw-shells and Flexible Tubing (non-metallic), are out for comment at the present time.

Under Part III of the Code, dealing with the general subject of Outside Wiring Rules, there has been considerable activity in connection with Overhead Systems, particularly the question of railway crossings. The Association has been in close touch with the railways and communication companies and has been studying a draft set of regulations dealing with this important subject, which it is hoped to issue in tentative form very shortly. Under Inductive Co-ordination, a report on Definitions and Principles has been prepared, also a draft covering regulations for Radio Interference. In connection with Conductive Co-ordination, a report has been prepared dealing with Electrolysis and a report on Grounding has also been issued.

Enamelled Magnet Wire.—Nothing further has been done on the specification for this material as further information is being prepared by the manufacturers.

Insulated Power Cable.—A meeting of the committee was held during the year, but it has been found impossible to secure agreement on the latest draft. Special information is being prepared and it is hoped to reach a decision shortly.

Dielectric Strength and Insulation Resistance.—A committee has been formed to discuss these questions but it has been decided in the first instance to discuss Dielectric Strength and a circular showing the variations in regulations prepared by different organizations has been sent out for preliminary comment.

The Association has continued the procedure of issuing bulletins to electrical manufacturers in connection with test requirements, etc., and bulletins covering Heater Cord, Rubber-covered Wire and Cable, and Flexible Cord and Fixture Wire, have been issued during the year.

G — Ferrous Metallurgy

Heavy Steel Shaft Forgings.—Final agreement was secured and specification G 38-1935, under the title "Carbon-steel Forgings" has been issued.

Commercial Bar Steel.—The committee held a meeting during the year to consider revisions to the present specification, and it is hoped to reach a final agreement very shortly.

Reinforcing Materials for Concrete.—A special circular covering suggested revisions necessary to bring the present specification up to date has been sent out to the committee for their consideration.

S — Steel Construction

The four specifications covering Mild Steel, Medium Steel, Silicon Steel and Rivet Steel, have now been published under the designation S 39-1935, S 40-1935, S 41-1935, S 42-1935 respectively. Copies of the specifications and memorandum outlining suggested unit stresses have been submitted to the chairmen of the committees on bridges and buildings for their report.

The specification covering Structural Steel Welding has not yet been finally drafted, but preliminary studies are in circulation among the members of the panels concerned.

Co-operation and Publicity

Close contact has been maintained with the standardizing bodies in the other Dominions, and particularly with Great Britain. Drafts of specifications prepared under Part II of the Code have been sent regularly to the electrical committees of the British Standards Institution and very helpful comments have been received. These drafts are also sent to the Underwriters' Laboratories at Chicago and to the Standard Committee of the National Electrical Manufacturers Association at New York, and from these sources also much help has been obtained.

The technical press and newspapers have continued their generous co-operation and some of the items which have been published have been unusually helpful.

The sale of publications has been well maintained and the C.E.S.A. specifications are being more freely used.

Exchange of publications with the different standardizing bodies has been continued and a rather interesting feature has been the somewhat increased sale of British publications in Canada.

Respectfully submitted,

P. L. Pratley, m.e.i.c., *Chairman.*

Committee on Relations with National Societies

The President and Council:—

Two outstanding meetings, in which many of our members may be interested, are, first, the recent Plenary meeting, in June 1935, in Holland and in Belgium, of the International Electrotechnical Commission, and, second, the coming meeting of the World Power Conference, in September, 1936, at Washington, D.C.

Fifteen of the twenty-five countries which make up the International Electrotechnical Commission were represented at the meetings in Holland and Belgium last June. Canada was fortunate in being able to secure the good offices of Messrs. Kaelin and Edgar of the Shawinigan Water and Power Company, who were, at the time, in Europe—on other business—and they attended as Canada's representatives.

One matter of very considerable importance was finally dealt with at the International Electrotechnical Commission meetings: the Giorgi system—the meter-kilogram-second system—of units was adopted unanimously. To those who are specially interested in such matters the comprehensive paper of Dr. A. E. Kennelly of Harvard University is commended. It appears in unabridged form in the December, 1935, number of Electrical Engineering, the official Journal of the American Institute of Electrical Engineers.

Reports of nineteen other International Electrotechnical Commission Committees, besides the one on "Nomenclature," were presented and discussed at those meetings; they were on the following subjects:—

Rating of Electrical Machinery.
Symbols.
Steam Turbines.
Lamp Caps and Holders.
Aluminium.
Standard Voltages and Currents and High-Voltage Insulators.
Electric Traction Equipment.
International Comité Mixte on Electric Traction Equipment.
Insulating Oils.
Rules and Regulations for Overhead Lines.
Radio-Communication.
Measuring Instruments.
Shellac.
Terminal Markings.
Switchgear.
Electrical Installations on Ships.
Internal Combustion Engines.
Electric Cables.
Committee of Action.

The programme for the "Third World Power Conference," which is to be held in Washington next Septemtember has just been issued and a glance at it shows that almost the whole world of "power" is to be explored before the prospective authors of papers will have finished their jobs.

From the "foreword" in the programme the following extract is taken:—"...it seems desirable to change the *emphasis* at the Third World Power Conference, and to devote its discussions to the more fundamental, and in many respects more important, problems of the relations of power resources, their development and use to the social and economic interests of the nation."

The expression, "The National Power Economy," stands out as the key note of the Third World Power Conference. Eighteen *national* papers, each prepared on the same basis, are to be prepared and presented by each country's representatives; they are all to be in such shape as to make the data concerning the subjects dealt with readily comparable.

The Conference is to be divided into the following seven sections, namely:—

1. Physical and Statistical Basis, Technical, Economic, and Social trends.
2. Organization of fuel industries and of Gas and Electric Utilities.
3. Public Regulation.
4. National and Regional Planning.
5. Conservation of fuel and water resources.
6. Rationalization of Distribution.
7. National power and resources policies.

The Second Congress on Large Dams will also be held in Washington during the progress of the Third World Power Conference. Dr. O. O. Lefebvre, M.E.I.C., Past-President of The Engineering Institute of Canada, is Canada's representative, from its National Committee of the World Power Conference, on the International Commission on Large Dams.

Canada's participation in the Third World Power Conference has not yet been arranged for. Mr. Norman Marr, M.E.I.C., of Ottawa, is the Secretary of the Canadian Committee.

Respectfully submitted,
JOHN MURPHY, M.E.I.C., *Chairman.*

Board of Examiners and Education

The President and Council:—

Your Board of Examiners and Education for the year 1935 beg to report as follows:—

In accordance with request received from Council your Board prepared the following examination papers, namely:—

For May—
Schedule C
(A) General Paper on Structures.
(B1) Structural Steel Design.
(B2) Reinforced Concrete Design.

For November—
Schedule C
II. Civil Engineering
(A) General Paper in Civil Engineering.
(B2) Hydraulic Engineering.
V. Metallurgical Engineering.
(A) General Metallurgy.
Schedule B
I. Elementary Physics and Mechanics.
II. (A) Strength and Elasticity of Materials.

We received papers from one candidate for the May examination and from two candidates in November, and these papers were duly marked and returned with reports to Council.

In July Council submitted to your Board, names of four applicants requesting recommendation as to the examinations they should be requested to pass in order to qualify for membership and after carefully considering the matter, your Board forwarded recommendations as requested.

The results of the examinations held during 1935 were as follows:—

Examined under	*Number of Candidates* May	Nov.	*Numbers passed* May	Nov.	*Passed in all subjects Completely*
Schedule B (Junior)					
Elementary Physics and Mechanics	4	1	3	1	
Strength and Elasticity of Materials	4	1	3	1	4

Schedule C
(Associate Member)

VII Structural Engineering						
(A) General Paper on Structures..................	3	—	2	—		
(B1) Structural Steel Design..	2	—	2	—		
(B2) Reinforced Concrete Design....................	1	—	—	—		2
II Civil Engineering						
(A) General Papers..........	1	—	—	—		
(B2) Hydraulic Engineering..	1	—	—	—		

In conclusion I wish to express my appreciation to the members of the Board for the ready way in which they have assisted in this work.

Respectfully submitted,
H. M. White, A.M.E.I.C., *Chairman.*

Committee on Western Water Problems

The President and Council:—

The following members of The Engineering Institute of Canada were nominated as a committee to follow up the drought situation on the Western Prairie:

G. A. Gaherty, M.E.I.C., *Chairman.*
C. H. Attwood, A.M.E.I.C.
Charles Camsell, M.E.I.C.
L. C. Charlesworth, M.E.I.C.
T. H. Hogg, M.E.I.C.
O. O. Lefebvre, M.E.I.C.
C. J. Mackenzie, M.E.I.C.
S. G. Porter, M.E.I.C.

Since the formation of your committee the Federal government has taken steps to alleviate conditions in the affected area and under the Prairie Farm Rehabilitation Act has appointed a Water Development Committee. Its function is to review existing water developments, and make recommendations regarding new projects.

The personnel of the water development committee (two of whom are also members of our committee) have wide experience in this class of work, and their selection is sufficient evidence of the earnestness of the Dominion government in finding a proper solution to this problem. In its work to date the water development committee has wisely avoided the more spectacular projects which would at best benefit but a few. Its activities have been directed mainly toward developing domestic water supply for individual farms and groups of farms.

Following the discussion on the Western Drought Problem which took place at the 1935 Annual Meeting in Toronto, the Minister of Agriculture was advised of The Institute's desire to render any possible assistance in the matter and an appreciative reply was received from the Hon. Mr. Weir.

Your chairman has visited the affected area and through members of this committee, who are also members of the water development committee, has kept in touch with the activities of that committee.

Droughts are a recurring phenomenon and remedial measures to be effective must be adopted before the incidence of the next drought, thus a search for a proper remedy must not cease on account of temporarily favourable weather conditions. We wish particularly to stress the importance of continuing the collection of the fundamental data regarding surface and subsurface water supplies, soil analyses, precipitation, etc., for which in the past funds have sometimes been lacking.

As the work is in good hands there is little assistance your committee can render, but it is holding itself in readiness should any problems be submitted to it for consideration by the water development committee.

Respectfully submitted,
G. A. Gaherty, M.E.I.C., *Chairman.*

Committee on Consolidation

(Part II*)

It has been the policy of this Committee to keep the profession fully informed as to its activities by means of periodic reports in the "Journal," and it is therefore only necessary to review its work briefly at this time.

The Committee held its organization meeting in the Royal York hotel on the evening of February 8th, which also provided an opportunity of discussing the whole subject with a number of engineers from various parts of Canada. Subsequently Dr. O. O. Lefebvre and Professor R. E. Jamieson were added to the Committee and fourteen meetings of the Committee were held in Montreal.

A review was made of the activities toward the Consolidation of the profession which had taken place in the past. A programme for the carrying out of the work of the Committee, in accordance with the authority of the resolution of the Annual Meeting, was determined, and it was decided that the Committee should communicate with each Branch of The Institute and with the Secretaries of the Provincial Associations, advising them of the work being undertaken by the Committee and ascertaining the extent to which they might be expected to participate and co-operate in it.

The Committee suggested that Provincial Joint Committees of the Branches and the Professional Associations might make some constructive contribution toward the solution of the problem. The Committee felt, however, that the constitution of such committees must be left to the discretion and action of the local members of the profession, and therefore took no part in their formation. It was found that joint committees on this subject already existed in Nova Scotia, Manitoba, and Saskatchewan, and a joint committee was formed in New Brunswick. In addition to this, a majority of the Branches formed special committees to consider Consolidation and appointed corresponding members to keep in touch with the national "Committee on Consolidation."

It has been evident for a considerable time that there was a strong sentiment in favour of the broad principle of Consolidation, and this review of the activities within the profession in recent years corroborates this fact. The problem was to obtain such an expression of opinion from the various interested organizations as would indicate a plan for Consolidation which would harmonize the ideals and meet the requirements of the component parts of the profession.

The Committee therefore proceeded to evolve a scheme which was calculated to provide an opportunity for every individual member of the profession to express his views as to how the principles and details of administration involved in the consolidation of the profession would affect him personally. This method of approach naturally suggested a questionnaire, and it became necessary for the Committee to determine on a questionnaire which would at once indicate an acceptable, broad basis for consolidation, and at the same time provide every requisite latitude for the satisfactory development of the more intricate details of its successful consummation.

In framing such a questionnaire your Committee had also to consider certain established conditions which must be recognized and provided for in any scheme of consolidation. It was also deemed advisable to preface each question with an explanatory note drafted with the sole object of informing the member of the ideas and conditions prompting the question.

The Committee authorized the questionnaire to be issued to the Secretaries or Corresponding Members of the

*Part I of this report appeared in the January 1936 issue of The Journal.

Branches, the Registrars of the Provincial Associations, and the Secretary of the Committee of Eight. A copy of the "questionnaire" appeared in the June 1935 issue of The Journal.

Whereas it had been anticipated that replies to the questionnaire would have been returned by the middle of July, it transpired that action was not taken by some of the Branches and Associations until late in the autumn. Finally your Committee was able to make a detailed report on the returns to the date of October 24th, 1935, which was published in the November issue of The Journal. This report has since been supplemented by a return from the Association of Professional Engineers of the Province of Alberta, which indicated that this Association was continuing its endeavours for co-ordination through the "Dominion Council." The St. Maurice Valley Branch also made a return, answering all the questions in the affirmative with the proviso to No. 2 that corporate membership in the national body shall be based on the admission requirements laid down by the statutes of the Provincial Professional Association.

The "Questionnaire" was designed not only to obtain categorical answers to its five questions, but also to provide an opportunity for any suggestion or qualification which any member or organization might desire to make. As noted in the "Report on the Returns," a number of suggestions, explanatory remarks, or qualifications were received. These were bound in a "docket" and made available to every member of your Committee, to assist him in the drafting of the final recommendations of this Committee to The Institute.

The constituency to which this questionnaire was submitted consisted of the corporate membership of The Engineering Institute of Canada and the corporate membership of the eight Provincial Professional Associations, representing in round numbers:—

Engineering Institute	2,630
Professional Associations	3,807
A total voting constituency of	6,437

It will be noted that of this total possible figure of some 6,437 engineers, some 4,289 were represented in the replies received, or 66 per cent. Where the Executive of the Branch or Association replied to the questionnaire on behalf of their membership, the number of the corporate membership of that body has been included in the returns. In those cases where the members of a Branch or Association were given an opportunity of expressing their individual opinions, the actual number of the replies received have been indicated in the returns.

The Branches of The Institute and the Provincial Professional Associations not represented in the replies are as follows:—

Lethbridge Branch	24
Professional Association of Alberta	253
Vancouver Branch	127
Professional Association of British Columbia	808
	1,212

These organizations took no part in the questionnaire and their membership was given no opportunity of expressing their individual opinions thereon. They represent about 20 per cent of the total possible vote.

Considering the replies received to the various questions in detail, we submit the following analysis:—

Question No. 1

Are you in favour of the broad principle of Consolidation of the Engineering Profession in Canada?

This question was drawn in the broadest possible sense, the idea being to ascertain if the member was in favour of some form of consolidation of the engineering profession provided a generally acceptable plan for its consummation could be evolved. If the majority opinion was opposed to consolidation under any scheme, it would be useless to proceed further in the matter, and any consideration of detail would be obviated. It is interesting to note that there were several members of the profession who could not express an opinion on Consolidation without access to all its final details. It is apparent that such an approach to the consideration of the question is impracticable.

The replies to Question No. 1 were:—

Yes, 4,261 (99.3 per cent); No, 28 (0.7 per cent).

These figures show conclusively that a large majority of the profession are in favour of Consolidation in some practical form.

Question No. 2

In your opinion, should the corporate membership of the Provincial Professional Associations and of the National organization be identical?

The preamble to this question indicates the idea which prompted its phraseology. Consolidation is a unification, a combination into a coherent whole, a single body and as in this case, the elements to be combined in that single body are the members of the engineering organizations in Canada represented for the purpose of this questionnaire by the membership of The Engineering Institute of Canada and the Provincial Professional Associations, therefore the essential fact to be determined is whether the membership of these organizations should be identical. It will be noted that this question suggests no time factor, the idea being to determine the desirability of the ultimate integration of the two memberships into one national organization. Further, it is not complicated by any suggestion as to details of membership classification which may be necessary to achieve the ultimate goal, it being the opinion of the Committee that the conciseness of the issue should not be obscured by a multiplicity and complication of detail.

The replies to Question No. 2 were:—

Yes, 3,868 (91.6 per cent); No, 353 (8.4 per cent).

Question No. 3

Are you in favour of The Engineering Institute of Canada being accepted as the national body of the consolidated engineering profession in Canada?

The preamble and the question itself make the purpose of this question obvious.

The replies to Question No. 3 were:—

Yes, 3,927 (92 per cent); No, 343 (8 per cent).

In explanation of the negative answers received to Question No. 2 and Question No. 3, attention is drawn to the fact that both the Halifax Branch and the Association of Professional Engineers of Nova Scotia, representing 310 engineers, answered the second question "No, not necessarily," and the third question, "No, not as at present constituted," which for purposes of the record are indicated as negative answers, though in the broader sense they might not be so interpreted.

Question No. 4

Under Consolidation, would you be willing to pay a single annual membership fee which would include a uniform subscription from each member of the profession throughout Canada to the National organization?

As the question of fees will undoubtedly be one of the major problems in the consummation of consolidation, this question was asked in order to bring fees directly to the attention of the membership of both organizations. It is put in its simplest form and is not confused by any suggestions which might involve the consideration of the classifications of membership or the benefits to be derived from

Provincial or national organization as dependent on the local opportunities and privileges of the individual. There is no doubt that in the detailed planning of consolidation these features will have to be compensated for in the schedule of fees. The method of their collection will also have to be carefully considered in order to avoid all possible complication as to their payment and proper distribution.

The replies to Question No. 4 were:—

Yes, 3,184 (99 per cent); No, 33 (1 per cent).

(Note:—As nothing in the Resolution of the Corporation of Professional Engineers of the Province of Quebec answers this question directly, though an affirmative answer might be taken as implied by Section No. 2, no expression on this question by the Corporation has been included in the above returns.)

Question No. 5

In view of the fact that discipline and legal action are at present a function of the Provincial Associations, are you in favour of the administration of admission to membership and collection of fees also being made the responsibility of the Provincial organizations?

This question was designed to draw the attention of the membership to the fact that admission to the Provincial Associations is a legal function which is not susceptible to modification to meet the conditions of any scheme of consolidation. In certain provinces also the collection of fees is covered in the legal enactments. Further, it will be noted from the historical review, which forms part of this report, that in the past, great emphasis has been laid on the importance of attaining uniformity in entrance requirements to all organizations of the profession throughout Canada. If this proves to be ultimately attainable, any criticism of the principle of admission to the profession being made a matter of provincial responsibility, would be obviated. With proper organization this most desirable policy of a uniform standard of admission would be very simple to achieve, and would definitely clear the way for interprovincial practice within the profession.

This question also raised the point in the mind of the member as to whether he considered it in the best interests of the profession that progress toward the early consummation of consolidation should be rendered impossible or delayed until such time as the theoretical uniformity in standard of admission in all provinces and to The Engineering Institute had been attained.

Further, this question involved a consideration of the best means of attaining a high degree of local autonomy and administration within the profession, it being considered that decentralization to a greater degree than at present would be of benefit to the whole organization.

The replies to Question No. 5 were:—

Yes, 3,980 (97.8 per cent); No, 87 (2.2 per cent).

In connection with the returns on the questionnaire your Committee received suggestions, recommendations and explanatory remarks from some 88 members, some of which were along the same lines and on the same ideas. These may be briefly summarized under the following headings:—

1. Provision for membership in the national body by engineers resident outside of Canada.

2. Provision for members of the profession resident in Prince Edward Island.

3. Provision for membership of the technical man who by necessity or personal choice, is not a member of a provincial Professional Association and is not required to practise under a license.

4. Suggestion that the Provincial Associations be related to the national body in the same sense as the present Branches of The Institute.

5. Suggestion of the recognition and acceptance by The Institute of the admission qualifications of the Provincial Associations.

6. Suggestion of the acceptance of membership in The Engineering Institute as qualification for membership in a provincial Professional Association.

7. General supervision and control of the ethics and membership requirements of the Provincial Associations by the national body.

8. Legal limitations placed on qualification requirements for admission to the Provincial Associations.

9. Suggestion of optional provincial registration for non-practising members.

10. Membership in the national body a requisite for but not identical with membership in the Provincial Professional Associations.

11. Possibility of general uniformity in admission requirements and standards.

12. Suggestion that non-licensed Association members pay a higher fee and have no voting power.

13. Fees and admission to be subject to the approval of the national body.

14. Recommendation for admission to be made by the provincial Professional Association and approved by the national body.

15. Licence for a man drawing a salary over a certain amount.

16. See a grading of the fee based on the members' accessibility to the privileges of the local or national organization, such as in Montreal.

17. Relation of the fees of the professional organization to the Provincial Acts, and how this affects methods of collection of fees both in a provincial and a national sense.

18. The amount of the proposed single annual fees not to exceed the combined present provincial and Institute fee.

19. What is the significance of the variation in requirements for admission to the various Provincial Associations in relation to qualification for membership in the national body?

20. See period of indenture for college graduates before admission and its significance, if any.

21. Significance and use of various classifications of membership.

22. Provision for special groups of the different technical branches of engineering within the profession.

23. Reciprocal rights to practise between the provinces.

24. Note the position of the engineer in the smaller centre where one organization can most acceptably perform all functions.

25. Of what use is membership in a national body to an engineer in a provincial centre, if he has no access to the activities of the local organization.

26. Is it a sound and acceptable principle that practising engineers, though licensed under provincial enactment, should have no technical or educational facilities and no articulate and recognized national body.

In addition to the results of the questionnaire and the suggestions it inspired, your Committee has also taken cognizance of the reports of the various committees appointed by The Institute during the past eighteen years, whose work was in any way related to the consolidation of the profession. In this connection your Committee wishes to express its appreciation of the able work done by Mr. S. G. Porter and his committee on "The Relationship of The Engineering Institute of Canada with the Provincial Associations of Professional Engineers." Your

Committee is of the opinion that the successful solution of this problem of consolidation lies generally along the lines suggested by Mr. Porter.

This Committee has also reviewed the report of the "Committee of Four" of September 4th, 1931, and the report of the "Committee of Eight" of February 3rd, 1933. It has also had before it the report of the "Joint Committee of Eight for Closer Union of the Association of Professional Engineers and The Engineering Institute of Canada in Nova Scotia," under date of November 10th, 1935, also the brochure prepared by Gordon McL. Pitts, outlining a broad basis for "The Consolidation of the Engineering Profession in Canada," of January, 1935; the remarks by President F. P. Shearwood, at a special meeting of the Montreal Branch held on January 30th, 1935. It has also taken cognizance of the plan for consolidation presented by Mr. P. L. Pratley of July, 1935, and the critical analysis of this scheme submitted by Mr. E. A. Wheatley of September, 1935; the report prepared by Mr. P. H. Buchan, in "Presentation of the views of British Columbia on the Federation Problem"; the proposals for provincial consolidation as approved by the engineers of the Province of Manitoba; the reports, resolutions and discussions on consolidation in the Province of Saskatchewan; the recommendations of the Quebec Branch of The Institute, through Mr. Cimon, at the Annual Meeting of The Institute in 1933; the significance of the special questionnaire and its answers as prepared by Mr. C. C. Kirby, and issued by the Professional Association of New Brunswick to its membership; the recommendations of the Corporation of Professional Engineers of the Province of Quebec, at its Annual Meeting of March 27th, 1935.

Your Committee has also had before it the five papers submitted for the Past-Presidents' Prize, 1934-35, on the subject, "The Co-ordination of the Activities of the various Engineering Organizations in Canada."

Before submitting its recommendations as to the procedure which, in its opinion, is best calculated to facilitate the consummation of the consolidation of the engineering profession in Canada, based on all the foregoing information, your Committee would briefly draw attention to certain features of the organization of the profession as it now exists, and their inter-relation under consolidation.

Present Conditions Within the Profession

In Canada the term "engineer" refers to those who, of whatever age, class, experience, education, technical division, or geographic location, make up that body of scientifically trained men, recognized and included within the engineering profession, whether in a legal or popular sense. In fact, it is usually through membership in an accredited engineering organization that the individual is recognized as an "engineer."

The profession is sub-divided and classified in various ways:—

First, there is that classification indicative of age, educational qualifications and experience, such as students, juniors, associate members and members.

Again, there is the division imposed by location, giving rise to Branches, Provincial Divisions, etc.

Again, there is that differentiation imposed by the law and the privileges which it confers, by which the legally licensed professional engineer is differentiated from the general public and even from those who have an engineering education and background but are not required by the nature of their employment to practice under a licence.

Again there is the sub-division created by the peculiar technical education and experience of the individual which relates him to some specialized technical group within the profession. These sub-divisions have a tendency to increase in step with scientific development and specialization.

It is thus apparent that an engineer may fall into a number of cross classifications which reflect his professional relationships. It is the object of consolidation to give him all the opportunities and privileges which a comprehensive professional organization should provide in the simplest, least expensive and most direct way.

Taking the smallest group within the profession, we find the Branch as a local manifestation, performing the function of bringing together a comparatively small number of engineers of varying classifications, technical grouping and legal status. The essential feature is that they are engineers, and the branch organization provides them with the opportunity of professional contact and of the attainment and interchange of professional knowledge.

The Provincial Division is a larger local grouping, which may include within its organization the smaller branch unit. As indicated by its name, its policies are gauged to serve its members in a provincial sense. Although Provincial Divisions have been provided for in the By-laws of The Institute, they have never been fully developed.

In parallel with the Provincial Division, but functioning in a different sense in that they are constituted with a legal significance and powers to license to practise, we find the Provincial Professional Associations. These have organizations peculiar to the function they are required to perform, in accordance with the special provincial law under which they are incorporated. Being activities of the same profession in the same province, the Branch, Provincial Division and Professional Association, are bound to have a large common membership.

While the above organizations fulfil all provincial requirements, they cannot individually attain or enjoy national recognition. Engineers, appreciating the experience of sister professions, show an increasing desire to enjoy the benefits to be realized through a Dominion-wide organization which would act as a liaison between the various branches of the profession, disseminate professional knowledge, and promote generally the interests of the profession at home and abroad. Such benefits can obviously best be obtained by a strong, well-organized, inclusive national body of definite substance and authority.

The engineering profession in Canada was organized primarily as a national body which later set up small local organizations as branches. The above national organization could not exercise a legal control of the practice of the profession, owing to the limitations of the British North America Act, therefore the provincial Professional Associations or "licensing bodies" were formed. At their inception no arrangements were made for correlating these licensing bodies with the branch organizations within the provinces, and with the national organization. The result has been that there is an ever-increasing tendency for these two types of organization within the profession to create a duplication of effort.

The provincial Professional Associations admit men to membership under qualifications independently determined in each province. Officially, there is no relation between the standards of admission to the provincial organizations in respect to each other or to the national body of The Engineering Institute. The latter prescribes a definite standard of admission for all its component parts.

Again, while that technical, though voluntary group of engineers included in the membership of The Engineering Institute of Canada and its branches, is admirably organized in a national sense, the provincial Professional Associations are not as yet correlated nationally, although a step to this end has been taken in the formation of "The Committee of Eight."

Many members who are striving to find a satisfactory basis upon which the engineers of Canada may be brought into one comprehensive and nationally expressive organization, believe that unless some generally acceptable solution of this problem can be found within a reasonable time, the tendency is towards greater diversity in thought, ideals and action between unrelated organizations in the profession.

Such a solution must maintain all provincial professional legal enactments in full force and recognition and should be designed to compensate for the lack of uniformity at present existing in these provincial laws. Similarly, for the time being at least

(*a*) it should accept a certain difference in standards of admission between certain groups until such time as it is practicable to bring these into more uniform alignment;

(*b*) it may provide a classification of membership which is indicative of the affiliation of every member in the profession (i.e. whether member of The Engineering Institute of Canada only, member of The Engineering Institute of Canada and the provincial Professional Association, or member of the provincial Professional Association only), in which case it should provide a fee for each class of membership which will be commensurate with the privileges and standing which that class enjoys;

(*c*) it should provide a method of administration and control which is direct, economical, and representative; and

(*d*) it should at the same time provide the greatest opportunity for local autonomy and development.

To meet the foregoing conditions, and with due regard to the expressions of opinion of the membership as to the necessity for and the general character of the re-organization of the profession in Canada, your Committee on Consolidation submits the following conclusions and recommendations:—

First,—It has been determined by an overwhelming majority that the profession is in favour of consolidation.

Second,—The great majority of the profession are of the opinion that, ultimately at least, the corporate membership of the Provincial Associations and the national body should be identical.

Third,—The great majority of the profession is also definitely in favour of The Engineering Institute being accepted and recognized as the national body of the profession.

Fourth,—It has been indicated that the members of the profession are agreeable to the payment of such fees as are necessary to promote the work and interests of the engineers of Canada both in a local and in a national sense.

Fifth,—In connection with the administration of the profession, its membership has pronounced itself as in favour of such re-organization as will give the maximum of local autonomy and constructive opportunity, with a reasonable division of labour and responsibility, based on mutual confidence and appreciation, as between the local organizations.

In view of the fact that consolidation in this instance is the unifying or bringing together of organizations which have a definite provincial significance, it is therefore necessary to approach the problem in the provincial sense. Omitting for the time being any consideration of the junior or educational grades of membership, we find the profession within any given province to be composed of three classifications:—

(1) Engineers who are members of The Engineering Institute of Canada and its local branch, and are also members of the Professional Association of their province, designated as Class "A."

For this "common membership" class, consolidation presents no difficulties and is only a matter of re-organization, questions of membership qualification and fees not being involved.

(2) Engineers within the province who are members of The Engineering Institute of Canada and its local branch, but who are not, by necessity or choice, members of the Professional Association of their province. Class "B."

In this class are included certain engineers who are in the services of the various governments, or who hold similar appointments. These form a very important group in the profession. This class would also accommodate those foreign engineers who desire membership in the Canadian profession as, with one or two exceptions, the Provincial Acts preclude membership in Class "A" by non-residents of the province.

(3) Engineers who are members of the Professional Association of their province, but who, on account of expense, lack of interest, or other reason, have not obtained membership in The Engineering Institute and its local branch. Class "C."

The problem of consolidation is the development of an organization which will accommodate these three classifications within the province in an equitable manner, providing proper recognition of their professional standing and determining a fee schedule commensurate with the privileges they enjoy.

In such an organization of the three classes within a province, it is necessary for legal reasons that Class "A" and Class "C" be administered as a unit with proper officers to carry out the provisions of the law as it affects that particular group within the profession. This arrangement, however, in no way conflicts with the organization of all three groups into a provincial body, administered by officers and council properly representative of the whole profession within the province.

In such an arrangement a plan might be followed in which the officers and council are largely drawn from Class "A" and are common to both organizations and co-operation carried to the point where the administrative personnel of the Provincial Professional group and that of the Provincial Division is practically identical. In line with this thought special attention is drawn to the proposals which are being promoted by the engineers of Manitoba.

This suggested provincial organization is susceptible to certain modifications to meet local conditions. It is apparent of course that the tendency is for Classes "B" and "C" to be definitely reduced as time passes, and finally to disappear.

The Branch organizations within the province are formed in a different sense from those of the main provincial groups "A," "B" and "C," and its membership would be a cross-section of the members of all of these three groups. The basis of this suggestion can probably be most comprehensively expressed in the accompanying diagram, which indicates the groups within the Provincial organization and the lines of Branch membership. (See Fig. 1.)

The procedure to be followed in the selection of the officers and council to represent this provincial unit is a matter of detail. The election of the officers for the professional organizations is already determined by law.

With the realignment of the profession within the province in the manner above indicated, and with the acceptance of the principle that The Engineering Institute, re-constituted to meet the new conditions, is accepted as the national organization of the profession, the uniting of these Provincial bodies in a national sense through The Institute, presents no difficulties. All recognized members of the engineering profession being members under some classification of the Provincial organizations, are in turn members under these classifications of the National organization.

Your Committee on Consolidation therefore recommends:—

(1) That in view of the general approval which has been given the broad principle of consolidation by the profession in Canada, The Engineering Institute of Canada take immediate steps to put the same into effect with those Provincial Professional Associations with whom satisfactory arrangements can be made.

(2) That The Engineering Institute agree to accept as qualification for admission to membership in The Institute the standard of membership requirement of the Provincial Professional Associations or Corporations and that when the engineers of a Province come into Consolidation, only members of the Provincial Professional Association or Corporation of such Province shall, thereafter, be accepted into membership in The Institute from that Province.*

(3) That The Engineering Institute agree to accept into membership of a certain class, upon payment of a determined nominal fee, those members of the Provincial Professional Associations coming into consolidation, who are not and may not become full members of the national body.

(4) That The Engineering Institute of Canada make representation to the several Provincial Professional Associations for the acceptance of corporate membership in The Institute as qualification for admission to the Professional Association when permissible under the law of the province. This to apply only to those who are corporate members of The Institute at the time of consolidation with such Provincial Professional Association.

*See paragraph No. 7 of Report of Committee on Relations of the E.I.C. with the Professional Associations as passed with one dissenting vote at the Annual Meeting of February 12th, 1930. Page 3 of this report.

(5) That The Engineering Institute apply the principle of Provincial Divisions and that the same shall include the present branches of The Institute and the membership of the Provincial Professional Associations on a system of organization and administration to be determined by a properly representative committee of the Associations and The Institute.

(6) In the event of consolidation being effected as between The Institute and any Provincial Professional Association, The Institute agree to the establishment of a properly constituted authority in such province for the collection and distribution of membership fees within the province and to the national body, in accordance with a mutually approved contract.

(7) That The Institute agree to act as the national body in the event of consolidation being consummated with any or all of the Provincial Professional Associations.

(8) That The Institute undertake to constitute the members of The Institute within any province nito a Provincial Division of The Institute in that province should the Provincial Professional Association not be prepared to proceed to consolidation at this time.

(9) That The Institute continue the present Committee on Consolidation with the commission to represent The Institute in discussions with the Provincial Professional Associations and for the purpose of achieving consolidation on the general basis above outlined.

The Committee regrets that it has not been possible to submit to Council for action at this Annual Meeting, certain specific recommendations involving basic changes in the By-laws of The Institute as outlined in paragraph No. 2 of the above recommendations, which would materially facilitate the early consummation of consolidation.

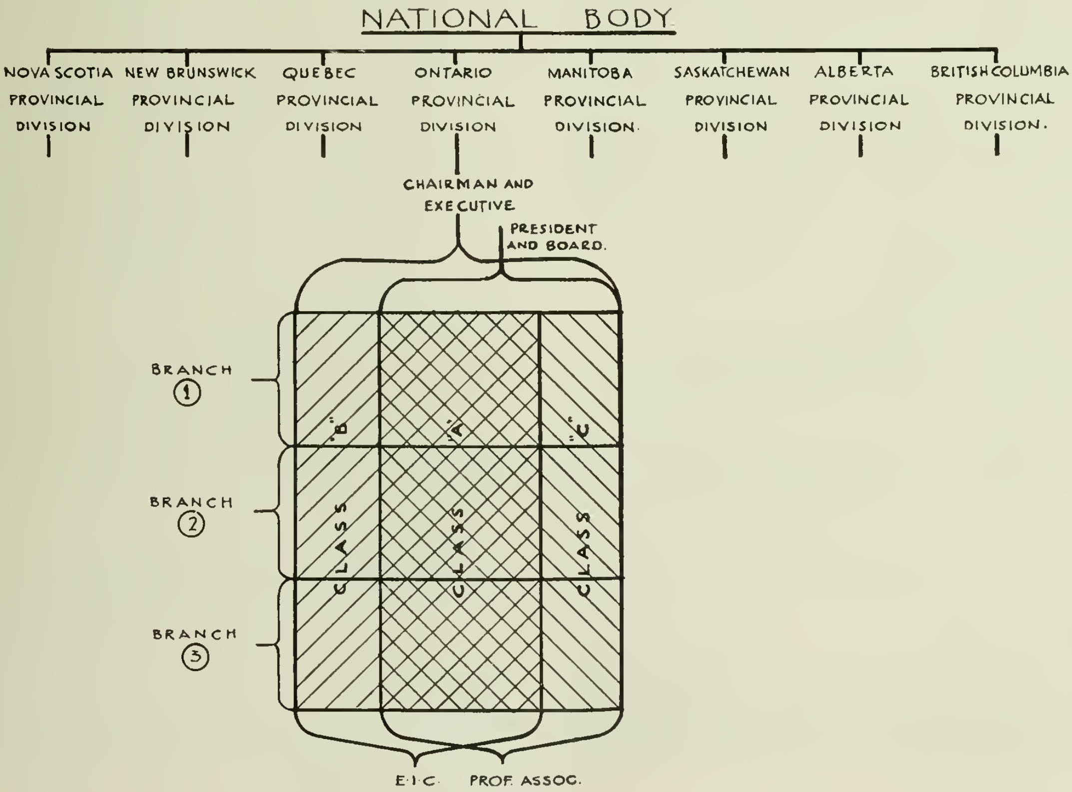


Figure 1

Respectfully submitted,

R. E. Jamieson, m.e.i.c.
Robert F. Legget, a.m.e.i.c.,
O. Lefebvre, m.e.i.c.,
G. J. Desbarats, m.e.i.c.,
A. R. Decary, m.e.i.c.,
J. B. Challies, m.e.i.c.,
Gordon McL. Pitts, a.m.e.i.c., *Chairman.*

Dated January 9th, 1936.

I endorse recommendations (1) and (2) and suggest that the word "Consolidation" be replaced by the word "Confederation" as being a more appropriate term.

The other recommendations deal with details which might be in order but appear somewhat premature until the general principle defined in recommendation (2) is accepted by ballot of membership.

(*Sgd.*) A. R. Decary

With the reservation that "consolidation" connotes cooperation and co-ordination between two separate and distinct corporate entities—The Institute and the provincial Professional Associations, but not their amalgamation or their merger.

(*Sgd.*) J. B. Challies

Legislation Committee

The President and Council:—

Your Legislation Committee wishes to report that during 1935 it has had very little to do and that a meeting of the committee has not been necessary.

The action of the Ontario Association of Architects in attempting to obtain restrictive legislation at the 1935 sitting of the Ontario Legislature was reported to Council and their failure to obtain this was duly reported. The attitude of the Association of Professional Engineers of the Province of Ontario toward this legislation was also noted.

The report of the Special Committee of Council consisting of J. A. Vance, a.m.e.i.c., of Woodstock, F. W. Paulin, m.e.i.c., of Hamilton and the writer, dated June 12th, 1935, relative to the situation of the E.I.C. and the Highway Improvement Act of Ontario has been referred to this committee and it is hoped that when the next revision to the Act is contemplated that the wording "a member of The Engineering Institute of Canada" will be changed to read "a Corporate Member of The Engineering Institute of Canada."

The above constitutes the activities of the Legislation Committee for the year 1935.

Respectfully submitted,

Archie B. Crealock, m.e.i.c., *Chairman.*

Communication Engineering Sections

The President and Council:—

As chairman of the Committee on the Organization of Communication Engineering Sections of The Engineering Institute of Canada and the Institution of Electrical Engineers, I wish to submit the following progress report of the Committee.

The organization of the Montreal Branch Communication Engineering Section has been completed, and it now has forty registered members.

A study has been made of the situation in each of the branches throughout the Dominion, with the result that we are now corresponding with the officials of the Ottawa, Winnipeg, Halifax, and Vancouver Branches, in the hope of getting Communication Sections started in these branches.

Respectfully submitted,

G. A. Wallace, a.m.e.i.c., *Chairman.*

Unemployment Committee

The President and Council:—

Your Committee which was re-appointed by Council in April 1935, has continued its efforts to maintain contact with the various Branches of The Institute, through the Branch Unemployment Committees particularly where there was the greatest unemployment.

In December 1935 a request was sent to all Branches asking for a report on the year's activities and enquiring—(*a*) Assistance given members of the Branch during 1935? (*b*) Employment Prospects during present winter and spring? (*c*) Suggestions.

Fifteen Branches replied to this enquiry and from these replies it would appear that the financial assistance which it has been necessary to give to a number of members during the last few years has been greatly reduced, only amounting to some four hundred dollars during the past year, all of which was distributed by the Montreal Branch. It was not necessary for this Branch, however, to make any new canvass for funds.

Several of the Branches were exceedingly active in assisting members to obtain employment. In Halifax some twenty-five openings were filled during the past summer, all unemployed engineers in the Branch being offered positions; while the Saskatchewan Committee was successful in assisting seven members to obtain employment. Any placements reported made by the Branch committees are in addition to those made by the Employment Service Bureau.

A brief synopsis of the comments received from the Branch Committees, appear as follows:—

Cape Breton—Employment still holds fair. Those in "steel" are on full time, but the majority of those in "coal" are again on five days a week. Prospects for 1936 are very fair.

Halifax—Some unemployment expected during winter months, but prospects for re-employment in spring is good.

Saint John—Employment conditions not very bright, especially among younger members, with no visible signs of an improvement during the present winter and spring.

Montreal—Continued decrease in the number of unemployed, and indications are that conditions will improve further by the spring.

Ottawa—Very few applications for employment in the hands of the committee. Conditions would appear to be considerably improved.

Kingston—No change over last year regarding employment prospects for 1936.

Peterborough—Employment conditions about the same as a year ago.

Toronto—Employment in mechanical, metallurgical, mining and chemical fields appears to have arrived at a normal point. The situation in civil and electrical has improved, especially in the latter. There are, however, still a number of civil engineers on relief work and unemployed or engaged in temporary work.

Hamilton—Much improved, in as far as companies are recalling their own men, but the demand for new men is slight.

Niagara Peninsula—Prospects for further employment in this district during the winter and spring remain as they are at present; there being no immediate prospect of additional work, nor does there appear to be any diminution in work.

Border Cities—Employment prospects for coming winter and spring at least equal to or better than a year ago.

Saskatchewan—Employment prospects poor for winter, spring promises to be better.

Edmonton—Employment prospects in this district for the present winter and spring, very uncertain.

Calgary—Dominion Government efforts at relief of drought areas has absorbed a number of men and although that work will be closed during the winter it should again be available in the spring.

Victoria—Unemployment prospects unchanged from last year.

Your Committee desires to express its appreciation of the work of the Branch Executives and Branch Unemployment Committees and to thank them for their assistance during the past year.

Respectfully submitted,

D. C. Tennant, m.e.i.c., *Chairman.*

Employment Service Bureau

The President and Council:—

The Employment Service Bureau of The Institute is again able to report an improvement in employment conditions as will be seen by the following figures for placements effected during the last five years:—

1931	*1932*	*1933*	*1934*	*1935*
33	58	50	70	77

The following figures show the extent of the Bureau's work for 1935 as compared with 1934:—

	1935	*1934*
Number of registrations during the year—members....	96	102
Number of registrations during the year—non-members	38	39
Number of members advertising for positions.........	86	115
Replies received from employers....................	59	56
Vacant positions registered........................	145	124
Vacancies advertised...............................	27	16
Replies received to advertised vacancies..............	124	59
Men notified of vacancies...........................	209	139
Men's records forwarded to prospective employers.....	518	446
Placements definitely known.........................	77	70

The above placements include three members and one non-member placed on the Supervisory staffs of the Department of National Defence Unemployment Relief Projects. There were very few openings with these projects during the past year also a considerable number of those already employed were able to leave for more remunerative positions.

At the present time 284 members are registered with the Employment Service Bureau, which compares with 334 a year ago, 99 of whom are temporarily employed, and 27 are employed with the Department of National Defence Unemployment Relief Projects.

The names of 121 members were removed from the list of unemployed during 1935, 45 of whom secured permanent employment through their own efforts, or the assistance of branch committees.

It should be noted that the positions filled during the past year have been of a much higher standard then during the previous three or four years, and also nearly all have been permanent.

There has been a continual increase in the demand for recent graduates, particularly men with a mechanical engineering training, or having some experience of a mechanical nature. There also continues to be a demand for junior men with pulp and paper mill design and maintenance experience. An increase in the number of inquiries for senior men has also been noted.

It is therefore to the advantage of all members who are unemployed, or who are considering a change of position, to register with our Employment Service Bureau. If necessary the registration form may be marked "confidential" and the applicant will then be advised of particulars regarding any openings of interest to him before his record is submitted to the employer for consideration.

Respectfully submitted,

R. J. Durley, M.E.I.C., *General Secretary.*

Branch Reports

Border Cities Branch

The President and Council:—

The Executive committee of the Border Cities Branch, Engineering Institute of Canada, submits the following report for the calendar year 1935:—

The Executive committee has held seven meetings for the transaction of business during the past year.

Eight regular dinner meetings and one special meeting were held and the following papers submitted:—

1935

Jan. 11.—**The Wind Sail as Applied to Yachts** by Dr. W. F. Gehrhardt, Professor at Wayne University, Detroit. Attendance at dinner, 20.

Feb. 15.—**The Value of Research to Industry** by Mr. F. A. Boyd of the Research Department of General Motors, Detroit. Attendance at dinner, 19.

Mar. 15.—**The Timken Roller Bearing** by Mr. M. S. Downes, M.Sc.M.E., of the Timken Roller Bearing Company, Detroit. Attendance at dinner, 17.

Mar. 29.—**The New Ford Foundry** by Mr. J. S. Beaumont, chief chemist of the Ford Motor Company of Canada. On this occasion the members were guests of the Ford Motor Company at a dinner given in the dining rooms of their offices in East Windsor. Attendance, 80.

April 12.—**Rubber and Its Uses in Transportation** by Dr. A. W. Bull, B.S., Ph.D., of the United States Rubber Products Incorporated. Attendance at dinner, 16.

May 17.—**The Design and Progress of the Island of Orleans Bridge** by P. L. Pratley, M.I.C.E., M.E.I.C., of Monsarrat and Pratley, consulting engineers, Montreal. Attendance at dinner, 17.

Oct. 18.—**Blended Fuel for Internal Combustion Engines** by J. Boyd Candlish, A.M.E.I.C., prominent member of the Border Cities Branch, E.I.C. Attendance at dinner, 15.

Nov. 15.—**Small Steam Power Stations** by Mr. W. D. Canon, M.Sc.E.E., M.A.S.M.E., of the Rust Engineering Company, Pittsburgh. Attendance at dinner, 15.

Dec. 13.—**Reminiscences of a Practising Engineer** by J. J. Newman, O.L.S., M.E.I.C., of the firm of Newman and Armstrong, land surveyors and professional engineers. This meeting was also the annual meeting for the election of officers and reception of committee reports. Attendance at dinner, 14.

The average attendance at regular meetings was 30. The average attendance at dinner was 15. The Papers committee are to be congratulated on the high standard of the papers submitted during the past year.

Membership

The membership of this Branch is made up as follows:—

	Resident	*Non-Resident*	*Total*
Members..........................	11	2	13
Associate Members................	29	6	35
Juniors..........................	1	2	3
Students.........................	7	4	11
Affiliates.......................	1	..	1
	49	14	63

A comparison of our present membership with that of other years is shown in the following table:—

	1931	*1932*	*1933*	*1934*	*1935*
Members..................	24	21	17	14	13
Associate Members..........	53	42	34	32	35
Juniors..................	12	8	5	3	3
Students.................	15	11	11	13	11
Affiliates................	1	1	1	1	1
	105	83	68	63	63

Financial Statement

Receipts

Balance on hand, January 1st, 1935..............	$144.88	
Rebates on dues for November and December, 1934	14.40	
Rebates on dues for January, February, March, April, 1935..............................	81.90	
Rebates on dues for May, June, July, August, September, 1935..........................	19.20	
Rebates on dues for October, November, December, 1935.................................	8.10	
Dinner receipts............................	73.80	
		$342.28

Expenditures

Printing..................................	$ 38.97	
Stamps and telegrams........................	3.29	
Typing....................................	17.50	
Meals.....................................	100.20	
Flowers...................................	3.00	
Miscellaneous..............................	9.00	
Balance on hand in bank......................	162.22	
Accounts receivable, rebates, October, November, December................................	8.10	
		$342.28

Respectfully submitted,

H. J. Coulter, A.M.E.I.C., *Chairman.*

C. F. Davison, A.M.E.I.C., *Secretary-Treasurer.*

Calgary Branch

The President and Council:—

On behalf of the Executive committee of the Calgary Branch, we have the honour to submit the following report covering the activities of this Branch for the year 1935:—

Membership

During the year we have received seven new members: three Associates, one Junior, and three Students, and on the other hand seventeen members have moved away: six Members, two Associates, two Juniors, five Students and two Affiliates. In this connection we wish particularly to mention R. S. Stockton, M.E.I.C., a valued member of this Branch for many years, who is retiring from the service of the Department of Natural Resources, C.P.R., at the end of this year and is going to live in Montana. We believe that the decrease in our membership is due to a great extent to the increased activity in metal mining and industrial lines in other parts of the Dominion. Our present membership is as follows:—

	Branch Resident	*Branch Vistrict*	*Total*
Members	17	3	20
Associate Members—on active list	38	10	48
Associate Members—on non-active list	5	..	5
Juniors	6	1	7
Students	9	1	10
Affiliates	8	..	8
	83	15	98

Meetings

Our Executive committee met seven times during the year for the purpose of conducting the business of the Branch and in addition the various committees held meetings as necessary under their own chairmen.

Eleven general and special meetings of the Branch were held as shown by the following summary:—

1935

Jan. 8.—Joint Luncheon Meeting with Calgary Canadian Club and Rotary Club.
Speaker: Mr. W. L. MacTavish, managing editor of "Winnipeg Tribune."
Subject: **The Drought Situation in the Prairie Provinces.**
Attendance: 38.

Jan. 14.—Branch General Meeting.
Speaker: W. Storrie, M.E.I.C., of Gore, Nasmith and Storrie, Toronto.
Subject: **Engineers and the Public Health.**
Attendance: 66.

Jan. 24.—Branch General Meeting.
Speakers: 1. H. B. Sherman, A.M.E.I.C.
2. J. H. Ross, A.M.E.I.C.
Subjects: 1. **Power Distribution in Alberta.**
2. **Engineering Education and Vocational Training.**
Attendance: 68.

Feb. 7.—Branch General Meeting.
Speakers: 1. I. Abramson, Jr.E.I.C. } In Junior Members
2. R. W. Dunlop, Jr.E.I.C. } Competition.
3. Mr. A. Hannah, K.C., of Bennett, Hannah and Sanford.
Subjects: 1. **Cement Testing.**
2. **Principles of Orifice Meters.**
3. **Democracy or Dictatorship.**
Attendance: 40.

Feb. 16.—Joint Dinner Meeting with Association of Professional Engineers of Alberta and Calgary Branch of the Canadian Institute of Mining and Metallurgy.
Speaker: Mr. W. F. Stephenson, of Fordyce and Stephenson, Calgary.
Attendance: 74.

Feb. 28.—Branch General Meeting—Ladies' Night.
Subject: Films showing Construction of Empire State Building, New York City, and George Washington Bridge over the Hudson River.
Attendance: 135.

Mar. 9.—Annual Meeting.
Speaker: S. G. Porter, M.E.I.C., Past-President of The Institute.
Subject: Annual Meeting of the E.I.C., Toronto, February 7th, 8th, and 9th, 1935.
Attendance: 23.

Aug. 24.—Annual Golf Tournament held at Strathmore Golf Course.
Attendance: 30.

Oct. 31.—Branch General Meeting.
Speaker: Mr. W. J. Oliver.
Subject: Films—"Hunting Big Game with Camera,"
"Grey Owl and his Beaver,"
"Climbing Mount Victoria, Lake Louise,"
"Banff-Jasper Highway,"
"Watertown Lakes National Park," and
"Vancouver Island."
Attendance: 40.

Nov. 14.—Branch General Meeting.
Speakers: 1. S. G. Coultis, M.E.I.C., Royalite Oil Company, Turner Valley.
2. Mr. C. C. Planche, Calgary Power Company, Calgary.
Subjects: 1. **Modern Methods of Producing Gas and Oil.**
2. **Municipal Waterworks.**
Attendance: 37.

Nov. 29.—Annual Dance held at Renfrew Club, Calgary.
Attendance: 113.

Dec. 12.—Branch General Meeting.
Speaker: Dr. T. A. Link, Imperial Oil Limited, Calgary.
Subject: **The Petroleum Industry Exhibit at Chicago Century of Progress Exhibition.**
Attendance: 43.

The average attendance at regular meetings was forty-five.

Special attention should be called to the Junior Members Competition for a prize generously donated by an anonymous member of this Branch for the best ten-minute paper on an engineering subject. In this competition four papers were given as follows:—

Nov. 1, 1934.—1. **Photo-Electric Cells and Some of their Applications** by D. C. Fleming, S.E.I.C.
2. **Pressure Vessels for Cracking Oil** by James Blair, S.E.I.C.

Feb. 7, 1935.—1. **Cement Testing** by I. Abramson, Jr.E.I.C.
2. **Principles of Orifice Meters** by R. W. Dunlop, Jr.E.I.C.

Excellent papers were given in each case and after due deliberation the prize was awarded to Mr. I. Abramson for his paper on "Cement Testing."

Financial Statement

Receipts

Balance in bank as at December 31st, 1934	$103.78		
Rebates—October, November and December, 1934	23.55		
		$127.33	
Interest and savings		44.97	
Applications, Fees and Affiliates		61.34	
Rebates—To September 30th, 1935		160.05	
Rebates—October, November and December, 1935		20.70	
			$414.39

Expenditures

Applications and fees sent to Headquarters	$ 54.34	
Meetings	74.93	
Stamps, printing and stationery	36.44	
Entertainments	31.10	
Miscellaneous	56.62	
		$253.43
Balance in bank as at December 31st, 1935		140.26
Rebates—October, November and December, 1935		20.70
		$414.39

Assets

Cash in bank	$140.26	
Rebates—October, November and December, 1935	20.70	
Bonds	950.48	
Motion picture screen	1.20	
Stamps and stationery	6.00	
		$1,118.64

Liabilities

None.

Audited and found correct,
W. T. McFarlane, A.M.E.I.C. } Auditors.
P. A. Fetterly, A.M.E.I.C. }

Respectfully submitted,
John Haddin, M.E.I.C., *Chairman.*
Per John Dow, M.E.I.C., *Vice-Chairman.*
James McMillan, A.M.E.I.C., *Secretary-Treasurer.*

Cape Breton Branch

The President and Council:—

Due to the fact that it was found difficult to obtain speakers, the Cape Breton Branch was not very active during the year, three meetings only being held as follows:

Jan.—Annual Meeting. Discussion on Consolidation.

Feb.—H. S. Mussett of the Canadian Liquid Air Company gave an illustrated lecture on **The Uses of Oxygen and Acetylene in Industry**, with special reference to Welding, Hardfacing and Cutting.

July—Dr. Adolphe Meyer spoke on the **Velox Boiler.**

Financial Statement

Receipts

Brought forward	$238.64	
Rebates from Headquarters	82.20	
Receipts, Annual Meeting	33.00	
		$353.84

Expenses

Meetings	$105.83	
Printing	4.75	
Postage	2.56	
Telegrams	2.35	
Re Consolidation	6.51	
Secretarial expense	12.00	
		134.00
Balance on hand		219.84
		$353.84

Respectfully submitted,
W. E. Bown, A.M.E.I.C., *Chairman.*
Sydney C. Mifflen, M.E.I.C., *Secretary-Treasurer.*

Edmonton Branch

The President and Council:—

On behalf of the Executive committee of the Edmonton Branch we beg to submit the following report for the year 1935:—

Membership

	December 31st, 1934 Resident	December 31st, 1934 Non-Resident	December 31st, 1935 Resident	December 31st, 1935 Non-Resident
Members	10	3	16	2
Associate Members	18	6	22	5
Junior Members	5	..	3	2
Student Members	26	..	23	..
	59	9	64	9

Meetings

The following meetings of the Branch were held during the year:—
1935

Jan. 12.—**The Engineer and Public Health** by William Storrie, M.E.I.C., of Gore, Nasmith and Storrie, consulting engineers of Toronto. Attendance, 35.

Feb. 6.—**The Snake Indian River** by R. W. Ross, A.M.E.I.C., divisional engineer at Edmonton for C.N.R. Attendance, 32.

Mar. 13.—An inspection of Radio Station C.K.U.A. of the University of Alberta, and demonstrations in the Electrical Engineering Department of the University of Alberta. Attendance, 35.

April 1.—**Timber Preservation** by H. N. Macpherson, A.M.E.I.C., consulting engineer of Vancouver. Attendance, 40.

Oct. 31.—A joint meeting with the Association of Professional Engineers of Alberta and the Northern Alberta Branch of the C.I.M. & M., in honour of the Rt. Honourable Sir Montague Barlow, chairman of Alberta Coal Commission, the Honourable Charles C. Ross, M.E.I.C., Minister of Lands and Mines of the Province, and Mr. William Armour, technical advisor to the Alberta Coal Commission.

Nov. 26.—**One Troy Ounce of Gold** by Mr. E. J. Carlyle, General Secretary of the Canadian Institute of Mining and Metallurgy. A joint meeting with the Northern Alberta Branch of the C.I.M. & M., the local members of the Professional Engineers of Alberta, the Mining and Geological Society of the University and the Engineering Students Society of the University of Alberta.

Dec. 6.—**Use of Explosives in Road Building** by Mr. L. B. Fox, manager of the Edmonton office of Canadian Industries, Ltd. Attendance, 20.

Eight meetings of the Executive committee of the Branch were held to deal with special questions which arose.

The Membership committee of the Branch was very active during the year. The success of their operations is shown by the considerable increase in the corporate membership of the Branch during the year.

Financial Statement

Receipts

Balance on hand, January 1st, 1935	$134.41	
Rebates from Headquarters	94.20	
Rebates due from Headquarters, December 31st, 1935	10.80	
		$239.41

Expenditures

Expenses of Branch meetings	$ 22.70	
Postage and telegrams	10.60	
Printing	16.61	
Honorarium to Secretary-Treasurer	50.00	
Balance on hand, December 31st, 1935	139.50	
		$239.41

Alan E. Cameron
M. L. Gale, A.M.E.I.C. } Auditors.

Respectfully submitted,
F. K. Beach, M.E.I.C., *Chairman.*
R. M. Hardy, Jr.E.I.C., *Secretary-Treasurer.*

Halifax Branch

The President and Council:—

As Secretary of the Halifax Branch, I wish to submit the following report for the year 1934-35.

Including the annual meeting there have been six regular meetings and six meetings of the Executive. The following is a summary of the meetings held:—
1935

Jan.— Annual Banquet held in conjunction with the Nova Scotia Professional Society of Engineers.

Feb.— Meeting at the Halifax hotel addressed by David Boyd, A.M.E.I.C., engineer in charge of welding for the Dominion Bridge Co., who addressed the Branch on **Modern Developments in Electric Welding.**

Mar.— Meeting held at the Halifax hotel, addressed by J. B. Hayes, A.M.E.I.C., Manager of the Nova Scotia Light and Power Co., who gave a very interesting paper on **Some Electric Problems in Nova Scotia.**

July— A summer meeting was held at Green Acres, Waverly, N.S.

Nov.— The annual Students Meeting held at the Royal Scotia Technical College, addressed by R. L. Dunsmore, A.M.E.I.C.

Dec.— The Annual Meeting was held at the Halifax hotel, at which the Executive was elected for the coming year.

The question of Consolidation was discussed and the following committee was appointed to look after the Branch interests in connection with this important question:—

F. R. Faulkner, M.E.I.C.
A. F. Dyer, A.M.E.I.C.
H. S. Johnston, M.E.I.C.

The Executive arranged for the continuing of the series of programmes over the local radio station.

Arrangements were also made for a joint meeting of the Halifax and Sydney Branches of The Engineering Institute of Canada and the Nova Scotia Society of Professional Engineers, who made a general study of amalgamation and a contact was established with The Institute Committee on Consolidation.

The financial statement of the Branch is attached.

Financial Statement

Income

Rebates, January, 1935	$ 32.85		
Rebates—June, 1935	160.50		
Rebates—November, 1935	33.00		
		$226.35	
Bank interest—May	$ 3.78		
Bank interest—November	2.44		
		6.22	
			$232.57

Expenses

Flowers—Mrs. Sherwood	$ 5.00		
Grant to banquet	60.00		
Annual grant to Secretary	50.00		
Banquet deficit	8.65		
Orchestra—Summer party	21.00		
Deficit—Summer party	4.61		
H. Moore—Students Meeting	2.00		
M.T. & Tl. mailing list	3.50		
Miss M. A. Campbell	10.00		
Wm. MacNab & Sons	26.77		
Secretary account attached	19.41		
		$210.94	
Credit balance for year 1935		21.63	
			$232.57

Summary

Bank balance forward from 1934	$455.95	
Balance, 1935	21.63	
		$477.58

Royal Bank	$467.05	
Bank of Commerce	10.53	
		$477.58

F. R. Faulkner, M.E.I.C.
G. H. Burchill, A.M.E.I.C. } Auditors.

Respectfully submitted,
H. Fellows, A.M.E.I.C., *Chairman.*
R. R. Murray, A.M.E.I.C., *Secretary-Treasurer.*

Hamilton Branch

The President and Council:—

The Executive committee of the Hamilton Branch, Engineering Institute of Canada, submits the following report for the year 1935:—

The Executive committee held seven meetings throughout the year.

Membership

The Membership committee under E. G. MacKay, A.M.E.I.C., has been very active and has secured several applications for admission to The Institute and has also sent forward a number of applications for advancement.

Outstanding in our membership statistics for the year is the fact that nine who were on the non-active list have been able to seek re-instatement and have resumed active membership in the Branch, a most healthy and desirable feature.

Membership statistics are as follows:—

	December 31st, 1934		
	Resident	*Non-Resident*	*Total*
Members	27	3	30
Associate Members	33	10	43
Juniors	8	2	10
Students	26	3	29
Affiliates	2	..	2
Branch Affiliates	17	..	17
	113	18	131

Also 1 Member, 11 Associate Members, 4 Juniors, and 2 Students on the non-active list.

	December 31st, 1935		
	Resident	*Non-Resident*	*Total*
Members	32	4	36
Associate Members	33	12	45
Juniors	11	2	13
Students	26	7	33
Affiliates	2	..	2
Branch Affiliates	16	..	16
	120	25	145

Also 1 Member, 4 Associate Members, and 4 Juniors on the non-active list.

Meetings and Papers

The following is the list of meetings throughout the year:—

1935

Jan. 8.—Annual Meeting. Dinner meeting in the Wentworth Arms hotel. Attendance, 37.

Feb. 19.—**Mines and Miners** by Mr. Balmer Neilly, Secretary, McIntyre Porcupine Gold Mines. Attendance, 80.

Mar. 12.—**Welding** by D. A. Boyd, A.M.E.I.C., assistant works manager, Dominion Bridge Co., Montreal. Meeting held in the auditorium of the Hamilton Technical Institute. Attendance, 450.

Apr. 12.—**High Lights of European Nights** by Mr. S. G. Hibben, Director of Applied Lighting, Westinghouse Lamp Co., Bloomfield, N.J. Joint meeting with Toronto Section, A.I.E.E., held in the Westinghouse Auditorium. Attendance, 200.

April 23.—**Weather Forecasting** by Mr. John Patterson, F.R.S.C., Director, Meteorological Service of Canada. Joint meeting with Hamilton Centre, Royal Canadian Astronomical Society. Meeting held in McMaster University. Attendance, 60.

May 14.—**Handling of Bulk Material** by Mr. J. Farley, district manager, Link-Belt Co. Meeting held in McMaster University. Attendance, 40.

Oct. 11.—**Personal Experiences in Russia** by Mr. Arthur G. McKee, President, Arthur G. McKee & Co., engineers and contractors, Cleveland. Joint meeting with Ontario Section, American Society for Metals, held in Royal Connaught hotel. Attendance, 180.

Nov. 12.—**Diesel Engine Design from 1897 to 1935** by Mr. E. F. Roberts, general manager, Jordan-Roberts Sales, Brantford. Meeting held in McMaster University. Attendance, 60.

Dec. 9.—Students' Night.
E. C. Hay, S.E.I.C., **Selection Factors of Photo-Electric Cells.**
N. Tucker, S.E.I.C., **Single-Phase Fractional Horse-Power Motors.**
H. F. McLachlin, S.E.I.C., **Modern Electric Lighting.**
W. Preston, S.E.I.C., **Why that Kind of a Bridge?**
Meeting held in McMaster University. Attendance, 75.

W. J. W. Reid, A.M.E.I.C., chairman of the Meetings and Papers committee, has spared no effort to obtain attractive subjects and the attendance at meetings indicates that he has succeeded.

The authorities of McMaster University have again afforded the Branch the privilege of meeting there—a privilege which is greatly appreciated. Following all meetings held at McMaster, coffee and sandwiches have been provided, and members have had an opportunity of meeting and greeting each other.

The Students' Night was a revival, and aroused a lot of interest. The papers were submitted in competition, prizes to be awarded at the meeting in January, and the four papers will be submitted for the Galbraith Prize Competition.

Publicity

The Executive committee wishes to acknowledge the many courtesies extended to the Branch by the local press.

Development

H. A. Lumsden, M.E.I.C., is Branch representative in the matter of the consolidation of the Engineering Profession in Canada, working in conjunction with the Ontario Provincial Section of The Institute Committee on Consolidation.

Annual Meeting of The Institute

The Hamilton Branch has invited Council to hold the 1936 Annual General Meeting in Hamilton. This invitation has been accepted and Hamilton members are making every effort to have a real successful meeting, and to ensure visiting delegates of a pleasant and profitable time.

Financial Statement

Income		
Balance in bank, January 1st, 1935	$ 54.54	
From Headquarters (due for 1934)	23.40	
Branch Affiliates	30.00	
Rebates on fees	196.20	
Interest	56.79	
		$360.93
Expenditure		
Printing and postage	$ 73.52	
Meeting expenses	96.20	
Stenographer	50.00	
Sundry	5.28	
Balance in bank	121.03	
Cash on hand	5.00	
Due from Headquarters (rebates for last quarter)	9.90	
		$360.93
Net income	$282.99	
Net expenditure	225.00	
Net operating surplus	$ 57.99	
Assets		
Bonds at cost	$915.00	
Lantern (less depreciation)	90.00	
Bank balance	121.03	
Cash on hand	5.00	
Due from Headquarters	9.90	
		$1,140.93

Respectfully submitted,
W. Hollingworth, M.E.I.C., *Chairman.*
Alex. Love, M.E.I.C., *Secretary-Treasurer.*

Kingston Branch

The President and Council:—

During the year 1934-1935 the Branch met five times as follows:—

1934

Dec. 4.—Annual meeting for the election of officers and presentation of reports.

1935

Jan. 16.—The Branch had the pleasure of entertaining at dinner F. P. Shearwood, M.E.I.C., President of The Institute, who gave a very informative talk on **Institute Affairs** followed by an illustrated discussion on **Bridge Engineering.**

Feb. 22.—Lt.-Col. N. C. Sherman, M.E.I.C., read a very interesting paper on **The Development of Machine Guns.**

Mar. 9.—The films illustrating the manufacture of steel products and shipbuilding at the Vickers plant were shown.

June 4.—A special meeting was held at the office of the Chairman to consider what steps should be taken in view of the action of Council re a case of alleged unprofessional conduct, and to frame a reply to the questionnaire of the Committee on Consolidation.

June 14.—The General Secretary E.I.C. and two members of Council came to Kingston to discuss the first of the above matters, and a meeting was held at the office of the Chairman at which he and several other members were present.

Employment

So far as known, no members of the Branch are without some employment at the present time, but some are in positions which cannot be considered as satisfactory.

Chamber of Commerce

No meetings of the Chamber of Commerce have dealt with questions in which the members of the Branch, as such, are interested.

Membership

The membership of the Branch for the past four years has been as follows:—

	1931-32	*1932-33*	*1933-34*	*1934-35*
Honorary Members	1	1	1	1
Members	12	13	11	11
Associate Members	17	16	19	18
Juniors	6	6	7	3
Students	7	16	14	13
	43	52	52	46

Finances

The income from rebates has been slightly greater this year. Expenses have however been a little heavier. A detailed statement is appended:—

Receipts

Balance forward	$ 52.48	
Oct. 8th—Rebates	11.70	
Dec. 4th—Excess receipts, annual meeting	.45	
Dec. 31st—Interest	.46	
Jan. 23rd—Rebates	9.60	
June 30th—Interest	.16	
Aug. 12th—Rebates	64.20	
		$139.05

Expenditures

Jan. 16th—Dinner	$ 2.20	
Jan. 24th—Secretary	25.00	
Feb. 22nd—Dinner	4.45	
Mar. 9th—Dinner	3.05	
Speakers expenses, films, etc	24.55	
Printing, etc	8.47	
Postage and wires	4.06	
Chamber of Commerce	15.00	
Sundry	3.40	
Bank balance	48.87	
		$139.05

Assets

Bank balance	$ 48.87	
Note	50.00	
		$ 98.87

Liabilities

Owing to E.I.C	$ 50.00	
Surplus	48.87	
		$ 98.87

Respectfully submitted,

L. F. Grant, m.e.i.c., *Secretary.*

Lakehead Branch

The President and Council:—

On behalf of the Executive committee of the Lakehead Branch we beg to submit the following report for the year 1935.

During the year the following meetings were held:—

1935

Jan. 7.—Dinner meeting at which Wm. Storrie, m.e.i.c., consulting engineer, spoke on **The Engineer and Public Health.**

April 12.—Dinner meeting at which J. Antonisen, m.e.i.c., retiring city engineer of the City of Port Arthur, was guest of honour. Representatives from other professional bodies were present.

June 18.—Annual Meeting at which the officers for the ensuing year were elected.

Sept. 18.—Dinner meeting devoted to business of the Branch.

Oct. 20.—Dinner meeting at which the Hon. C. D. Howe, m.e.i.c., Federal Minister of Railways and Canals and Marine, and a charter member of the Branch, was guest of honour and speaker.

Nov. 20.—Dinner meeting at which Mr. L. G. Dandeno, superintendent of the Thunder Bay Hydro System, was the guest speaker.

Dec. 18.—Dinner meeting addressed by G. R. Duncan, a.m.e.i.c., on the subject **Real Estate and Engineering.**

Financial Statement

Receipts

Balance in bank, June 1st, 1935	$273,79	
Rebates from Headquarters:—		
January to April incl	57.90	
May to September incl	10.65	
October to December incl	12.30	
Bank interest	1.44	
		$356.08

Expenditures

Expenses of meetings	$ 43.65	
Telegrams	2.95	
Stationery	13.95	
Postage and excise stamps	6.13	
Mimeographing	.95	
Printing	3.18	
Cash on hand	13.44	
Balance in bank, December 31st, 1935	259.53	
Rebates due October to December	12.30	
		$356.08

Respectfully submitted,

R. J. Askin, a.m.e.i.c., *Chairman.*

G. R. McLennan, a.m.e.i.c., *Secretary-Treasurer.*

Lethbridge Branch

The President and Council:—

The following is a report of the operations of the Lethbridge Branch, Engineering Institute of Canada, for the year 1935.

Since January 1st, 1935, seven regular meetings and four Executive meetings were held, attendance at the former averaging 39 and at the latter seven. One of these meetings was a Ladies' Night. On March 23rd, a joint meeting of the Lethbridge Branch, Engineering Institute of Canada, and the Association of Professional Engineers of Alberta was held.

Through the untiring efforts of the Entertainment committee the social side of our programmes was well up to average.

The list of speakers and subjects follows:—

1935

Jan. 12.—Motion picture films.
(1) **Trail, the Metallurgical Mecca of Canada.**
(2) **Petroleum: The Turner Valley Oil-fields.**
Speaker: Mr. S. E. Slipper, chief geologist for the Canadian Western Natural Gas, Light, Heat and Power Co., Calgary. Attendance, 40.

Feb. 2.—Motion picture films.
(1) **The Romance of Rubber.**
(2) **The Chicago Century of Progress Exhibition.**
(3) **Modern Cement Concrete Highway Construction.**
Attendance, 45.

Mar. 2.—Annual Meeting. Dinner. Motion picture films.
(1) **Construction of the Empire State Building in New York.**
(2) **Construction of the Brooklyn Suspension Bridge.**
Speaker: Mr. W. Pratt, representative of the Otis Fensom Co. Attendance, 30.

Mar. 23.—Joint meeting of the Lethbridge Branch, Engineering Institute of Canada, and the Association of Professional Engineers of Alberta.

Oct. 26.—Inspection trip to Picture Butte, Alberta, for the purpose of viewing the new reservoir of the Lethbridge Northern Irrigation District and the construction of the new beet sugar factory.
Speaker: Mr. C. Bentall, president of the Dominion Construction Co., Vancouver.
Subject: **The Construction of a Beet Sugar Factory.**
Attendance, 43.

Nov. 9.—Motion picture films. **The Shawinigan Water Power.** Attendance, 30.

Nov. 23.—Speaker: B. Russell, m.e.i.c., chief engineer, Water Development Committee, Swift Current, Sask.
Subject: **Rehabilitation of the Dried Out Areas.**
Attendance, 35.

Dec. 7.—Ladies' Night. Motion picture films, musical programme, bridge.
(1) **Niagara.**
(2) **Making a Newspaper.**
Attendance, 51.

The annual meeting was held on March 2nd, 1935, officers being elected for the 1935-1936 season.

At December 31st, 1935, the membership of the Branch stood as follows:—

	Resident	*Non-Resident*	*Total*
Members	4	..	4
Associate Members	17	4	21
Juniors	..	2	2
Students	6	3	9
Affiliates	25	..	25
	52	9	61

FINANCIAL STATEMENT

Receipts

Rebates received from Headquarters for January to September incl.	$ 61.50	
Rebates received from Headquarters for October to December, 1934	8.70	
Branch Affiliate fees and Journal subscriptions	18.00	
Bank interest	.26	
Total revenue	$ 88.46	
Bank balance as at December 31st, 1934	26.15	
		$114.61

Expenditures

Printing and stationery	$ 25.16	
Meeting expenses: Dinners, music, films, etc.	52.92	
Orchestra	15.00	
Postage, exchange, telegram, etc.	8.99	
		$102.07

Assets

Bank balance as at December 31st, 1935	$ 12.54	
Holmes projector, value $360.25, less 50% depreciation	180.12	
		$192.66

Liabilities

Journal subscriptions for O. B. Tucker due Headquarters .... $ 2.00

We have examined the books, papers, vouchers and the foregoing statement prepared by the Secretary-Treasurer and find the same to be a true and correct account of the standing of the Branch.

P. M. SAUDER, M.E.I.C. }
G. S. BROWN, A.M.E.I.C. } Auditors.

Respectfully submitted,
W. L. MCKENZIE, A.M.E.I.C., *Chairman.*
EDWARD A. LAWRENCE, S.E.I.C., *Secretary-Treasurer.*

London Branch

The President and Council:—

1. GENERAL

1935

Jan. 23.—Annual meeting with Prof. P. H. Hansel, head of the Department of Business Administration at the University of Western Ontario, as guest speaker. Attendance, 47.

Feb. 20.—Illustrated lecture by Mr. C. E. Simpson of the All Weld Co. Toronto, on **The Metallizing Process.** Attendance, 40.

Mar. 20.—Address by Mr. Gordon Culham, B.S.A., M.L.A., on **Relation of Assessment Value to New Housing.** Attendance, 33.

April 17.—A social evening by members at the home of E. V. Buchanan, M.E.I.C. The guests were entertained at bridge. Refreshments served by the host.

Oct. 25.—The Members of the London Branch E.I.C. were guests of the Association of Professional Engineers of Ontario at a dinner in Hotel London.

Nov. 17.—Address by Mr. B. W. Grover of the local Public Utilities Commission on **The New Science of Seeing.** Attendance, 23.

Average attendance of all meetings, 38.

2. EXECUTIVE

In addition to above, six Executive meetings were held, with an average attendance of 7.

FINANCIAL STATEMENT

Receipts

Cash on hand, January 1st, 1935	$ 3.10	
Bank balance	131.29	
Affiliate fees for 1935	5.00	
Rebates from Headquarters for 1934	8.70	
Rebates from Headquarters for 1935	72.90	
Rebates due from Headquarters for 1935	12.90	
		$233.89

Expenditures

Annual dinner expenses	$ 33.55	
Stenographer for 1935	5.00	
Journal subscriptions for affiliates	2.00	
Printing	13.92	
Flowers—re Angus	4.00	
Flowers—re Harcourt	4.00	
Auditorium and elevator service	4.00	
Travelling expenses for speaker	5.03	
Secretary's expenses—stamps, etc	7.49	
		78.99
Cash on hand, December 31st, 1935		3.10
Bank balance		138.90
Rebates due from Headquarters		12.90
		$233.89

V. A. MCKILLOP, A.M.E.I.C. }
D. M. BRIGHT, A.M.E.I.C. } Auditors.

Respectfully submitted,
S. W. ARCHIBALD, M.E.I.C., *Chairman.*
S. G. JOHRE, A.M.E.I.C., *Secretary-Treasurer.*

Moncton Branch

The President and Council:—

On behalf of the Executive committee we beg to submit the sixteenth annual report of Moncton Branch.

The Executive committee held seven meetings. Seven meetings of the Branch were held, at which addresses were given and business transacted as follows:—

1935

Jan. 29.—A meeting was held in the City Hall. David Hourston, Branch Affiliate, read a paper on **Coal Tests.**

Feb. 19.—A meeting was held in the City Hall. David Boyd, A.M.E.I.C., Dominion Bridge Co., Montreal, delivered an illustrated address on **Modern Arc Welding.**

Mar. 14.—The Branch Executive entertained at luncheon R. F. Legget, A.M.E.I.C., Secretary of the Committee on Consolidation. Mr. Legget spoke briefly on the proposed amalgamation of The Institute and the Provincial Associations.

April 1.—A meeting was held in the City Hall. T. H. Dickson, A.M.E.I.C., read a paper on **Nickel and Its Uses.** Three motion pictures were shown, "Power," "Making Money" and "Forest Fighters of the Skies."

May 10.—A meeting was held for the purpose of nominating Branch officers for 1935-36.

May 30.—The annual meeting of the Branch was held on this date.

Dec. 17.—A meeting was held in the City Hall. Horace L. Seymour, M.E.I.C., delivered an address on **Town Planning.**

MEMBERSHIP

Our membership at present consists of fifty-four members, as follows:—

	Resident	*Non-Resident*
Members	6	2
Associate Members	16	4
Juniors	2	1
Students	4	10
Affiliates	9	..
	37	17

During the year there was an Institute admission to the grade of Member through this Branch, and at the present time, there is a Junior application pending. We have had a gratifying increase of Branch Affiliates, all of whom are actively engaged in engineering.

Early in the year, a portable standard size moving picture projector was purchased. We are indebted to our Branch Councillor, H. J. Crudge, A.M.E.I.C., for giving unstintingly of his time and expert knowledge in selecting and negotiating the purchase of this machine.

FINANCIAL STATEMENT

Receipts

Balance in bank, January 1st, 1935	$175.30	
Cash on hand, January 1st, 1935	3.51	
Rebates on dues	65.25	
Affiliate dues	40.00	
Bank interest	2.21	
Rebates due from Headquarters	9.90	
		$296.17

Expenditures

Expenses of meetings	$ 10.36	
Printing and advertising	3.40	
Postage	7.79	
Telegrams and telephones	2.21	
Motion picture equipment	85.62	
Honorarium to Secretary	25.00	
Miscellaneous	34.65	
Balance in bank	111.02	
Cash on hand	6.22	
Rebates due from Headquarters	9.90	
		$296.17

Assets

Balloptican lantern	$ 30.00	
Motion picture equipment	85.00	
Attache case	5.00	
Unpaid Affiliate dues	5.00	
Cash in bank	111.02	
Cash on hand	6.22	
Rebates due from Headquarters	9.90	
		$252.14

Liabilities

None

Audited and found correct,
JAMES PULLAR, A.M.E.I.C. }
R. H. EMMERSON, A.M.E.I.C. } Auditors.

Respectfully submitted,
H. B. TITUS, A.M.E.I.C., *Chairman.*
V. C. BLACKETT, A.M.E.I.C., *Secretary-Treasurer.*

Montreal Branch

Chairman: F. S. B. Heward, A.M.E.I.C.
Vice-Chairman: J. B. D'Aeth, M.E.I.C.
Past Chairman: Dr. A. Frigon, M.E.I.C.
Secretary-Treasurer: C. K. McLeod, A.M.E.I.C.

COMMITTEE

Elected

F. E. V. Dowd, A.M.E.I.C.	R. H. Findlay, M.E.I.C.
J. G. Hall, M.E.I.C.	B. R. Perry, M.E.I.C.
J. H. Landry, A.M.E.I.C.	J. A. Lalonde, A.M.E.I.C.

Ex-Officio

F. A. Gaby, M.E.I.C.	J. A. McCrory, M.E.I.C.
F. P. Shearwood, M.E.I.C.	C. B. Brown, M.E.I.C.
O. O. Lefebvre, M.E.I.C.	A. Cousineau, A.M.E.I.C.
P. L. Pratley, M.E.I.C.	E. A. Ryan, M.E.I.C.
J. L. Busfield, M.E.I.C.	

Section	*Chairmen*
Civil Section	W. G. Hunt, M.E.I.C.
Electrical Section	K. O. Whyte, A.M.E.I.C.
Mechanical Section	M. J. Berlyn, A.M.E.I.C.
Municipal Section	C. C. Lindsay, A.M.E.I.C.
Transportation	R. O. Stewart, A.M.E.I.C.
Junior Section	E. R. Smallhorn, A.M.E.I.C.
Radio and Communication	J. H. Thompson, A.M.E.I.C.

Sub-Committee	*Chairmen*
Papers and Meetings	H. J. Vennes, A.M.E.I.C.
Membership	W. McG. Gardner, A.M.E.I.C.
Admission	F. E. V. Dowd, A.M.E.I.C.
Reception	R. H. Findlay, M.E.I.C.
Nomination	L. C. Jacobs, M.E.I.C.
Publicity	J. M. Fairbairn, A.M.E.I.C.
Unemployment	J. A. McCrory, M.E.I.C.
Town Planning	Leonard Schlemm, M.E.I.C.

On behalf of the Committee, I have the honour to submit the Annual Report of the Montreal Branch for the Eighteenth Session, 1935.

THE ROLL

The changes in Membership during the year ending 31st December, 1935, are shown in the following statement:—

	Number	*Increase over 1934*
Montreal Branch Active List		
Honorary Members	1	0
Members	221	11
Associate Members	486	58
Juniors	81	0
Students	206	2
Affiliates	16	2
	1,011	73
Montreal Branch District		
Members	8	3
Associate Members	33	1
Juniors	11	2
Students	13	0
	65	6

		Decrease from 1934
Non-Active List		
Members	5	5
Associate Members	54	31
Juniors	17	5
Students	8	3
Affiliates	1	1
	85	45

Summary	
Total Active Members	1,076
Total Non-Active Members	85
Total Membership	1,161
Increase over 1934	34

During the year there has been a satisfactory increase in the active Membership of the Branch. This increase is observed in almost every Membership classification, but it is especially noteworthy in the Associate Membership group.

A welcome decrease has taken place in the number of members recorded on the non-active list. This also is a most encouraging sign of progress during the past year, leading the Committee to hope that other members reported on this list will be able to resume their active membership in the coming year.

MEMBERS DECEASED

The Committee deeply regrets to report the loss by death of the following Members:—

Members:
William Charles Adams; Frederick P. Gutelius; John Herbert Larmonth; Thomas W. Lesage; Frank Henry Pitcher; Albert Henry Pattenden.

Associate Members:
Joseph O. Bonin; Charles L. Cantley.

PAPERS AND MEETINGS

Twenty-nine general meetings were held during the Session, several of which were held in conjunction with other organizations, either as a joint meeting or by invitations extended to other organizations such as the Province of Quebec Association of Architects and the Canadian Institute of Mining and Metallurgy. There were three Special General Meetings of the Branch, also.

The suggestion tabled by last year's Papers and Meetings Committee that the individual sections add to their numbers and discuss the programme for the year apart from the general Committee Meetings, has been carried out to good advantage.

The approximate figures for the past three years, as regards Meetings, attendance and average attendance for Meetings held from July to the end of the year, are as follows:—

Year	*1933*	*1934*	*1935*
Meetings	11	16	14
Attendance	1,155	1,747	2,070
Average	105	109	147

Above figures do not include the Junior Section Meetings nor the Smokers which are reported separately. The following is the complete list of papers as presented and discussed during 1935.

Jan. 10.—Annual Meeting of Branch.
Jan. 17.—**Noise Limit in Communication** by Dr. O. E. Buckley.
Jan. 24.—**Problems in Land Surveying** by C. C. Lindsay, A.M.E.I.C.
Jan. 25.—**The Boulder Dam Transmission Line** by O. W. Titus.
Jan. 31.—**Modern Arc Welding** by D. Boyd.
Feb. 7.—**Design of Air Compressors** by F. G. Ferrabee.
Feb. 14.—**Radio Broadcasting** by Colonel Steel.
Feb. 21.—**Lightning** by A. C. Monteith.
Feb. 28.—Junior Section.
Mar. 7.—**Recent Developments in Sound Pictures** by S. T. Fisher, Jr.E.I.C.
Mar. 14.—**Air Conditioning in Industry** by W. L. Fleisher.
Mar. 21.—**Stainless Steel—Its History and Application** by C. M. Carmichael.
Mar. 28.—**Some Basic Principles in Making Durable Concrete** by E. Viens, M.E.I.C.
April 4.—**Water Filtration** by W. S. Lea, M.E.I.C.
April 11.—**Electrical Industrial Heating** by Lee P. Hynes.
April 12.—Smoker.
April 18.—**Use of X-Ray in Metallurgy** by André Hone, D.Sc.
June 22.—Visit to St. Hubert Airport.
Sept. 18.—Luncheon on board R.M.S. "Ascania."
Oct. 4.—Smoker.
Oct. 10.—**The Evolution of the Warship** by Comdr. A. D. M. Curry, M.E.I.C.
Oct. 15.—**Voices Across the Sea** by Dr. J. O. Perrine.
Oct. 17.—**A National Slum Clearance and Housing Programme** by J. H. Craig.
Oct. 23.—**D.C. Power Transmission** by C. W. Stone.
Oct. 31.—**Historical Survey of Development, Application and Uses of Nickel and its Alloys** by T. H. Wickenden.
Nov. 4.—**British Methods of Power Factor Correction** by B. M. Burt.
Nov. 7.—**Manufacture of Vacuum Tubes** by W. E. Davison.
Nov. 14.—**Engineering and Traffic Aspects of Holland and Midtown-Hudson Tunnels** by A. C. Davis.
Nov. 18.—**Electricity and Matter** by Dr. D. A. Keys.
Nov. 21.—Junior Section.
Nov. 28.—**Navigation** by Carl Bodensiech, R.N.V.R.
Dec. 5.—**Industrial Application of X-Ray** by Dr. Page.
Dec. 12.—**Orleans Bridge** by P. L. Pratley, M.E.I.C.
Dec. 19.—**New System of Block Caving** by E. L. Rainboth.

JUNIOR SECTION

The Junior Section of the Branch has concluded its third session and has held fourteen meetings at ten of which two papers have been read, one in French and one in English. The remaining four meetings took the form of visits to plants in and about the city. Total attendance 634; Average per meeting 45.

RECEPTION

The endeavour has been made this year to promote a number of social events that have included two Smoking Concerts, each of which was attended by some 325 members and friends; a visit to the St.

Hubert Airport and a luncheon aboard R.M.S. "Ascania." The success of these four occasions is indicative of the desire of the members for the continuance of events of this nature.

Branch Nominations

This Sub-Committee is charged with the responsibility of representing the Branch in connection with nominations to Council in which the Montreal Branch is interested. Three meetings in all have been held and all duties required of this Committee for the year have been discharged.

Publicity

This Sub-Committee has been endeavouring to obtain improved write-ups of the activities of the Branch in all the local trade journals and daily newspapers. Reporters sent to meetings have been met and furnished with all possible assistance. An improvement in the general publicity accorded the Branch has resulted.

Branch Unemployment

The Branch Unemployment Committee have found that conditions of employment have generally been much better during the past year and do not feel that additional funds should be collected from the membership at this time. Several members have been given assistance with the funds in hand and it is proposed to assist only those in dire need as long as the fund lasts. The financial statement of the fund for the year is as follows:

Balance from 1934	$373.96	
Bank Interest	3.65	
Subscriptions	112.00	
		$489.61
To Assistance to Members	$391.17	
Balance on hand	98.44	
		$489.61

Town Planning

Activities in the District of Montreal emanate from two sources, one being the Town Planning Commission appointed by the City of Montreal and headed by Mr. H. A. Terrault, M.E.I.C., and the other sponsored by the Civic Improvement League, the latter dealing mainly with such items as Slum Clearance and Housing. Recognizing the great importance of the subject, the Montreal Branch duly appointed its own observer of current events in the person of Mr. Leonard E. Schlemm, M.E.I.C., Town Planning Committee.

In view of the fact that Mr. Schlemm's report is the first to be submitted for the information of Members, the report will be published verbatim in The Journal.

Finance

The following is the financial statement for the year and we have also included the figures for 1934 so that members may make a comparison. It will be noticed that there is a surplus of $32.91 on the two smoking concerts that we gave. One item that has increased considerably is the cost of postcard notices and mailing. This, of course, is due to the increased number of meetings held in which are included the meetings of the Junior Section. We have also contributed rather largely this year towards the travelling expenses of out-of-town speakers.

Revenue

	1934		*1935*	
Rebates from Headquarters	$1,593.60		$1,439.60	
Rebates due from Headquarters			130,60	
Affiliate Dues	43.00		55.00	
Interest	7.53		13.03	
		$1,644.13		$1,638.23
Surplus previous year	1,220.48		1,138.00	
Extraordinary Revenue	1,859.59		480.66	
Dinners to Speakers	50.80		154.25	
		4,775.00		3,411.14

Disbursements

Postcard notices	$ 669.11		$ 826.72	
Stationery and Stamps	25.35		24.02	
Secretary's Honorarium	300.00		300.00	
Stenographical Service	120.00		120.00	
Telephones and Telegraphs	60.95		60.00	
Lantern Operator and Slides	103.00		81.00	
Subscriptions to Journal	18.00		18.00	
Thursday Refreshments	76.80		40.78	
Speakers—Travelling Expenses	109.24		129.38	
Speakers—Dinners			183.46	
Smokers			447.75	
Annual General and Professional Meeting	2,106.11			
Miscellaneous	48.44		39.92	
Cash Balance	1,138.00		1,140.11	
		$4,775.00		$3,411.14

Committee Meetings

During the Season the Committee has held 9 regular Meetings, at which the attendance was as follows:—

F. S. B. Heward	9	J. A. Lalonde	3
Dr. A. Frigon	3	J. L. Busfield	8
J. B. D'Aeth	8	J. A. McCrory	
C. K. McLeod	7	C. B. Brown	1
F. E. V. Dowd	8	A. Cousineau	1
J. G. Hall	4	F. P. Shearwood	4
J. H. Landry	4	P. L. Pratley	7
R. H. Findlay	7	E. A. Ryan	7
B. R. Perry	6		

In presenting this Report the Committee desires to acknowledge the assistance from members during the year. It is felt that by its activities the Branch is fulfilling its objects to the best of its resources, i.e., 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.

Respectfully submitted,
F. S. B. Heward, A.M.E.I.C.
Chairman

Niagara Peninsula Branch

The President and Council:—

The Executive committee of the Niagara Peninsula Branch presents herein the report for the year 1935.

The Executive held five regular meetings and one Electoral meeting with an average attendance of 10.

The Branch meetings are listed as follows:—

1935

Jan. 22.—Inspection trip to Spun Rock Wools Ltd. at Thorold. Dinner at Trinity United Church, and talk by Mr. C. R. Buss on **Insulation.**

Feb. 15.—Informal meeting at Council Chambers, Thorold, with a talk by Mr. J. M. Barclay on **Amateur Sports.** Also reports on Annual Meeting in Toronto.

Mar. 13.—Dinner meeting at King Edward hotel, Niagara Falls, with talk by David Boyd, A.M.E.I.C., of the Dominion Bridge Co., on **Modern Arc Welding.**

April 11.—Joint dinner meeting with the Niagara District, Chemical and Industrial Association, at the Hotel Leonard, St. Catharines. Mr. W. Davidson, of General Motors, gave a talk on **Automobile Manufacture.**

May 2.—Joint meeting with the A.S.M.E. in Welland. The afternoon was devoted to inspection trips to various Welland industries. Dinner at 6 p.m. followed by moving pictures of the Canada Atlas Steel Co. and talks on **Heavy Forgings** by representatives of the Erie Forge Company.

May 31.—Annual Meeting at General Brock hotel, Niagara Falls. Dr. F. A. Gaby, M.E.I.C., President of The Engineering Institute of Canada, gave a talk on **Institute Affairs** and on **Transportation.**

Sept. 26.—Inspection trip through McKinnon Industries branch of General Motors, St. Catharines. Dinner at Welland House, with talks on various phases of the automotive industry by representatives of the above firm.

Oct. 22.—Dinner meeting at King Edward hotel, Niagara Falls, followed by talk on the **Boulder Dam Transmission Lines** by Mr. O. W. Titus, of the Canada Wire and Cable Co.

Dec. 4.—Joint meeting with the A.O.P.E. at the plant of the North American Cyanamid Co., Niagara Falls. Inspection of the plant was followed by dinner as guests of the Company. Afterwards a discussion on **Consolidation** was held.

Membership

Members	19
Associate Members	55
Juniors	3
Students	8
Affiliates	15
Non-active	10
	110

Financial Statement

Receipts

Bank balance, January 1st, 1935	$215.75	
Rebates	162.60	
Affiliate dues	70.00	
Meetings	175.47	
Bank interest	3.60	
		$627.42

Expenditures

Meetings	$153.00	
Printing and postage	42.84	
Exchange on cheques	.90	
Secretary's honorarium	100.00	
Affiliate Journals	30.00	
Bank balance, December 31st	300.68	
		$627.42

Respectfully submitted,
P. E. Buss, A.M.E.I.C., *Chairman.*
P. A. Dewey, A.M.E.I.C., *Secretary-Treasurer.*

Ottawa Branch

The President and Council:—

On behalf of the Managing committee of the Ottawa Branch we beg to submit the following report for the calendar year 1935.

During the year the Managing committee held seven meetings for the transaction of general business. In addition the Branch held fourteen meetings. These meetings were well attended and excellent addresses were enjoyed.

It is with deep regret that we report the loss through death of two members—A. B. Lambe, A.M.E.I.C., and Noulan Cauchon, A.M.E.I.C.

As in previous years the Branch donated two sets of draughting instruments to the Ottawa Technical School for presentation as prizes for proficiency in draughting.

Proceedings and Publicity

During the year seven luncheon meetings and six evening meetings were held, and a visit made to the paper mills of the E. B. Eddy Company at Hull, P.Q. The dates of the meetings and speakers are as follows:—

1935

Jan. 10.—Luncheon address, Hon. Grote Stirling, M.E.I.C. Attendance, 142.

Jan. 10.—Annual Meeting of Branch, film **Flying Over the Empire** by courtesy of the National Council of Education. Attendance, 80.

Jan. 24.—Evening meeting, B. G. Ballard, A.M.E.I.C., **Some Aspects of High Tension Direct Current Power Transmission.** Attendance, 75.

Feb. 18.—Evening meeting (Joint Meeting with Service Clubs), Dr. W. H. Fyfe, Principal, Queen's University, **Why Democracy?**

Feb. 21.—Luncheon meeting, H. E. M. Kensit, M.E.I.C., **Present Status of Tidal Power.** Attendance, 75.

Mar. 7.—Luncheon meeting, Dr. D. C. Rose, **Thunder Storms and Electrical Effects in the Atmosphere.** Attendance, 84.

Mar. 21.—Evening meeting, J. W. Lucas, M.E.I.C., **Some Basic Principles in Making Durable Concrete.** Attendance, 60.

Mar. 30.—Luncheon address and trip through Eddy's Paper Mills, W. S. Kidd, A.M.E.I.C., **Pulp and Paper.** Attendance, 153.

April 9.—Evening meeting, Discussion of Consolidation of the Engineering Profession in Canada. Attendance, 40.

April 25.—Luncheon address, Dr. F. J. Alcock, **Geological Mapping with Aeroplane Assistance.** Attendance, 59.

Oct. 29.—Evening meeting, Eng.-Commander A. D. M. Curry, M.E.I.C., **From Sail to Steam in the Royal Canadian Navy.** Attendance, 100.

Nov. 14.—Luncheon address, J. L. Rannie, M.E.I.C., **Splitting Hairs.** Attendance, 88.

Dec. 5.—Dinner Dance, Hon. C. D. Howe, M.E.I.C., **The Engineer in Politics.** Attendance: Dinner, 343; dance, 87; total, 430.

Dec. 19.—Luncheon address, H. L. Seymour, M.E.I.C., **The Trend in Town Planning.** Attendance, 70.

Membership

With several adjustments during the year the membership roll now shows an increase of 22 during the year.

The following table shows in detail the comparative figures for the years 1934 and 1935:—

	1934	*1935*
Honorary Members	1	1
Members	76	83
Associate Members	166	170
Affiliates of Institute	3	3
Juniors	15	14
Students	34	32
Branch Affiliates	31	31
Resident Members	326	333
District Members	59	74
Total	385	407

Finances

The attached financial statements show that the Branch had a surplus of $16.93 in revenue over expenditure at the end of the year. The year closed with a balance of $666.90 in the bank, $19.57 cash on hand, and $1,000 in Government bonds. In addition the Branch had assets of $43.90 in rebates due from the Main Institute, $91.95 due from the Dinner Dance committee, $10.00 due from the Proceedings committee, and $21.00 in equipment, etc., making a total of $1,853.32.

Financial Statement

Receipts

Proceeds from sale of bonds	$ 500.00	
Interest on Dominion of Canada bonds	42.50	
Bank interest	8.71	
Rebates from Main Institute—		
October to December, 1934	42.90	
January to April, 1935	360.50	
May to September, 1935	70.00	
Branch Affiliate fees	93.00	
Proceeds from sale of luncheon tickets	298.72	
	$1,416.33	
Balance in bank, January 1st, 1935	652.49	
Cash on hand, January 1st, 1935	17.05	
		$2,085.87

Expenditures

Purchase of bonds	$ 519.99	
Chateau Laurier luncheons	355.65	
Standish Hall, luncheon	96.39	
Catering evening meetings	50.00	
Advances re dinner dance, December 12th, 1935	118.00	
Grant to Aeronautical Section	20.00	
Printing	139.51	
Subscriptions to Engineering Institute Journal	6.00	
Sundries, gratuities, prizes, etc	55.65	
Petty cash, postage, telegrams	38.21	
	$1,399.40	
Cash on hand, December 31st, 1935	19.57	
Cash in bank, December 31st, 1935	666.90	
		$2,085.87

Assets

Stationery and equipment	$ 20.00	
Library	1.00	
Rebates due from Main Institute, account 1935 fees	43.90	
Dominion Government bonds	1,000.00	
Due from Dinner Dance committee	91.95	
Due from sale of luncheon tickets	10.00	
Balance in bank	666.90	
Cash on hand	19.57	
		$1,853.32

Liabilities

Surplus	$1,853.32

Officers for 1936

The Annual Meeting of the Branch will be held on January 9th when the officers and members of the Managing committee for 1936 will be elected.

Respectfully submitted,
R. W. Boyle, M.E.I.C., *Chairman.*
F. C. C. Lynch, A.M.E.I.C., *Secretary-Treasurer.*

Aeronautical Section

The officers for the year were:—

Chairman—Group-Capt. E. W. Stedman, M.E.I.C., Chief Aeronautical Engineer, Department of National Defence, Ottawa, Ont.

Secretary—Mr. K. F. Tupper, Model Testing Basin, National Research Council, Ottawa, Ont.

Meetings

The following technical papers were given at evening meetings of the Aeronautic Section:—

1935

Jan. 23.—**The Fourcade Stereogoniometer** by Major E. L. M. Burns, A.M.E.I.C., of the Geographical Section, General Staff, Department of National Defence.

Feb. 1.—**The Winter Operation of Aircraft Engines** by Squadron-Leader A. Ferrier, A.M.E.I.C., of the R.C.A.F.

Feb. 26.—**Construction of Airways in Canada** by Mr. A. D. McLean, acting superintendent of Airports and Airways of the Civil Aviation Branch.

Mar. 21.—**The Automatic Pilot** by Sergeant J. D. Hunter of the R.C.A.F.

April 12.—**The Use of Wood in Aeroplane Construction** by Mr. W. E. Wakefield, of the Forest Products Laboratories.

Financial Statement

Receipts

Cash carried over from 1934	$ .05	
Bank balance carried over from 1934	.29	
Fees	23.00	
Grant from Ottawa Branch	20.00	
		$ 43.34

Expenditures

Cash on hand, December 31st, 1935	$ .85	
Cash in bank, December 31st, 1935	9.10	
Postcards	5.00	
Printing	25.97	
Stationery, mimeographing and postage stamps	2.42	
		$ 43.34

Membership

The membership of the section is made up as follows:—

E.I.C. members	52
R.Ae.Soc. members	7
Joint E.I.C.-R.Ae.S.	4
Affiliates	24
Total	87

The apparent decrease of eight members since last year is largely caused by the deletion of the names of those affiliates who were two years in arrears with dues and who did not reply to the secretary's communication.

The average attendance at the evening meetings was about 18.

Respectfully submitted,

E. W. Stedman, m.e.i.c., *Chairman.*

Peterborough Branch

The President and Council:—

On behalf of the Executive committee, Peterborough Branch, we have the honour to submit the following report covering the activities of the Branch during the year 1935:—

1935

Jan. 10.—**Modern Arc Welding** by David Boyd, a.m.e.i.c., Dominion Bridge Co., Montreal. Attendance, 74.

Feb. 21.—Public meeting. "**Better Light, Better Sight**" Collegiate Institute, by Mr. R. Wilde, Canadian General Electric Co., Toronto, also representatives of Canadian Westinghouse and the H.E.P.C. Attendance, 200.

Mar. 14.—**The New Science of Lighting** by Mr. J. W. Bateman manager, Lighting Service Dept., Canadian General Electric Co., Toronto. Attendance, 20.

April 11.—**Aerial Exploration in Canada** by Mr. A. M. Narraway, Associate Director, Topographical Survey and Air Bureau, Chief Aerial Survey Engineer, Department of Interior. Attendance, 34.

May 8.—Annual Meeting, reports and election of officers. Attendance, 20.

June 8.—Annual outing, inspection of New Hydro-Electric Power Plant at Minden, Ontario, serving Orillia, Ontario. Attendance, 40.

Sept. 26.—Opening meeting, non-technical, supper and social gathering. Attendance, 52.

Oct. 10.—**Wood Preservation by the Creosoting Process** by Mr. W. H. Greene, chief engineer, Canadian Creosoting Company. Attendance, 14.

Nov. 19.—Annual Banquet. Speakers: Dr. F. A. Gaby, m.e.i.c., on **Transportation Problems** and Mr. Frind, Eldorado Gold Mines, on **Mining and Extracting Radium.** Attendance, 76.

Dec. 12.—**Diesel Engines** by Mr. G. R. Wyer, managing engineer, Pump and Electrical Department, Canadian Fairbanks Morse, Toronto. Attendance, 39.

Number of Executive meetings held during the year was five. Special sub-committees were as follows:—

Meetings and Papers Committee	V. R. Currie, a.m.e.i.c.
	E. J. Davies, Jr.e.i.c.
	B. Ottewell, a.m.e.i.c.
Branch News Editor	E. J. Davies, Jr.e.i.c.
Membership and Attendance Committee	H. R. Sills, Jr.e.i.c.
	D. J. Emery, s.e.i.c.
	A. L. Killaly, a.m.e.i.c.
Unemployment Committee	W. M. Cruthers, a.m.e.i.c.
Social and Entertainment Committee	R. L. Dobbin, m.e.i.c.
	A. L. Killaly, a.m.e.i.c.
	E. R. Shirley, m.e.i.c.
By-laws and Developments	H. R. Sills, Jr.e.i.c.
	R. L. Dobbin, m.e.i.c.
	J. W. Pierce, m.e.i.c.
Auditor	E. R. Shirley, m.e.i.c.

Membership

January 1st,	*1930*	*1931*	*1932*	*1933*	*1934*	*1935*	*1936*
Members	20	18	15	13	13	11	11
Associate Members	31	30	34	36	35	30	32
Juniors	20	20	19	13	11	12	11
Students	30	23	19	16	16	18	25
Branch Affiliates	25	17	15	17	14	13	9
	126	108	102	95	89	84	88

Financial Report

Receipts

Balance, January 19th, 1935	$ 80.67	
Affiliate fees	38.85	
Rebate from Headquarters	103.80	
Banquet	105.00	
Bank interest	1.46	
	329.78	
Rebate from Headquarters	6.90	
		$336.68

Expenses

Affiliate fees to Headquarters	$ 18.30	
Repayment of loan to Headquarters	25.00	
Rent	20.00	
Printing	40.80	
Stamps, telegrams, etc.	7.85	
Flowers	2.00	
Annual banquet	109.95	
Lantern insurance	4.80	
Express charges	.65	
Balance, December 31st, 1935	100.43	
	329.78	
Balance, including rebate from Headquarters	6.90	
		$336.68

Respectfully submitted,

A. L. Dickieson, a.m.e.i.c., *Chairman.*

W. T. Fanjoy, Jr.e.i.c., *Secretary-Treasurer.*

Quebec Branch

The President and Council:—

The Executive committee of the Quebec Branch, Engineering Institute of Canada, submits the following report for the calendar year 1935.

Meetings

The Executive committee held five meetings for the transaction of business during the past year, and general meetings were held as follows:—

1935

Jan. 14.—Luncheon meeting at Chateau Frontenac. Speaker: E. D. Gray-Donald, m.sc., a.m.e.i.c., Superintendent, Power Division, Quebec Power Company. Subject: **Some Considerations Governing the Undertaking of Hydro-Electric Power Developments.**

Feb. 18.—Luncheon meeting at Chateau Frontenac. Speaker: Alphonse Paradis, m.e.i.c., chief engineer of Quebec Roads Department. Subject: **La Route Moderne.**

Mar. 4.—Evening meeting at Montcalm Palace. Speakers and subjects: René Dupuis, a.m.e.i.c., Quebec Power Company, **Aperçu sur la canalisation du St-Laurent;** James O'Halloran, a.m.e.i.c., Anglo-Canadian Pulp and Paper Mills, **Newsprint Paper Machines;** Jean St-Jacques, s.e.i.c., Quebec Power Company, **Le Coût d'Exploitation des Centrales Diesel.**

April 1.—Evening meeting at Montcalm Palace to discuss the project of consolidation of the Engineering Profession in Canada.

April 8.—Evening meeting at Montcalm Palace. Speaker: P. L. Pratley, m.e.i.c., Monsarrat and Pratley, consulting engineers, Montreal. Subject: **Ile d'Orleans Bridge.**

May 8.—Luncheon meeting at Chateau Frontenac. Speaker: A. O. Dufresne, m.e.i.c., Director, Bureau of Mines, Quebec. Subject: **Les Risques de la Prospection.**

May 20.—Annual meeting and election of officers at Montcalm Palace.

June 15.—Visit to the Valcartier Camp.

June 17.—Evening meeting at Chateau Frontenac to discuss the project of consolidation of The Engineering Institute of Canada with the Provincial Corporations of Professional Engineers.

Oct. 24.—Visit to the factory of the Rock City Tobacco Company Limited, Quebec City.

Dec. 9.—Evening meeting at Chateau Frontenac. Speaker: O. W. Titus, chief electrical engineer of the Canada Wire and Cable Company. Subject: **Boulder Dam Transmission Line.**

These meetings were well attended and the excellent addresses enjoyed.

MEMBERSHIP

A comparison of our present membership as at January 1st, 1936, with that of other years is shown in the following table:—

	1932	1933	1934	1935	1936
Honorary Member (Branch)	1	1	1	1	1
Members	17	16	14	14	19
Associate Members	64	67	72	72	73
Juniors	12	11	2	2	2
Students	13	15	11	11	11
Affiliates	3	3	1	1	1
	110	113	101	101	107

It is with deep regret that we record the loss of Messrs. C. E. Gauvin, A.M.E.I.C., and C. J. Pigot, A.M.E.I.C.; both these gentlemen passed away during the course of the year.

COMMITTEES

Special Branch Committees are as follows:—

Nominating Committee	L. P. Methé, A.M.E.I.C.
	E. D. Gray-Donald, A.M.E.I.C.
	Marc Boyer, A.M.E.I.C.
Legislation Committee	Louis Beaudry, A.M.E.I.C.
	J. O. Martineau, M.E.I.C.
	Robert Wood, A.M.E.I.C.
Membership Committee	Hector Cimon, M.E.I.C.
	O. Desjardins, A.M.E.I.C.
	J. Joyal, A.M.E.I.C.
Unemployment Committee	Alex. Larivière, M.E.I.C.
	A. G. Sabourin, A.M.E.I.C.
	P. Marcotte, A.M.E.I.C.
Excursion Committee	T. M. Dechene, A.M.E.I.C.
	A. J. Kerry, A.M.E.I.C.
	J. L. Bizier, A.M.E.I.C.
Library Committee	L. P. Methé, A.M.E.I.C.
	T. M. Dechene, A.M.E.I.C.
	R. J. L. Savary, A.M.E.I.C.

FINANCIAL STATEMENT

Receipts		
Bank balance, January 1st, 1936	$ 43.53	
Rebates, May, 1935	178.65	
Rebates, October, 1935	18.60	
Rebates, December, 1935	23.10	
Bank interest	.76	
		$264.64
Expenditures		
Meetings	$ 44.10	
Stamps, post cards, etc	21.72	
Printing	40.28	
Flowers: re Messrs. Gauvin and Pigot	20.00	
Honorarium to Secretary	100.00	
	$226.10	
Bank balance, December 31st, 1935	38.54	
		$264.64

Respectfully submitted,
ALEX. LARIVIERE, M.E.I.C., *Chairman.*
JULES JOYAL, A.M.E.I.C., *Secretary-Treasurer.*

Saguenay Branch

The President and Council:—

The Executive committee of the Saguenay Branch wish to submit the following report for the calendar year 1935.

MEMBERSHIP

During the year the membership of the Branch was increased by six members. At present one application for admission is under consideration.

The numbers in the different classes of membership as at December 31st are shown below:—

	1932	1933	1934	1935
Members	4	3	3	2
Associate Members	16	18	19	23
Juniors	4	3	3	6
Students	5	5	6	6
Affiliates	1	..	..	..
	30	29	31	37

MEETINGS

During the year meetings were held as follows:—

1935

May 10.—At Arvida. S. J. Fisher, M.E.I.C., addressed the meeting, his subject being **Paper Making, Ancient and Modern.**

June 21.—At Arvida. G. F. Layne, A.M.E.I.C., gave a paper on **Sugar.**

Aug. 3.—The Annual General Meeting and luncheon was held at Lake Onatchiway.

Nov. 9.—At Arvida. A paper on the **Design and Construction of the Reinforced Concrete for the Bayer Process Plant of the Aluminum Company of Canada** was presented by A. I. Cunningham, A.M.E.I.C.

FINANCIAL STATEMENT

Receipts		
Balance at December 31st, 1934	$154.57	
Rebates from Headquarters	71.10	
	225.67	
Rebates payable, December 31st, 1935	3.30	
		$228.97
Disbursements		
Stationery	$ 4.20	
Exchange on cheques	.73	
Postage	8.36	
Expense of meetings	21.70	
	34.99	
Balance in bank, December 31st, 1935	190.68	
	225.67	
Rebates payable December 31st, 1935	3.30	
		$228.97

Respectfully submitted,
J. SHANLY, A.M.E.I.C., *Chairman.*
L. R. BEATH, S.E.I.C., *Secretary-Treasurer.*

Saint John Branch

The President and Council:—

On behalf of the Executive committee, we beg to submit the annual report for the calendar year 1935:—

MEMBERSHIP

	Resident	Non-Resident	Total
Members	10	6	16
Associate Members	19	14	33
Juniors	3	3	6
Students	22	29	51
Affiliates	1	..	1
	55	52	107

It is with deep regret that we report the death of J. S. Armstrong, M.E.I.C., of Fredericton, who died July 4th, 1935.

MEETINGS

Six meetings of the Branch Executive committee were held during the year and six Branch meetings, as follows:—

1935

Jan. 30.—The annual joint dinner meeting with the Association of Professional Engineers of the Province of New Brunswick. A. Gray, M.E.I.C., gave a talk on the **History and Development of the Saint John Harbour.**

Feb. 18.—**Modern Arc Welding** by David Boyd, A.M.E.I.C., of the Dominion Bridge Co.

Mar. 15.—**Radio Interference** by H. C. Risteen, east coast division engineer of the Radio Branch of the Department of Marine.

May 9.—Annual Meeting and dinner of the Branch at the Riverside Golf and Country Club. The present officers of the Branch were elected at this meeting.

Nov. 12.—**Steel Piling**—Some notes on its development and use with special reference to Canada by R. F. Legget, A.M.E.I.C., of the Canadian Steel Piling Co. Mr. Legget also gave a short report on the work of the Consolidation Committee of which he is secretary.

Dec. 11.—**Town Planning** by Horace L. Seymour, M.E.I.C., consultant to the Saint John Town Planning Commission.

FINANCIAL STATEMENT

Receipts		
Balance, December 31st, 1934	$305.94	
Headquarters rebates, January to April	82.80	
Headquarters rebates, May to September	20.40	
Headquarters rebates, October to December	14.70	
		$423.84
Expenditures		
Printing and postage	$ 50.37	
Branch meetings	34.45	
Lantern rental	10.50	
Stenographer	10.00	
Honorarium to Secretary	25.00	
Balance, December 31st, 1935	293.52	
		$423.84

Respectfully submitted,
V. S. CHESNUT, A.M.E.I.C., *Chairman.*
F. A. PATRIQUEN, Jr.E.I.C., *Secretary-Treasurer.*

St. Maurice Valley Branch

No report received.

Saskatchewan Branch

The President and Council:—

On behalf of the Executive we submit the following report of the activities of the Saskatchewan Branch for the year 1935.

MEMBERSHIP

The membership of the Branch shows an increase of ten over last year, being as follows:—

	Resident	Non-Resident	Total
Members	10	7	17
Associate Members	30	23	53
Juniors	2	5	7
Students	7	10	17
Branch Affiliates	2	1	3
	51	46	97

COMMITTEES

The Executive committee was elected on March 22nd, 1935, and held five meetings during the year.

The standing committees are:—

Papers and Library..........C. J. McGavin, A.M.E.I.C. (Convenor)
Nominating..................H. R. MacKenzie, A.M.E.I.C. (Convenor)
Unemployment...............H. R. MacKenzie, A.M.E.I.C. (Convenor)
Membership.................J. J. White, A.M.E.I.C. (Convenor)

MEETINGS

There were six regular meetings of the Branch, each being preceded by a dinner at which the average attendance and general interest was good. In addition a general meeting was held during the month of October under the auspices of the Association of Professional Engineers. At this meeting questions relating to the consolidation of the engineering profession were under discussion, the attendance being above the average.

The programme for the year was as follows:—

1935

Jan. 24.—Address by Wm. Storrie, M.E.I.C., on **The Engineer and Public Health**, illustrated by lantern slides.

Mar. 2.—Ladies' Night.

Mar. 22.—Eighteenth Annual Meeting, address by E. E. Lord, A.M.E.I.C., on **River Improvement Work in Manchuria**.

April 8.—Address by H. N. MacPherson, A.M.E.I.C., on **The Preservation of Timber**, illustrated by lantern slides.

Nov. 22.—Address by M. Marshall, M.E.I.C., on **The Construction of the Hydro-Electric Power Plant at Island Falls, Saskatchewan**, illustrated by lantern slides.

Dec. 23.—Address by Mr. J. H. Lee-Grayson on **The Italo-Ethiopian Situation.**

FINANCIAL STATEMENT

Receipts		
Bank balance, December 31st, 1934	$ 89.03	
Rebates from Headquarters	151.50	
Branch dues	5.00	
Miscellaneous	6.00	
		$251.53
Expenditures		
Postage	$ 9.00	
Meetings (notices, printing, etc.)	61.49	
Secretarial (1933-35)	100.00	
Miscellaneous	27.65	
Bank balance, December 31st, 1935	53.39	
		$251.53

Respectfully submitted,

A. P. LINTON, M.E.I.C., *Chairman.*
STEWART YOUNG, M.E.I.C., *Secretary-Treasurer*

Sault Ste. Marie Branch

The President and Council:—

On behalf of the Executive committee we submit the following report of the Sault Ste. Marie Branch for the calendar year 1935.

At the annual meeting the following were appointed by the Chairman to be chairmen of the standing committees:—

Papers and Publicity..................A. E. Pickering, M.E.I.C.
Legislation and Remuneration.........C. W. Holman, A.M.E.I.C.
Entertainment........................J. L. Lang, M.E.I.C.
Membership...........................J. L. Lang, M.E.I.C.
Unemployment.........................E. M. MacQuarrie, A.M.E.I.C.

The Executive committee of the Branch held nine Executive meetings during the year.

Some difficulty was experienced in obtaining papers for the regular monthly meetings, and as a result some of the regular meetings were cancelled.

The following dinner meetings were held during the year:—

1935

Jan. 23.—**Theory and Practise of Assaying** by O. A. Evans, JR.E.I.C., Algoma Central Railway, Mines Department. Present: Dinner, 26; meeting, 40.

Feb. 22.—**Research Work in the Ceramic Industry** by Mr. James Kelleher of the FitzGerald Laboratories, Sault Ste. Marie, Ont. Present: Dinner, 16; meeting, 28.

April 30.—**Modern Highway Construction** by Mr. R. T. Lyons of Department of Northern Development, Sault Ste. Marie, Ont. Present: Dinner, 27; meeting, 40.

Oct. 25.—**Development and Use of Timken Roller Bearings in Various Industries** by Mr. J. L. Young, assistant manager, Timken Roller Bearing Co., Canton, Ohio. This was a talk illustrated with motion pictures and was held as an open meeting. Present: Dinner—20 members, 34 guests; meeting, 65.

MEMBERSHIP

The membership of the Branch at the close of the year stands as follows, which does not include four members still on the non-active list:—

	Resident	Non-Resident	Total
Members	9	11	20
Associate Members	10	25	33
Juniors	4	10	14
Students	1	12	13
Branch Affiliates	8	..	8
	32	58	90

This represents a total decrease from last year's membership of eight.

FINANCIAL STATEMENT

Revenue		
Rebates from Headquarters	$145.20	
Journal subscriptions—Affiliates	10.00	
Affiliates fees	24.00	
Entertainment	44.00	
Interest on savings account	3.96	
		$227.16
Expenditure		
Printing and stationery	$ 31.68	
Journal subscriptions to Headquarters	10.00	
Postage and telegraph	8.14	
Entertainment	68.05	
Miscellaneous expenses	3.00	
Honorarium—1935	25.00	
		$145.87
Surplus—1935		$ 81.29
Assets		
Cash balance—Current account	$184.23	
Cash balance—Savings account	201.96	
Cash balance—Petty cash	3.56	
Stationery	12.30	
Property	1.00	
Affiliates fees unpaid	12.00	
Journal subscriptions unpaid	4.00	
		$419.05
Liabilities		
Capital surplus	$394.05	
Honorarium due Secretary	25.00	
		$419.05

Respectfully submitted,

F. SMALLWOOD, M.E.I.C., *Chairman.*
H. O. BROWN, A.M.E.I.C., *Secretary-Treasurer.*

Toronto Branch

The President and Council:—

On behalf of the Executive committee we submit the annual report of the Toronto Branch for 1935.

The annual meeting of the Branch was held at the Canadian Military Institute on April 4th, 1935, at which the officers for 1935-36 were elected. The meeting was preceded by a dinner at which Professor N. A. M. MacKenzie was the guest speaker.

Following the annual meeting the undermentioned were named chairmen of the standing committees:—

Papers.............................W. E. Bonn, M.E.I.C.
Finance............................O. Holden, A.M.E.I.C.
Publicity..........................A. U. Sanderson, A.M.E.I.C.
Meetings...........................C. E. Sisson, M.E.I.C.
Membership.........................J. M. Oxley, M.E.I.C.
Student Relations..................A. M. Reid, A.M.E.I.C.
Branch Editor......................Nicol MacNicol, M.E.I.C.

During the year the Executive committee has held thirteen meetings for the transaction of Branch business, with an average attendance of nine at each meeting.

The following regular meetings were held during 1935:—

1935

Jan. 10.—Ontario Research Foundation. A joint meeting with the Ontario Section of the A.S.M.E. in the form of a visit to the Ontario Research Foundation Laboratories. Attendance, 125.

Feb. 7, 8 and 9.—Annual General and Professional Meeting of The Institute.

April 4.—Annual Meeting of the Branch. Dinner at Canadian Military Institute. Professor N. A. M. MacKenzie spoke on **The Present International Situation.** Attendance, 60.

April 16.—**Some Phases of Material Handling** by Mr. John Farley of Link-Belt, Limited. This meeting was arranged by the Ontario Section, A.S.M.E.

Oct. 10.—**Installation and Preliminary Tests on the 74-inch David Dunlap Telescope** by Professor R. K. Young. The Ontario Section, A.S.M.E., invited the E.I.C. to attend this meeting. Attendance, 100.

Oct. 17.—**Competitive Transportation Problems** by Dr. F. A. Gaby, M.E.I.C. A luncheon meeting at which 90 were present.

Nov. 7.—**Aircraft Development in Europe** by Professor T. R. Loudon, M.E.I.C. Attendance, 125.

Nov. 23.—David Dunlap Observatory, Richmond Hill. A visit to the Observatory, with an opportunity to look through the large telescope. Meeting open to members and friends. Attendance, 125.

Dec. 4.—Social evening at Engineers Club, open to members and their wives. Attendance, 70.

The Annual General and Professional Meeting of The Institute was held at the Royal York hotel on February 6, 7 and 8, 1935. A special committee was appointed by the Branch to look after this meeting with J. J. Traill, M.E.I.C., chairman, and W. B. Dunbar, A.M.E.I.C., secretary. Mr. Traill was compelled, through illness, to relinquish the chairmanship which was taken over by Archie B. Crealock, M.E.I.C., and he, with his committee, carried the meeting through to a successful conclusion.

It will again be noted that quite a number of meetings have been held jointly with other engineering societies and these have proved very successful. Dinner is frequently arranged before the meetings and affords an opportunity to meet other members in a social way. The dinner held on the evening of the Annual Meeting was most successful, and the Social Evening held at the Engineers Club, to which members brought their wives, was also most enjoyable.

The income of the Branch has again fallen, but in spite of this the Branch has been able to keep its expenditures within the amount. The Branch contributed toward the cost of the Annual General and Professional Meeting out of the accumulated surplus of previous years.

The Toronto Branch E.I.C. Loan Fund, established three years ago for the assistance of members, is in a satisfactory condition, and during the past year no applications for help have been received.

A Branch Committee on Consolidation, consisting of Messrs. Sisson, Holden and Bonn, was appointed in May and has co-operated with The Institute's Committee on Consolidation. This Committee sent out the questionnaire prepared by The Institute's Committee and tabulated the results. A report was prepared which was sent out to all members of the Branch and to The Institute's Committee.

The membership of the Branch, as at December 31st, 1935, is as follows:—

	Resident	Non-Resident	Total
Members	109	2	111
Associate Members	236	10	246
Juniors	49	1	50
Students	81	16	97
Affiliates	4	..	4
	479	29	508

It is with regret that we record the death of the following members of the Branch during the year: R. O. Wynne-Roberts, M.E.I.C., G. H. Davis, M.E.I.C., and Wm. Inglis, AFFIL.E.I.C. Our heartfelt sympathy is extended to their families in their loss.

FINANCIAL STATEMENT

Receipts

Bank balance, January 2nd, 1935		$ 824.49	
Rebates	$512.20		
Affiliate fee	10.00		
Refund from Annual Meetings Committee	210.25		
Interest	6.20		
Proceeds of dinner, Engineers Club	65.00		
		803.65	
			$1,628.14

Expenditures

Affiliate, Journal subscription	$ 2.00	
Advance to Annual Meetings Committee	450.00	
Printing and notices of meetings	225.19	
Meeting expenses	39.85	
Gratuities	10.00	
Flowers	10.00	
Stenographic services	50.86	
Advertisement in "Transactions"	20.00	
Secretary's honorarium and expenses	142.22	
Advertising services	5.00	
Refund to Headquarters re Annual Meeting	30.12	
Engineers Club dinner	83.40	
Harris Ramsay & Company, $100.00 bond	106.73	
	$1,175,37	
Bank balance, January 6th, 1935	452.77	
		$1,628.14

Respectfully submitted,

W. E. BONN, M.E.I.C., *Chairman.*

W. S. WILSON, M.E.I.C., *Secretary-Treasurer.*

Vancouver Branch

The President and Council:—

We beg to submit the following report of the activities of the Vancouver Branch during 1934.

MEETINGS

Six general meetings of the Vancouver Branch were held during the year, as follows:—

1935

Jan. 7.—Joint meeting with the American Institute of Electrical Engineers, Vancouver Branch. Speaker: Professor F. H. Soward of the Department of History, University of B.C. Subject: **Looking Back on 1934.**

Jan. 17.—Speaker: William Storrie, M.E.I.C., of the firm of Messrs. Gore, Nasmith and Storrie, consulting engineers, Toronto. Subject: **The Engineer and Public Health** (illustrated with lantern slides).

Feb. 18.—Speaker: Chas. L. Bates, A.M.E.I.C., maintenance of way engineer, Pacific Great Eastern Railway. Subject: **Replacement and Renewal of Bridges on the P.G.E.**

Mar. 18.—Speaker: Major E. C. G. Chambers, A.M.E.I.C., Royal Canadian Engineers, District Engineer Officer, M.D. No. 11. Subject: **Development of Aerodromes and Intermediate Aerodromes in British Columbia.**

May 29.—Speaker: Major D. Campbell MacKenzie, general manager, Consolidated Gold Alluvials of British Columbia Ltd. Subject: **Description of Deep Lead Mining System Used at Wingdam Properties on Lightning Creek, B.C.** (illustrated with slides.)

Nov. 20.—Speaker: Christopher E. Webb, B.A.SC., M.E.I.C., district chief engineer, Dominion Water Power and Hydrometric Bureau. Subject: **The Columbia Basin Project.** Illustrated by lantern slides of the Grand Coulee Dam Construction Project.

Your Executive committee held eight meetings during the year for the transaction of the Branch business.

ASSOCIATION OF PROFESSIONAL ENGINEERS

The President and Registrar of the Association of Professional Engineers were again honorary members of the Executive.

WALTER MOBERLY MEMORIAL BOOK PRIZE

The Walter Moberly Memorial Book Prize for the year 1935 was awarded to Gleb Goumeniouk of Vancouver, B.C.

GZOWSKI AWARD

The Gzowski Medal Award for the first time in a number of years came to British Columbia. W. H. Powell, M.E.I.C., was awarded the medal for his paper on "The First Narrows Pressure Tunnel." The medal was duly presented to Mr. Powell at the Branch meeting held on March 18th by Mr. Wootton, M.E.I.C.

INSTITUTE DEVELOPMENT

The past year has not witnessed any noteworthy progress of either the federation movement or Institute development other than further attempts to clarify the sectional points of view on these questions. The Branch executive has had under consideration three separate schemes, one proposed by P. L. Pratley, M.E.I.C., another by Gordon McL. Pitts, A.M.E.I.C., and a third by J. B. de Hart, M.E.I.C. The executive has continued its active support of the views and policies of the B.C. Association, and has made a successful effort to have these views and policies published in The Journal. In this effort they enjoyed the co-operation of Institute Council. An article entitled "A Presentation of British Columbia's Views on the Federation Problem," prepared by P. H. Buchan, M.E.I.C., appeared in The Journal, August, 1935.

MEMBERSHIP

Early this year a committee under the chairmanship of E. A. Wheatley, M.E.I.C., was formed with the object of carrying on an active campaign to add new members to the active list of The Institute. This committee did splendid work with the following results:—

Transfers to a higher classification	16
Admissions	7
Reinstatements	11

The membership of the Branch at this date is as follows:—

	Resident	Non-Resident	Total
Members	47	10	57
Associate Members	43	35	78
Juniors	5	7	12
Students	16	10	26
Affiliates	3	..	3
	114	62	176

It is with deep regret that we record the decease of the following four members of the Vancouver Branch during the year 1935: C. J. Fox, A.M.E.I.C., J. P. Hodgson, M.E.I.C., Major R. W. Brock, M.E.I.C., and Chas. Moorhead, Affil.E.I.C.

FINANCIAL STATEMENTS

Financial Statements of the General and Walter Moberly Trust Account—duly audited by H. B. Muckleston, M.E.I.C.—are appended hereto.

GENERAL ACCOUNT

November 15th, 1934 to December 15th, 1935

Bank balance—November 14th, 1934		$ 33.48
Receipts		
Rebates from Headquarters	$287.63	
Bank interest	1.72	
		289.35
		$322.83
Disbursements		
Meetings:		
Printing notices, etc	$ 20.51	
Rental of auditorium	33.75	
Rental of lantern	6.00	
Annual meeting	12.70	
		$ 72.96
Office expenses:		
Rent	50.00	
Stenographic services	15.00	
Secretary's honorarium for 1934	50.00	
Petty cash account	10.00	
		125.00
Sundries—Wreaths		10.03
Total disbursements		207.99
Bank balance, December 15th, 1935		114.84
		$322.83

WALTER MOBERLY MEMORIAL FUND

Receipts		
Bank balance, November 15th, 1934		$ 98.99
Interest on $500.00 City of Vancouver 5% bonds	$ 25.00	
Interest on $100.00 Dominion of Canada 5% bond	5.00	
Interest on bank balance	3.63	
		33.63
		$132.62
Disbursements		
Charges for safe keeping of securities	$ 1.00	
Bursar—University of British Columbia 1935 award	25.00	
Bank balance, December 15th, 1935	106.62	
		$132.62

Audited and found correct:
H. B. MUCKLESTON, M.E.I.C., Auditor.

Respectfully submitted,
JAMES ROBERTSON, M.E.I.C., *Chairman.*
G. M. GILBERT, M.E.I.C., *Secretary-Treasurer.*

Victoria Branch

The President and Council:—

We beg to submit the following report on the activities of the Victoria Branch of The Institute during the year 1935.

MEETINGS

Four meetings of the Executive committee were held during the year with an average attendance of 85 per cent. The Branch has continued its practice of holding Executive meetings at the homes of the various members, a custom which has proved successful as well as enjoyable in the past.

Four general meetings were held during the year, two of which were luncheon meetings, with an average attendance of twenty-six. Technical papers presented at the general meeting were:—

The Engineer and Public Health by Wm. Storrie, M.E.I.C., and **The Columbia River Basin and Grand Coulee Dam** by C. E. Webb, M.E.I.C., Dominion Hydrometric Engineer.

The latter address proved exceptionally interesting due to the proximity of the project and its consequent relation to the province of British Columbia.

MEMBERSHIP

A net loss of three members resulted during the year. One new member was admitted through the efforts of the membership committee, and two Members, one Associate Member and one Student were transferred to this Branch from other branches. One Associate Member was transferred from this Branch to the Halifax Branch. One Member was removed from the list who has since deceased, and four members of the Branch were lost by death: Joseph Hunter, M.E.I.C., and Alfred O'Meara, M.E.I.C., Life Members of the Branch; G. R. Richardson, A.M.E.I.C., and Captain H. L. Leverin, Jr.E.I.C., member of the 1935 Branch Executive, who lost his life in an automobile accident.

Two applications for admission from this district are now pending.

ANNUAL MEETING

The annual meeting of the Branch which took the form of a luncheon was held on December 13th at which the election of officers for 1936 took place.

In conclusion we wish to extend our sincere thanks and appreciation to the Secretary and Assistant Secretary at Headquarters for their unfailing kindness and assistance during the past year.

FINANCIAL STATEMENT

Receipts		
Balance on hand, December 4th, 1934		$ 96.34
Rebates	$108.45	
One Branch Affiliate's dues	3.00	
		111.45
		$207.79
Disbursements		
Cost of meetings	$ 16.32	
Mimeographing and letter service	13.31	
Presentation to retiring Secretary	16.58	
Motion picture service and express on films	10.23	
Postage and stationery	9.20	
Three floral wreaths	9.00	
Telegrams and telephones	2.50	
Stenographic service (1934)	2.23	
		$ 79.37
Balance in hand, December 13th, 1935		128.42
		$207.79

Audited and found correct:
H. N. GAHAN, M.E.I.C., Auditor.

Respectfully submitted,
D. MACBRIDE, A.M.E.I.C., *Chairman.*
KENNETH REID, Jr.E.I.C., *Secretary-Treasurer.*

Winnipeg Branch

The President and Council:—

The following report of the Winnipeg Branch for the year ending December 31st, 1935, is respectfully submitted.

The membership of the Branch is as follows:—

	Resident	Non-Resident	Total
Members	32	3	35
Associate Members	77	20	97
Juniors	7	6	13
Students	30	7	37
Affiliates	1	..	1
Branch Affiliates	2	..	2
	149	36	185

Transfers have resulted in a net loss to the Branch of four corporate memberships. H. L. Briggs, A.M.E.I.C., chairman of the Membership committee, was asked to curtail a definite drive for members until the campaign of the Consolidation committee was completed. However, he has now under way an active campaign which it is believed will increase the membership.

There were 12 general meetings of the Branch during the year with an average attendance of 59. The details are as outlined below:—

1935

Jan. 3.—**Personal Impressions of Russia** by Professor A. F. Kerr, M.A., Wesley College. Attendance, 44.

Jan. 25.—**The Engineer and Public Health** by Wm. Storrie, M.E.I.C., consulting engineer of Toronto. Attendance, 61.

Feb. 7.—**A New Discourse on a Stale Subject** by Professor R. A. Wardle, M.Sc., University of Manitoba. Attendance, 52.

Mar. 7.—**Explosives** by J. S. Morrey, Canadian Industries Ltd. Attendance, 50.

Mar. 21.—**Items of Interest in Aviation** by Pilot J. C. Uhlman, Manitoba Government Air Service. Attendance, 55.

April 4.—**Protective Relays** by H. L. Briggs, A.M.E.I.C., Winnipeg City Hydro. Attendance, 34.

April 18.—**Modern Sewage Disposal** by W. D. Hurst, A.M.E.I.C., City of Winnipeg Engineers Department. Attendance, 80.

Oct. 3.—**A Philosophical View of the World Today** by Professor R. C. Lodge, M.A., University of Manitoba. Attendance, 44.

Oct. 17.—**The Flow of International Rivers into Manitoba** by Dean E. Chandler, University of North Dakota, U.S.A. Attendance, 102.

Nov. 7.—**Consideration of the Joint Committee Proposals on Consolidation.** Attendance, 67.

Note.—This was a joint meeting of the voting members only of the Winnipeg Branch and the Association of Professional Engineers of Manitoba.

Nov. 21.—**Cross Connections** by Mr. J. Smith, chief building inspector, City of Winnipeg. Attendance, 90.

Dec. 5.—**The Old Fashioned Universe** by Professor W. T. Allison, M.A., Ph.D., University of Manitoba. Attendance, 40.

The Executive committee held ten meetings including one jointly with the Council of the Professional Association of Manitoba.

The Branch appreciated the visit of Mr. Storrie and the paper he delivered to a general meeting and it is hoped that the visits of this nature will be continued.

We were also fortunate in having as a visitor and speaker Professor E. Chandler of the University of North Dakota.

There has been close co-operation between the Association of Professional Engineers of Manitoba and this Branch. The members of the Association have been on the mailing list for notices of meetings and we were assisted in the extra cost by a grant from the Association.

A. J. Taunton, A.M.E.I.C., and his Committee on Consolidation have done excellent work and have had their concrete proposals adopted by almost unanimous votes of the Branch and the Professional Association. This has been really the most outstanding accomplishment of the engineering profession in Manitoba during the past year.

Financial Statement

Receipts

Balance in bank, December 31st, 1934	$155.37	
Rebates last three months of 1934	29.87	
W. H. Reynolds, Branch Affiliate	3.00	
C. G. Wallman, re contribution	1.00	
Interest on bond	22.50	
Professional Engineers of Manitoba	50.00	
Rebates, January to April	210.00	
Interest on deposit	1.40	
Rebates, May to September	27.00	
		$500.14

Expenditures

Outstanding cheques at December 31st, 1934	$ 76.89	
Printing re meetings and postage	115.10	
Committee on Consolidation	26.50	
Refreshments and service, January to April	14.33	
E. W. M. James, honorarium	25.00	
Secretary—Petty cash and operation	40.00	
Rent, re hall	10.00	
Bank ledger fees	.50	
Safe keeping of bond	1.00	
Honorarium to Secretary	50.00	
	$359.32	
Balance in bank, December 31st, 1935	140.82	
		$500.14
Accounts payable	$ 8.40	
Accounts receivable, rebates for last three months of 1935	26.75	

Respectfully submitted,

Fred V. Seibert, M.E.I.C., *Chairman.*
J. F. Cunningham, A.M.E.I.C., *Secretary-Treasurer.*

THE
ENGINEERING JOURNAL
THE JOURNAL OF
THE ENGINEERING INSTITUTE
OF CANADA

VOLUME XIX FEBRUARY 1936 No. 2

His Majesty The King

At its meeting on January 24th, Council directed that the following cable be sent to the King:—

"His Majesty King Edward VIII
London.

The President and Council of The Engineering Institute of Canada desire to convey to your Majesty, as an Honorary Member of The Institute, and to Her Majesty the Queen Mother, and to all members of the Royal Family, The Institute's respectful sympathy in your bereavement.

F. A. GABY, President."

It was of course impossible in a brief message to name the various zones or centres of our membership, but these are included in the term "The Institute."

The James Watt Bicentenary

Many people have the idea that the epoch-making inventions which have made our present manner of life possible sprang into existence suddenly as the result of some brilliant inspiration on the part of the inventor. One is apt to think that when mechanical science was in its infancy and the field for the inventor seemed boundless, the inventor's task was a comparatively easy one.

The story of James Watt, however, whose two-hundredth birthday was on January 19th last, would rather lead to an opposite conclusion. It is true that the notion of the most important improvement which he made in the steam engine, namely the use of a separate condenser, came to him on a Sunday afternoon in 1765 when he was walking on Glasgow Green and "thinking upon the engine." He reflected that "as steam was an elastic body, it would rush into a vacuum, and if a communication were made between the cylinder and an exhausted vessel, it would rush into it, and might be there condensed without cooling the cylinder." "I had not walked further than the Golf house," he says, "when the whole thing was arranged in my mind." The idea, however, was really no sudden revelation, but the result of much previous work, since he had been experimenting for more than two years with a model Newcomen engine. His enquiries had caused him to realize that the waste of fuel occurring with that engine was due to the loss of heat by cooling the cylinder and to the imperfect method of condensation. Almost at the beginning of his work he had found that very little was known about the properties of steam. He soon determined to ascertain some pertinent facts for himself.

His apprenticeship at the age of eighteen to learn the trade of a mathematical instrument maker had given him little opportunity for education, and his ill health prevented his making rapid progress. But he had the temperament of the true investigator, and realized the impossibility of devising the necessary improvements in the steam engine unless certain fundamental data were available. So he went to work to find out:—

"1. The capacities for heat of iron, copper and of some sorts of wood as compared with water.

"2. The bulk of steam compared with that of water.

"3. The quantity of water evaporated in a certain boiler by a pound of coal.

"4. The elasticities of steam at various temperatures greater than that of boiling water, and an approximation to the law which it follows at other temperatures.

"5. How much water in the form of steam was required every stroke by a small Newcomen engine, with a wooden cylinder 6 inches in diameter and 12 inches stroke.

"6. The quantity of cold water required in every stroke to condense the steam in that cylinder so as to give it a working power of about 7 pounds on the square inch."

After these investigations he was enabled to enter upon the work of improving the Newcomen engine with an intelligent understanding of its defects as they then existed, and with some knowledge of their causes.

James Watt, in fact, arrived at his inventions through laborious research; research which was especially difficult at a time when so little mathematical, physical and chemical information was available to the ordinary student. His knowledge of the trade of instrument making enabled him to make the most of the meagre facilities for accurate mechanical work which then existed, for his skill in his craft was such that in 1757 he had been established as mathematical instrument maker of the University of Glasgow. He had opportunities for discussing scientific problems with friends at the University and took full advantage of them. Indeed, the model engine with which he experimented belonged to the University collection of scientific apparatus, of which it is still one of the treasures.

The operation of the separate condenser and air pump duly produced the improvement in engine performance which Watt had predicted, but the financial results left much to be desired. Other troubles came at this time, including the loss of his wife, and it was not until 1769 that a partnership with Matthew Boulton of Birmingham offered a more cheering prospect. Before the partnership became effective, Watt had suggested a number of further improvements, including the use of the steam jacket. Later, after the successful erection and operation of several engines, his cares were lessened, he married again, and in

His Majesty King George the Fifth

Born 1865 - Died 1936

"His life was gentle; and the elements
So mixed in him, that nature might stand up
And say to all the world, 'This was a man!'"

1782 obtained a patent covering the expansive working of steam and the double-acting cylinder. The centrifugal governor and a mercury steam gauge were among the many accessories which Watt devised for the satisfactory and economical working of his engine, and which formed the subjects of a series of patents. By 1784 the double-acting engine had assumed its distinctive form and the firm of Boulton and Watt had become firmly established. Watt's mind lost none of its activity for many years, and he continued his study of scientific questions almost until his death in 1819.

Some of his ideas were markedly conservative, for it is remarkable that while his own invention of expansive working must have opened his eyes to the advantages of high pressure steam, he refused to employ it in his practice. Richard Trevithick, his rival inventor, who developed the non-condensing engine about 1800, had ventured to use pressures as high as 120 pounds per square inch, but at one time Boulton and Watt actually endeavoured to secure the passage of an act of Parliament forbidding the use of high pressure steam on the ground that the lives of the public were in danger.

The early and middle part of Watt's life was a long struggle with poor health. His disposition was retiring. He was a man of warm friendships, and the numerous letters which he left are full of sagacity and insight. In 1800 Watt gave up his share in the business of engine building to his two sons and the remainder of his life was spent quietly at his house near Birmingham.

The two hundredth anniversary of his birth is being celebrated in England, the United States and Canada by groups under the leadership of engineering colleges and societies, who unite in drawing attention to James Watt's position as the principal forerunner of the machine age.

His life and the influence of his work on modern life and industry will be the topics dealt with at a meeting at the Royal Ontario Museum, Toronto, arranged by the University of Toronto. At this commemoration members of The Institute will be joined by the Ontario members of the Institution of Mechanical Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, in paying tribute to the memory of James Watt,

PERSONALS

W. D. Black, M.E.I.C., vice-president and general manager of the Otis-Fensom Elevator Company Limited, Hamilton, Ont., has been elected chairman of the city of Hamilton Hydro-Electric Power Commission for the year 1936.

H. W. Furlong, A.M.E.I.C., is now connected with Stone and Webster Engineering Corporation, Boston, Mass. Mr. Furlong who was formerly with Sir Alexander Gibb and Partners, London, England, was at one time previously assistant engineer with Stone and Webster.

E. C. Hague, A.M.E.I.C., formerly chief engineer of the Erie Resistor Limited, London, England, has been appointed director and chief engineer of the Quadrant Carbon and Metal Products Limited, London. Mr. Hague is a graduate of McGill University, having received the degree of B.Sc. in 1923, and he was for a time research engineer with the Victor Talking Machine of Canada, Montreal.

At the recent annual meeting of the Montreal Branch of The Institute, J. B. D'Aeth, M.E.I.C., was elected chairman for the ensuing year.

Mr. D'Aeth was educated at Upper Canada College and McGill University, from where he graduated in 1908 with the degree of B.Sc.

After graduation he went to Jamaica, where he was engaged on the construction of reinforced concrete buildings following the earthquake of 1907. Later, he went with the Ambursen Hydraulic Construction Co. as resident engineer on the development of the Barnett Shoals Hydro Electric Development at Athens, Georgia, after which he returned to Canada and in 1912-1913 he was field engineer on the construction of the Saskatoon Street Railway.

In 1914, he joined the staff of the Quebec Streams Commission being engaged on river investigation and survey work and later was resident engineer on the construction of the Gouin dam on the Upper St. Maurice river. Upon completion of this work Mr. D'Aeth went with Fraser,

J. B. D'Aeth, M.E.I.C.

Brace, Limited as construction engineer on the Big Eddy dam for the International Nickel Company and the Great Falls hydro development in Manitoba. Later he became designing engineer for the company, during which time the following works were either wholly or partially designed by that firm and under his direction: The hydro-electric development at Deer Lake, Nfld., Chelsea and Farmers developments on the Gatineau river, the Big Eddy power house on the Spanish river, log chute at Aubrey Falls, Ont., for Carpenter Hixon Co. Ltd., Island Falls hydro-electric development on the Churchill river for the Hudson Bay Mining and Smelting Co. Limited.

L. Beaudry, A.M.E.I.C., has been named chief engineer of the Port of Quebec. Mr. Beaudry graduated from the Ecole Polytechnique with the degree of B.A.Sc. in 1921, and was subsequently for two years engaged on construction work at Three Rivers under the firm name of Trépanier and Beaudry. In 1923 he joined the engineering staff of the Department of Public Works of the Province of Quebec, and in 1926 became associated with the Wm. I. Bishop Construction Company Limited. In 1929 Mr. Beaudry became engineer with the Harbour Commissioners of Quebec.

J. D. Jones, M.E.I.C., formerly vice-president and general manager of the Algoma Steel Corporation Limited, Sault Ste. Marie, Ontario, has become connected with the Youngstown Sheet and Tube Company at Youngstown, Ohio. Mr. Jones thus severs an association of many years standing, as he first joined the staff of the Algoma Steel Company as engineer, in 1910. From 1912 to 1914 he was assistant chief engineer. In 1914-1916 he was with the Illinois Steel Company at Gary, Ind., and in 1916 returned to the Algoma Steel Company as chief engineer. In 1919 Mr. Jones became general superintendent, and in 1920 he was appointed general manager.

A. Laframboise, A.M.E.I.C., has accepted the position of engineer with the new Quebec Electricity Commission. Mr. Laframboise graduated from the Ecole Polytechnique, Montreal, in 1911 and from August of that year until 1912, was structural engineer for the National Transcontinental Railway at Ottawa. He was later, until 1913, a designer and draughtsman with the Dominion Bridge Company at Lachine. In 1914 Mr. Laframboise became city engineer of Lachine, Que., remaining in that office until 1930 when he again entered the service of the Dominion Bridge Company, as sales engineer. In 1933 he was appointed town engineer of Ville LaSalle, from which position he now resigns.

Lieut.-Colonel H. F. Morrisey, A.M.E.I.C., has been appointed Honorary A.D.C. to His Excellency Baron Tweedsmuir, Governor-General of Canada. Colonel Morrisey who is district engineer of the Department of Marine at Saint John, N.B., is the Commanding Officer of the Third (N.B.) Medium Brigade, R.C.A.

Colonel Morrisey graduated from the University of New Brunswick in 1912 with the degree of B.Sc., and obtained his M.Sc. in 1915. From May 1912 until July 1920 he was assistant engineer on the River St. Lawrence Ship Channel, except for the time of his service in the Navy during the War. In 1920 he received the appointment which he now holds.

R. J. Gibb, M.E.I.C., formerly city engineer and superintendent of waterworks of Edmonton, Alta., has been appointed third city commissioner of that city, having charge of public works and civic utilities. Mr. Gibb was educated at George Watson's College and Herriot-Watt Technical College, Edinburgh, and from 1895 to 1899 served four years' apprenticeship as a civil engineer. From 1899 until 1902 he was resident engineer on dock work with the Trustees of Clyde Navigation, Glasgow, Scotland. The next four-year period saw him in service as a contractor's agent on sundry water and sewage works in various parts of Scotland. Coming to this country in 1906, Mr. Gibb was engaged on the Canadian Pacific Railway Company's terminals in Montreal, and later entered the service of the then Grand Trunk Pacific Railway as resident engineer and assistant engineer in the field on the construction of bridges. In 1913 Mr. Gibb joined the engineering department of the city of Edmonton and was engaged on sewer construction work until 1915 when he was appointed assistant city engineer. He took over the supervision of the waterworks department in 1932.

Otto L. J. Brauns, A.M.E.I.C., has resigned from the Abitibi Power and Paper Company, Sault Ste. Marie, Ont., to accept the position of superintendent of the sulphite department of the Algonquin Paper Corporation at Ogdensburg, N.Y. Mr. Brauns graduated from the Royal Institute of Technology, Stockholm, in 1928, and in September of the same year became connected with the department of industrial chemistry at McGill University. In February 1929 he joined the staff of the Abitibi Power and Paper Co. Limited, at Iroquois Falls, Ont., as research engineer, and from December of the same year until March 1930, Mr. Brauns was located at the Sturgeon Falls mill being engaged on semi-commercial sulphite cooking. From that time until 1931 he was interested in pitch investigation, being the recipient of the Weldon Gold Medal for his publication on that research. In 1931 Mr. Brauns was appointed assistant chief chemist at Sault Ste. Marie in charge of routine mill control work and research projects, and for the past six months he has been assistant to the board mill superintendent and in direct charge during the recent illness of the superintendent.

H. F. Bennett, M.E.I.C., formerly district engineer with the Department of Public Works of Canada at Sault Ste. Marie, Ontario, has been promoted to be district engineer at London, Ontario. Mr. Bennett was educated at the University of New Brunswick, graduating with the degree of B.Sc. in 1908. He joined the Department of Public Works immediately after graduation, and served as assistant engineer until 1916, when he was attached to the Canadian Expeditionary Forces, serving in France with the 48th How. Battery, 2nd Brigade, C.F.A. Returning to the Department in 1919, Mr. Bennett remained on the Saint John, N.B., staff until 1924, when he was appointed senior assistant engineer at Halifax, retaining that position until 1931 when he was transferred to Sault Ste. Marie. Mr. Bennett has taken an active interest in the affairs of The Institute, having served as chairman of both Saint John and Halifax Branches, and represented the Halifax Branch on the Council in 1931. He has served as Councillor of both the Association of Professional Engineers of New Brunswick and Nova Scotia, and was Maritime vice-president of the Professional Institute of the Civil Service of Canada in 1926-1927.

George H. Ferguson, M.E.I.C., who was elected president of the Canadian Institute on Sewage and Sanitation at the last convention held in Toronto, is chief sanitary engineer of the Department of Pensions and National Health, Ottawa. Mr. Ferguson graduated from the University of Toronto with the degree of B.A.Sc. in 1906, and for the two succeeding years was engineer-in-charge of the layout of the buildings at the plant of the Dominion Radiator Company, Limited, Toronto. In 1908 Mr. Ferguson was employed as transitman on surveys in Southern Alberta, and in 1909 was engineer-in-charge of the preliminary surveys for the Matabitchouan power development. Later in the same year he was appointed assistant to the hydraulic engineer of the Hydro-Electric Power Commission of Ontario, and in 1911 became hydraulic engineer to the National Conservation Commission. Mr. Ferguson secured a commission in the Canadian Engineers, and served in France from 1915 to 1918, being awarded the Military Cross and promotion. At the conclusion of the war he returned to his duties with the Conservation Commission but resigned in 1920 to accept a position as assistant to the chief traffic advisor of the Grand Trunk Railway Arbitration Board. The following year he was appointed inspecting engineer on rehabilitation of lines of the Toronto Transportation Commission, and in 1923 was appointed to the position which he now holds.

Charles A. Magrath, M.E.I.C., has resigned as chairman of the Canadian Section of the International Joint Commission.

Mr. Magrath's professional career has been an outstanding one. In early days he practised the profession of land surveyor in the Northwest Territories, holding the titles of Provincial and Dominion Land Surveyor and Dominion Topographical Surveyor. He was land agent for the Alberta Railway and Coal Company and later played an important part in the development of the sub-arid districts of southern Alberta as manager of the Canadian North West Irrigation Company. Mr. Magrath entered politics in 1891 as member for Lethbridge, Alta., holding the post of minister without portfolio in the Haultain ministry in Saskatchewan from 1898 to 1901. He also represented Medicine Hat in the House of Commons from 1908 to 1911. In 1911 he became chairman of the Canadian section of the International Joint Commission, retiring in 1925 to accept the chairmanship of the Hydro-Electric Power Commission of Ontario, succeeding the late Sir Adam Beck. In 1928 Mr. Magrath was reappointed chairman of the Canadian section of the International Joint Commission, retaining the chairmanship of the Hydro-Electric Power Commission until 1931, when he retired from that office.

During the war Mr. Magrath was a member of the War Trade Board of Canada, and acted as fuel controller from 1917 until 1920. In 1922 he became a member of the Federal Advisory Committee. In 1920 he performed an important mission in acting as chairman of a commission appointed to investigate agricultural conditions in southern Alberta. In 1933 Mr. Magrath acted on the Newfoundland Royal Commission.

International Conference on Soil Mechanics and Foundation Engineering

June 22nd-26th, 1936

An International Conference on Soil Mechanics and Foundation Engineering will meet at Cambridge, Mass., on June 22nd to 26th, 1936.

A group of engineers headed by Dean H. E. Clifford of the Harvard Graduate School of Engineering, has formed a Committee on Organization, which is responsible for all arrangements for the Conference. Professor Karl von Terzaghi, of the Technische Hochschule in Vienna, Austria, has been elected President of the Conference.

This Conference is organized primarily for the following purposes:

1. To make a survey of investigations in progress in the various soil mechanics laboratories.
2. To collect as much information as possible on the recent developments in earth and foundation engineering and to make them available to all interested engineers.
3. To compare and co-ordinate experiences and the results of research.
4. To initiate closer co-operation for the purpose of advancing scientific methods in earth and foundation engineering.

Those wishing to attend all meetings, receptions and excursions, must file application accompanied by the specified fees with the Secretary not later than May 1st, 1936.

Those who wish to contribute papers and discussions without attending the Conference, or who wish to attend only certain meetings, need not file application, and will be exempt from payment of fees. Printed abstracts will be available at cost to such persons.

Those contributing papers must submit to the Secretary a description of the paper of about one hundred words not later than March 15th, 1936.

A bulletin containing detailed information on this Conference, its purpose, conditions for the contribution of papers, etc., will be mailed on request to the Secretary, Mr. Arthur Casagrande, Foundation Conference, Harvard Engineering School, Cambridge, Mass.

Visitors to Great Britain

A communication has been received from Dr. H. H. Jeffcott, Secretary of the Institution of Civil Engineers, London, on behalf of the President and Council of the Institution, advising that members of The Engineering Institute visiting Great Britain, if suitably introduced, will, as a matter of courtesy, be accorded the privilege of attending meetings of the Institution and using the library and reading rooms.

Further, such accredited visitors will, if desired, be presented with letters of introduction to members of the Institution to enable them to visit engineering works in that country.

Members of The Institute wishing to take advantage of this kind offer may at any time obtain the necessary credentials from the Secretary.

W. Hollingworth, M.E.I.C.,
Chairman,
Annual Meeting Committee
and
Finance Committee.

The Annual General

AND

General Professional

Meeting

February 5th, 6th and 7th

1936

E. P. Muntz, M.E.I.C.,
Chairman,
Reception Committee.

V. S. Thompson, A.M.E.I.C.,
Chairman,
Visits Committee.

A. Love, M.E.I.C.,
Secretary,
Annual Meeting Committee.

W. J. W. Reid, A.M.E.I.C.,
Chairman,
Papers and Technical Events
Committee.

THE HAMILTON BRANCH COMMITTEE IN CHARGE OF ARRANGEMENTS

E. H. MacKay, A.M.E.I.C.,
Vice-Chairman,
Annual Meeting Committee.

Royal Connaught Hotel,

Hamilton, Ont.

T. S. Glover, A.M.E.I.C.,
Chairman,
Publicity Committee.

R. K. Palmer, M.E.I.C.,
Chairman,
Ladies Committee.

G. Moes, A.M.E.I.C.,
Chairman,
Hotel Arrangements and Entertainment Committee.

A. R. Hannaford, A.M.E.I.C.,
Chairman,
Registration Committee.

CORRESPONDENCE

Room 1, Ontario Power Plant,
Niagara Falls, Ontario,
January 9th, 1936.

The Editor
The Engineering Journal.

Sir:—

The correspondence appearing in The Journal in recent months on the Consolidation question has been confined in general to criticism of Mr. Pitts' scheme and the offering of alternatives. However, judging from the tenor of many meetings across the country, Mr. Pitts' tentative outline is meeting with distinct approval from the majority of engineers. At the present stage and time, united support behind the committee would appear to be the most desirable attitude for all, and the spirit of willingness to compromise most essential; vociferous minorities and die-hards with set ideas who quibble over minor details, if given opportunity, may possibly wreck the plan. Consolidation in some form is becoming a necessity for The Institute and failure to achieve it at the earliest convenience will certainly weaken The Institute.

In common with other similar organizations, The Institute has suffered a falling off in membership in recent years. This is probably largely due to unemployment but there are other potent causes which may be covered in the statement that The Institute has failed to fulfil effectively all the functions of an ideal engineering society. Its more stressed objectives are too altruistic for most engineers, particularly those holding minor positions. Mr. Shearwood in his address to the Montreal Branch on January 30th, 1935, listed two main objectives; many engineers believe a third and most important one was omitted, that of the advancement of the profession in the interests of the engineers themselves. The professional associations have been criticized for setting up a form of trades-unionism under a cloak of professionalism but certainly there is a demand for such type of service as their growth indicates. As far as The Institute is concerned, many of its more prominent members have been little interested in improving the status and remuneration of junior and other engineers, even of those coming under their jurisdiction. The stronger provincial associations have certainly been attempting to give some much-needed protection to juniors but, without doubt, this could be more effectively achieved with a united Dominion-wide organization.

A large number of eligible engineers belong solely to such organizations as the American Institute of Electrical Engineers. This is probably due to the fact that it is impossible for The Institute to fulfil completely its function in regard to the interchange of professional knowledge for all the branches of engineering, particularly in the smaller centres. In order to draw in these men, The Institute must have other appeal; this would be supplied by consolidation, which should produce a strong country-wide society having, eventually, much improved legal status. Possibly there might be some advantage in further stressing the fact that The Institute has a working agreement with most engineering societies for a mutual exchange of publications at advantageous rates to its members.

These few ideas are expressed in hope of causing some thought, now that the time of the Annual Meeting approaches, when some action on consolidation is to be expected. Personally, I wish to express my appreciation of the energetic and resourceful manner in which Mr. Pitts and his committee have been carrying on.

Yours truly,

G. H. Wood, A.M.E.I.C., *Vice-Chairman*,
Niagara Peninsula Branch.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

The Iron and Steel Institute: Symposium on the Welding of Iron and Steel.

American Society for Testing Materials: Proceedings of 38th Annual Meeting Parts I and II.

Reports, etc.

Canada: Report of the Minister of Public Works, 1935.

U.S. National Resources Committee: Report of Special Advisory Committee to the Water Resources Committee: Standards and Specifications for Hydrologic Data.

International Tin Research and Development Council: Technical Publications: Series A, No. 25—Electrodeposition of Tin Alloys from Alkaline Stannate Baths.
Series A, No. 24—The Atmospheric Corrosion and Tarnishing of Tin.

Institution of Engineers Australia: Supplementary List of Members, 1935.

Canada, Dept. of Pensions and National Health: Home Treatment of Rural Water Supplies.

American Institute of Mining and Metallurgical Engineers Inc.: Year Book.

Canada, National Parks: Annual Report of the Commissioner for the year ending March 31st, 1935.

Canada, Dept. of Labour: Report for the year ending March 31st, 1935.

Technical Books, etc., Received

Whitaker's Almanack, 1936.

BOOK REVIEW

The Elements of Specification Writing

By R. S. Kirby. John Wiley and Sons (Renouf Publishing Company, Montreal), New York. 1935. Fourth edition. 6 by 9¼ inches. 168 pages. $2.00.

Success in the difficult art of writing specifications involves more than a mere knowledge of the technical requirements of construction or manufacture. It requires the power of clear expression and the framing of sentences and paragraphs in such a way that only one meaning, and that the desired one, can be conveyed by them. Further, the writer must have a working knowledge of the principles of the law of contracts and the various types of business arrangements which are commonly embodied in contracts.

The book under review is intended as a text-book and can be recommended as a succinct discussion of the many points involved in preparing specifications for construction work in the United States. The present edition has been largely rewritten. Its value to students is enhanced by the inclusion at the end of each chapter of a number of questions for discussion, as for example: "Suppose the consulting engineer for a municipality tests material which the contractor was to furnish, who should pay the laboratory fees?" or, "In describing the contractor's obligations what is the distinction between 'must.' 'shall,' 'will' and 'is to'?"

A number of problems are included for solution, and these, with the questions will give considerable food for thought. Some of them may even be a little beyond the capacity of the average student, in which case they should serve the excellent purpose of stimulating his desire for a mastery of the subject. The whole tendency of the book is to indicate to the undergraduate the value of experience in the rugged paths of specifications writing.

Professor Kirby renders a service to his readers by indicating many danger points at which caution is required, as for instance when questions arise involving the precise legal position of the engineer, or difficulties occurring in dealing with extras. He gives excellent directions for the actual composition of the necessary documents. The reviewer would especially commend the emphasis he lays on the necessity for clear, concise English and the need for the avoidance of indefinite words and phrases, and of clauses which may inadvertently contain some element of unfairness to either the owner or the contractor.

While the book is primarily concerned with construction work in the United States, its essential features are equally applicable to practice in Canada. Indeed, it will well repay careful study by anyone who has to deal with present day specifications and contracts.

List of New and Revised British Standard Specifications

(Issued during October and November, 1935)

B.S.S. No.

600—1935. *Application of Statistical Methods to Industrial Standardisation and Quality Control.*
Deals with the use of statistical methods applied to industrial processes and the assistance these can afford in interpreting test data, in the assessment of reliability, of sampling, in tracing sources of failure to comply with specified requirements, etc., with examples drawn from actual experience. 133 pages of text with tables and 12 plates.

626—1935. *Micanite for Commutator Separators.*
Micanite for commutator segments of reliable commercial quality supplied either as sheets or as segment separators, cut to size "ordinary" and "soft" grades are included.

633—1935. *Cotton Tapes and Webbing for Electrical Purposes.*
Provides for the construction, dimensions, weight, tensile strength, etc., of cotton tapes and webbing suitable for electrical purposes (other than the manufacture and jointing of cables). with methods of test.

634—1935. *Finishing Air-drying Insulating Varnish for Electrical Purposes.*
Provides for the physical and electrical properties of air-drying moisture-resisting varnishes for electrical purposes such as for the finishing of coils, armatures, etc., and methods of test.

635—1935. *Thermal-Type Time-Element Relays (Alternating or Direct Current) for Railway Signalling.*
Covers the construction and performance of relays capable of giving a delay of at least 5 seconds at their maximum settings between energization of the relays and operation of the appropriate contacts.

Copies of these specifications may be obtained from the British Standards Institution, 28 Victoria Street, London, S.W.1, England, and from the Canadian Engineering Standards Association, 79 Sussex Street, Ottawa, Ont.

The Need for an Active Associations' Dominion Council

Address of Mr. P. M. Sauder, M.E.I.C., President of the Association of Professional Engineers of Alberta, on the occasion of the Sixteenth Annual Meeting, December 7th, 1935, of the Association of Professional Engineers of British Columbia.

(Abridged)

I was very much surprised when I received your very kind invitation to attend your Annual Meeting and to speak to you today. I knew that I would enjoy your hospitality and the discussions at your meetings but realized my shortcomings as a speaker and would have declined with thanks, but my Councillors prevailed upon me to accept.

No topic was specified in the invitation, but I think that I am expected to discuss Co-ordination of the various Engineering Organizations in Canada.

As you know, the term "Civil Engineer" originally embraced all engineering other than "Military Engineering," and although by the year 1887, the year in which the Canadian Society of Civil Engineers was incorporated, the profession had split into several branches, such as Mining, Mechanical, Electrical, etc., the Society was open to all civil engineers, in the original and wider meaning of the term. The membership, however, was largely composed of civil engineers in the narrower sense, possibly because this interpretation had come into more common usage.

The membership of the Society being composed mostly of men who were practising civil engineering in the narrower sense of the term, most of its papers and publications dealt with that phase of engineering and those who were practising other branches of engineering gave allegiance elsewhere, mostly to the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the Canadian Institute of Mining and Metallurgy, in order to get the benefits of technical papers, discussions and publications which dealt directly with their branch of engineering. Thus, there was a long period when the tendency was for the Engineering Profession to gradually split into the various branches, and this tendency increased as more branches came into being, such as Highway Engineering, Automobile Engineering and Radio Engineering.

Realizing that this splitting up of the profession was not conducive to strength, the Canadian Society of Civil Engineers, in 1918, changed its name to The Engineering Institute of Canada, in the hope that it would then be able to embrace all branches of the profession. The hope was, however, only partially realized since, by that time, the Canadian Institute of Mining and Metallurgy had built up a strong organization and many members of the other branches of engineering belonged to, and were getting valuable literature from outside organizations.

Gradually a feeling grew up that the Profession of Engineering required some legal foundation on which to build a homogeneous whole, and The Engineering Institute of Canada sponsored a move in this direction. Under the British North America Act, any legislation had to be Provincial. A model Act was therefore prepared, and in 1920 the Provincial Associations of Professional Engineers were formed and attempts were made to have a model Act passed in each Province. The results were not uniform, some of the Associations obtaining strong Acts, and others weak ones. Nevertheless, the Professional movement grew; but still there was no unity in the Profession, perhaps even less than before, because there had been brought into existence eight Provincial Associations in addition to the other organizations.

It was realized that this continual subdividing of the profession would finally result in utter chaos, and in 1924 a move was instigated to try to get amalgamation between the Professional Associations and The Engineering Institute of Canada. A great deal of work was done with this end in view in order to try to harmonize the views of the various Associations and of the E.I.C., and in 1931 the eight Provincial Associations appointed representatives, four men who had authority to represent the eight Associations, and who were known as the "Committee of Four." This Committee met and made a report which was submitted to all the Associations, and the result was the formation of "The Committee of Eight," which consisted of one representative from each Provincial Association. It is significant that each member of the "Committee of Eight" was a member of The Engineering Institute of Canada, as well as of the Provincial Association which he represented. The Committee of Eight met early in 1933, and in turn submitted a report to each Provincial Association proposing that a Dominion Council of Professional Engineers be formed. In due course this was done and the Dominion Council of Engineering came into being, its objective as recommended by the Committee of Eight, being "The co-ordination of activities of Provincial Associations of Professional Engineers and by co-operation of other bodies, work towards the co-ordination of other activities of the engineering profession in Canada." The personnel of the Dominion Council was also composed of men who are members of the E.I.C. as well as members of their respective Provincial Associations.

The necessary training and the practice of engineering, teach engineers that efficiency is a necessity for continued existence. The organization of the profession, however, shows very little sign of any such efficiency as the individual practising engineer requires for the everyday problems of his profession, and while it is clear that since 1918 there has been a steady effort to achieve more unity for the engineering profession of Canada, the results have so far been meagre. Efforts have been made along several lines, and unquestionably a definite decision must be made as to the ultimate objective, and the method of advance towards that objective, in order to avoid waste effort. Before deciding upon what is practical, it is necessary to briefly scan the positions of the three major engineering organizations in Canada, and get a clear idea of their activities, their objectives and their accomplishments.

The Engineering Institute of Canada

There are 2,627 Corporate members resident in Canada. In addition, there are 300 Corporate members resident in other parts of the world, seven honorary members, 316 juniors, 806 students and 35 affiliates, making a total membership in all grades of 4,091.

The aims and objects as set forth in the By-laws of The Institute are broad enough to cover nearly anything in connection with the engineering profession, and could easily be made to include the operation of the Professional Engineers if the British North America Act permitted. Nevertheless, the main idea embodied in these aims and objects was that The Engineering Institute of Canada should be an educative body with a very wide interpretation of the word "educative."

The Canadian Institute of Mining and Metallurgy

The membership, not including student, corporation and corresponding members, is around 1,500.

The main purpose of the Canadian Institute of Mining and Metallurgy differs from that of any other of our engineering organizations. The prime motive is the advancement of the industry, and it is mainly through the achievement of this motive that the mining engineer benefits. Because the Mining Institute represents an industry, its membership is not limited to qualified engineers, and while no figures are available it is doubtful if more than half the membership would be eligible for membership in The Engineering Institute of Canada, or in a Professional Association.

A prospective employer cannot therefore assume that because a person is a member of the Canadian Institute of Mining and Metallurgy he is, *ipso facto*, a qualified mining engineer, and such employers make inquiries, from time to time, from the Professional Associations. Such engineers can only be responded to by giving the names of Association members who are registered in the mining branch, and for this reason it is unfortunate that in some of the provinces very few mining engineers are members of the Professional Associations. Obviously it is in the interests of the public that the mining engineers should belong to the Professional organizations, and it is also in the interests of the mining engineers themselves that they should support the Associations.

The Provincial Professional Associations

The total membership of the eight Associations is approximately 4,170 full members (student membership of 630—total of 4,800) and the purpose of the Associations is to administer the Provincial Acts in the interests of both the engineering profession and the public.

Approximate figures of the membership of the various Provincial Associations are as follows:

	Full Members	Students	
Alberta	270	100	
British Columbia	830	530	
Manitoba	200		
New Brunswick	138		
Nova Scotia	202		
Ontario	1,227		
Quebec	1,216		
Saskatchewan	88		
	4,170	630	Total: 4,800

Mr. de Hart estimates that there are approximately 2,500 members of the Professional Associations who do not belong to the E.I.C., and conversely there will be nearly 1,500 members of the E.I.C. who do not belong to any Provincial Associations. There are, therefore, roughly 4,000 men who are members of only one or other of these two organizations.

In addition to the Professional Associations, The Engineering Institute of Canada, the Canadian Institute of Mining and Metallurgy and the Dominion Council of Engineering, there are branches of some of the American Societies and Institutes in Canada, such as The American Society of Mechanical Engineers, The American Institute of Electrical Engineers, The Society of Automotive Engineers, The Institute of Radio Engineers, The American Society of Steel Treating and The American Waterworks Association.

Owing to the fact that the number of engineers in Canada practising in many of these branches of engineering is too small for the successful formation of separate Canadian Societies, the inception of branches of American organizations has been inevitable. In any scheme of co-ordination, however, the most important bodies are the previously mentioned Canadian organizations, although provision should be made for all other engineering bodies also.

Let us see what is the set-up for the other professions in Canada.

The legal profession has its Provincial Law Society in each Province and the Canadian Bar Association. Under the auspices of the Canadian Bar Association there has been organized a "Conference of Governing Bodies of the Legal Profession in Canada," which holds annual meetings and deals with matters of common interest to the governing bodies of the profession in the several provinces. By this means the Canadian Bar Association fosters harmonious relations and co-operation among the various governing bodies. This conference is the national executive for the profession. It is constantly endeavouring to encourage and maintain a high standard of legal education, training and ethics.

Generally speaking, a lawyer who is registered in any Provincial Law Society can become registered in the Law Society of another Province by simply passing an examination in the statutes of the Province where he wishes to register.

The Land Surveyors have Provincial Associations and a Dominion Association. A Land Surveyor who is registered in the Dominion Association can qualify to register in a Provincial Association by passing an examination in certain statutes. (British Columbia and possibly one other province is exempted from this statement.)

The Medical Profession has its College of Physicians and Surgeons in each Province and the Canadian Medical Council. The Canadian Medical Council has a register as well as the provincial Associations and registration in the Canadian register entitles the doctor to register and practise in any Province in Canada.

The Dental Profession has its Associations in each Province and a Dominion Dental Council. A certificate of qualifications of the Dominion Dental Council entitles the holder to a licence to practise dentistry in any province in Canada where the Provincial Association has representatives on the Dominion Dental Council.

The Chartered Accountants have their Institutes of Chartered Accountants in each province and a Dominion Association of Chartered Accountants. Each Provincial Institute is a unit in the Dominion Association and membership in any of the Provincial Institutes carries with it membership in the Dominion Association and a portion of the annual fee collected by the Provincial organization is passed on to the Dominion Association.

Consideration of all the facts can only lead to one conclusion, and that is that the activities of the various engineering bodies are in dire need of co-ordination, to attain which there must be some one body at the head of engineering affairs throughout the Dominion. Such a body must have the support of all the various organizations, it must be able to define the different spheres of activity, and it should be able to speak for all engineers in Canada.

There are, theoretically, two ways in which this can be accomplished. One is by amalgamating all the various organizations until there is only one, and the other is by placing some one body at the head to co-ordinate the activities of the component parts of the profession.

One very real difficulty in the way of amalgamation, even between The Engineering Institute and the Professional Associations, is the fact that there are about four thousand men who at present pay dues only to one or other of the two organizations. Doubtless the dues to an amalgamated body might be somewhat less than the sum of the separate dues, but certainly they would be higher than those of either separate body. These facts alone throw grave doubts on the wisdom of amalgamation at the present time.

On the other hand, unity in the profession can be obtained at very little cost and relatively easily by co-ordination, and Mr. de Hart suggests that the logical body to undertake this work is the Dominion Council of Engineering. In the first place it represents a larger number of engineers than any other one organization and the membership of the Associations includes engineers in every branch of the profession. In the second place, the Dominion Council is composed wholly of men who are members of the E.I.C. as well as of a Professional Association and in the third place, it was created mainly for the purpose of co-ordination. If this is accepted as correct, the Professional Associations should at once put the Dominion Council of Engineering on a firm foundation and an operating basis by agreeing on a constitution and providing the necessary funds so that an office and office equipment can be obtained and a permanent secretary appointed. The Dominion Council should also be authorized to expand so that representatives of other organizations, on an equitable arrangement as to numbers, can become part of the Council. This is a very important point in Mr. de Hart's proposal, as The Engineering Institute of Canada and the Canadian Institute of Mining and Metallurgy would be approached with a view to their appointing representatives to the Dominion Council of Engineering and later all other engineering organizations would also be invited to appoint representatives.

The proper way to finance the Dominion Council would be a per capita levy on all members of organizations which had representations on the Council, but at the start at least it would probably be necessary for the members of the Associations of Professional Engineers to carry the cost. If the cost were shared and if the Dominion Council received the full support of all the engineering organizations throughout the Dominion, the cost per capita would be very small. Members of Professional Associations would, of course, not be required to contribute through any other body to which they might belong.

So far, the Dominion Council of Engineering has not functioned. Your Council, realizing that nothing was being done, suggested that a meeting of Presidents and Secretaries of the Provincial Associations and the representatives on the Dominion Council be held in Montreal. The Alberta Association thinks this is a good suggestion and is prepared to participate in such a meeting. I believe that all of the difficulties standing in the way of co-ordination can be overcome at such a meeting. A constitution could be drawn up, a budget prepared, a Secretary selected and everything lined up to put the Dominion Council of Engineering into operation.

Should any of the other Engineering organizations wish eventually to amalgamate with the Dominion Council, there would be no difficulty in bringing this about at any later date.

It hardly seems necessary to point out the advantages of having a Dominion Council of Engineering at the head of all engineering affairs in the Dominion, or to enumerate the many duties which it could fulfil to the benefit of the engineering profession in Canada. In closing, however, I would like to enumerate some of them.

(1) To co-ordinate and unify the requirements of admission to the various engineering bodies in the Dominion.
(2) To define the sphere of each of its component parts so as to prevent overlapping and promote efficiency.
(3) To foster and effect any amalgamations which might be deemed advisable.
(4) To represent the whole of the engineering profession before the public, to look after judicious publicity and the general interests of the profession.
(5) To watch legislation affecting the profession and take action when considered advisable.
(6) To consolidate offices where possible with a view to economy.
(7) To look after the soliciting of advertising for the various publications, and to consolidate publications where it may be done to advantage.

In closing, I wish also to express the appreciation of the Alberta Association of the active interest that the B.C. Association and its officers have taken in co-ordination. Your initiative and energy have done a lot to keep co-ordination alive. I think that the steps proposed by you will bear fruit.

BULLETINS

Stucco.—The Portland Cement Association, Chicago, Ill., have issued a 32-page booklet containing instructions on how to produce a variety of stucco textures. Each step is illustrated by photographs with a set of specifications for the proper application on both old and new buildings.

Feedwater Heaters.—A 4-page folder received from the Worthington Pump and Machinery Corporation, Harrison, N.J., deals with their standard non-deaerating type of stationary feedwater heater.

Nickel-Clad Steel.—A 24-page bulletin received from Lukens Steel Company, Coatesville, Pa., gives various applications for the use of nickel-clad steel, together with illustrations.

Experimental Road Lighting in France

France is decidedly behind both Great Britain and the United States in so far as main road lighting is concerned. There have been a number of recent installations such as the St. Cloud-Versailles and Paris roads, and that of the Aix-en-Provence-Marseille route, which are among the most carefully planned of modern installations. As in other countries, plenty of evidence has been provided as to the effect of good lighting in reducing accidents. Thus in the Nanterre district, figures show that during the year after a modern lighting installation was in operation, fatal accident figures fell from 3 to 0, accidents causing serious injuries from 69 to 35 and accidents involving material damage from 70 to 57.

The committee responsible for propaganda in favour of the "Route Bleue" from Paris to the Cote d'Azur via Montargis, Nevers, St. Etienne, Tournon and Valence, have recently decided to bring the whole of this route up to the best lighting standards. An interesting scientific lighting exhibition was held near Nevers which was designed to show in practice the different effects of various types of lighting—incandescent and electric discharge, different spacing and light source heights etc.

The Committee was satisfied that electric discharge lighting was the most satisfactory from the point of view of high efficiency lighting. One of the tests made on the road showed that a variation of ten per cent in the circuit feeding the lamps had no perceptible effect on visibility.—*World Power.*

The Canadian Fairbanks-Morse Company Ltd. have issued their new General Catalogue No. 36. This volume which contains some 700 pages gives complete information regarding the various lines of Machinery, Tools Supplies supplied by this company. The data contained are presented in a useful and condensed form, and a complete index is included.

BRANCH NEWS

Border Cities Branch

C. F. Davison, A.M.E.I.C., Secretary-Treasurer.
F. J. Ryder, S.E.I.C., Branch News Editor.

The general annual meeting of the Border Cities Branch was held in the Prince Edward hotel, Friday, December 13th, 1935. Twenty-five persons were present. After the reading of the Secretary's report, a letter from the Hon. C. D. Howe, M.E.I.C., was read acknowledging the congratulations that this Branch had sent to him. The chairman called for the various committee reports, namely: Membership committee, presented by T. H. Jenkins, A.M.E.I.C., Executive committee by C. F. Davison, A.M.E.I.C., Paper and Entertainment committee by E. M. Krebser, A.M.E.I.C., Councillor's report by C. G. R. Armstrong, A.M.E.I.C. O. Rolfson, A.M.E.I.C., commended the committees on their very excellent reports. Fred. Stevens, A.M.E.I.C., and George Medlar, A.M.E.I.C., were appointed returning officers and the business of electing officers for the coming year was proceeded with.

The new chairman, Mr. T. H. Jenkins, presented the guest speaker, J. J. Newman, M.E.I.C., and H. J. Coulter, A.M.E.I.C., the retiring chairman, presented Mr. Newman with a membership badge in recognition of his services to the community.

Reminiscences of a Practising Engineer

Mr. Newman stated that to one who has lived in Essex county for only a short time it is hard to believe the changes that have been made within even the last decade. About thirty-five to forty years ago it took several days to make the round trip from Leamington to Windsor, about 35 miles. This time was later shortened by the building of corduroy roads mostly of the toll type. The district is flat and water remained on the surface of the land for long periods, forming excellent breeding places for flies and mosquitoes. However, by arousing the interest of the government in drainage matters, laws were passed to aid in this work; then due to overlapping and different interpretations it became necessary for the practising engineer to understand the workings of the mass of drainage laws that were to aid him in improving the land. The entanglements and drainage disputes became so muddled that the government found it necessary to appoint arbiters and special judges. Through it all the engineer has been able to drain miles of swamp land which at present supports hundreds of farms. The roads in Essex county are now comparable with any in the Dominion, and the agricultural products can compete with the best. The practising engineer has shown by his work how he has aided in the development of the community.

All through his talk Mr. Newman told of numerous personal experiences in practice and with lawyers. Slides of prominent men in drainage disputes were shown and incidents relating to their cases were given.

Mr. Rolfson moved a hearty vote of thanks to Mr. Newman which was seconded by W. J. Fletcher, A.M.E.I.C., and unanimously passed.

Calgary Branch

Jas. McMillan, A.M.E.I.C., Secretary-Treasurer.
H. B. LeBourveau, A.M.E.I.C., Branch News Editor.

The Calgary Branch of The Institute held its opening meeting of the 1935-36 season on October 31st at the Palliser hotel.

Mr. W. J. Oliver, well-known photographer, showed several very interesting films, among which were two reels featuring the naturalist, Grey Owl, and his beavers in the Prince Albert National Park.

Another film, which caused considerable comment, was entitled "Hunting Big Game with a Camera." The film was taken in Jasper National Park and Mr. Oliver obtained close-up "shots" of deer, moose, caribou, mountain sheep and goats.

Mr. Oliver accompanied a small party on their climb to the peak of Mount Victoria near Lake Louise and obtained some very excellent mountain pictures.

Other films shown were Jasper and Waterton National Parks and one taken in the vicinity of Victoria, B.C.

Colonel F. M. Steel, M.E.I.C., moved a vote of appreciation to Mr. Oliver, which was extended to the speaker by the chairman, J. Haddin, M.E.I.C.

Modern Methods of Producing Gas and Oil

The November meeting of the Calgary Branch of The Engineering Institute was held on November 14th, 1935.

The first speaker of the evening, S. G. Coultis, M.E.I.C., was then introduced. The subject chosen by Mr. Coultis was "Modern Methods of Producing Gas and Oil." In dealing with this subject Mr. Coultis gave his listeners a great deal of information regarding the production and consumption of oil and gas, including the following:—

World consumption.................... 4,800,000 barrels per day
U.S.A. consumption.................. 2,825,000 barrels per day
Canada has 42 refineries with 4,876 employees.
Only 3.7 per cent of oil used in Canada is produced in Canada.

In the discussion which followed a number of questions were asked and replied to by Mr. Coultis. These included a question by H. J. McLean, A.M.E.I.C., regarding the life of the Turner Valley field. Mr. Coultis, in replying to this question, stated that although the life of the field was unknown and difficult to estimate, he did not think it would peter out in the near future.

Municipal Water Works

The second speaker, Mr. C. C. Planche, was then introduced and took as his subject "Municipal Water Works" and gave a talk filled with interesting information on water works systems in general but with special reference to water works systems in this province. In many towns the water works and sewage systems were treated as minor problems which could be handled by anyone whereas in reality they are major problems which should be handled only by thoroughly competent persons.

After giving his talk Mr. Planche answered questions and some of these concerned the digging or drilling of wells and their effect on the water table. As a result of this discussion Colonel Steel moved, seconded by Mr. McLean: "That a committee be appointed by the chairman to report on the general practice of water well drilling in the Province of Alberta and its effect on the water table throughout the province and, if found desirable, to prepare a memorandum for presentation to the Alberta Legislature urging the passing of legislation to regulate the drilling into and protection of the sub-surface water resources." Carried.

A vote of thanks to both speakers was proposed by John Dow, M.E.I.C., and was heartily approved in the usual manner.

The Petroleum Industry Exhibit

The guest speaker at the meeting on December 12th, 1935, was Dr. T. A. Link, geologist, Imperial Oil Ltd., Calgary, who took as his subject "The Petroleum Industry Exhibit at the Chicago Century of Progress Exhibition."

Starting with a brief (and humorous) history of his appointment as director of the exhibit, Dr. Link proceeded, by the use of slides, motion pictures and phonograph records, to show the many features of this part of the Century of Progress Exhibition and, in an interesting way, explained many details as the scenes were shown on the screen.

Hamilton Branch

A. Love, M.E.I.C., Secretary-Treasurer.
A. B. Dove, Jr.E.I.C., Branch News Editor.

The annual meeting of the Hamilton Branch took place on Tuesday, January 14th, 1936, in the Science Building, McMaster University. The meeting was called to order by the chairman of the Branch, W. Hollingworth, M.E.I.C. The business proceedings were brief, as there was little change in the Executive.

The business meeting was closed at 8.15 p.m. and then Mr. Hollingworth extended a cordial greeting to the members of the Hamilton Chapter, Ontario Association of Architects, who had been invited to join the Branch on this occasion.

The speaker of the evening was Mr. J. W. Bishop, of the Heating and Cooling Division, Canadian General Electric Co.

Air Conditioning

Mr. Bishop went on to explain the advantages of air conditioning, its applications in past years to public buildings, theatres and such like, and the improvements made in recent years. He described briefly the hygrometric conditions and their effect on humans both in summer and winter.

With a series of lantern slides, Mr. Bishop showed equipment for installation in the average home. Starting with winter air conditioning equipment which circulates, filters, and humidifies the air, he went on to show the application of the oil fired furnace in bringing the air up to the proper temperature and in heating of domestic water.

There are all year air conditioning units and also split units, each with its own advantages. The all year unit has less sweating and rusting of equipment in the cellar, and tends to remove dampness from the cellar in summer time.

Summer cooling equipment has to be carefully considered. A few days in summer with relatively high humidity may call for an expensive outfit, while for average conditions the cost of a unit may be decidedly less. Is it worth while preparing for the worst condition?

Following the lecture Mr. Bishop answered questions which brought out some interesting points.

W. J. W. Reid, A.M.E.I.C., moved a vote of thanks which was heartily accorded the speaker.

L. W. Gill, M.E.I.C., chairman of the Judges' Committee on Students' papers, explained that the Committee had not been able to complete its report in time for the meeting but would have it ready in a few days.

Mr. Hollingworth urged all members to come out to the different events at The Institute Annual Meeting next month and help make it a real success. Following that, adjournment was made to an adjacent room for coffee and sandwiches.

Ottawa Branch

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

THE TREND IN TOWN PLANNING

Horace L. Seymour, M.E.I.C., spoke upon "The Trend in Town Planning" at the noon luncheon at the Chateau Laurier on December 20th, 1935. Mr. Seymour is a past-president of the Town Planning Institute of Canada, and occupied the position of special lecturer in Town Planning in the Universities of Toronto and Alberta. He was director of town planning in Alberta from 1929 to 1932, and is at present engaged in drafting an act for the Province of New Brunswick, as well as acting as consultant for the City of Saint John. His address was illustrated with lantern slides.

Dr. R. W. Boyle, M.E.I.C., chairman, presided and head table guests also included: Major D. H. Nelles, M.E.I.C., first vice-president of the Town Planning Institute of Canada; Dr. W. C. Clark, deputy minister of the Department of Finance; F. W. Nicolls, architect for the Federal Housing Commission; H. F. Ballantyne, chairman, and Ald. David McMillan and Ald. A. A. Pinard of the Ottawa Town Planning Commission; Controller-elect Allan B. Turner; Ald. A. Belanger, J. M. Kitchen, also of the Ottawa Town Planning Commission, and R. H. Macdonald, of Montreal.

In opening his address, Mr. Seymour first of all paid tribute to the late Noulan Cauchon who, he said, was one of Canada's greatest town planners. He then traced the history of town planning from the early days to the present. Insofar as it relates to the arrangement of houses, streets and shops, it was recognized in Egypt, Greece, and Rome and is, therefore, not a new idea. Much of the town planning in the past was autocratic but to be completely successful today it must conform to the principles of democracy.

In Canada we have been influenced in our town planning by England and the United States. In the former country town planning has always been stressed from the health side, and with the matter of housing considered of great importance.

In the United States there was not much city planning, apart from the city of Washington, until after the World's Fair in 1893. Then the "city beautiful" idea was evolved, having as its main thought the civic centre where all public buildings could be grouped in a pleasing manner. This idea was not consistently followed but two practical ideas took root: one, that a city should have control not only over its own area but also of that which in the future may become part of the city; and secondly, that not only should town planning deal with public property but that there should be restrictions on the use of private property in keeping with the city's development. This latter has been termed zoning.

At the time of the World's Fair the city of Toronto was realizing the need of some such control, and legislation was passed giving an unrelated zoning control. Toronto has been proceeding largely on that course ever since. The cities of Vancouver, Edmonton and Kitchener have zoning by-laws to conform with comprehensive town plans, and several other cities or towns have more or less similar by-laws in effect, although without as yet in each case a complete plan.

Mr. Seymour stated that town planning to be most effective must be based on an inventory of larger units such as a state or province. With a properly constituted board studies could be made of population, suitability of the region for agricultural development, industrial development, tourist development, and provision made for future trends in transportation.

The idea of establishing a provincial board in Alberta and the same idea contained in the proposed new Town Planning legislation for the province of New Brunswick is the correct method. Such a provincial board will be one that has not only inspirational and educational work to do, but one that can actually have an efficient provincial plan made to co-ordinate and correlate provincial activities, and by so doing be able to co-operate effectively with federal activities.

Peterborough Branch

W. T. Fanjoy, Jr.E.I.C., Secretary-Treasurer.
E. J. Davies, Jr.E.I.C., Branch News Editor.

DIESEL POWER

The regular monthly meeting of this Branch was held on Thursday, December 12th, 1935, with a good attendance of members and guests who were interested in the subject. The speaker was Mr. H. J. Ridge, of the Canadian Fairbanks Morse Company of Toronto, who spoke on Diesel engines.

In briefly tracing the history of Diesel power Mr. Ridge told of how Rudolph Diesel, late in the last century, evolved the principle of the engine in search of a combustion engine which would give an improved thermal efficiency over steam power. His first successful engine gave a thermal efficiency of over 30 per cent, converting more than 30 per cent of the heat energy produced by its combustion into power. In comparison, the efficiency of various forms of steam power plants even to-day afford efficiencies ranging only as high as 18 per cent.

The outstanding difference of Diesel engine from the more common internal combustion engines is represented in the fact that ignition is secured through the heat from engine's compression. Mr. Ridge gave as the modern definition of the Diesel engine: "One in which fuel is ignited slowly by the heat of compression in the power cylinder."

The present tendency in Diesel development is toward higher efficiency, lighter construction and higher speed. With a view to wider application to automobiles and airplanes, Europeans are progressing faster than Americans in this direction, the greater spread between the cost of fuel oil and gasoline in Europe being the incentive.

Mr. Ridge illustrated his talk by means of lantern slides and showed four reels of motion pictures illustrating the manufacture of a Diesel engine.

Quebec Branch

Jules Joyal, A.M.E.I.C., Secretary-Treasurer.

Le onze janvier 1936, notre section avait l'honneur d'avoir comme hôte d'honneur, à un déjeuner au Château Frontenac, Monsieur F. A. Gaby, D.Sc., M.E.I.C., Assistant du Président du C.P.R. et Président de l'Institut des Ingénieurs du Canada.

Le déjeuner était présidé par M. Alex. Larivière, M.E.I.C., président de la section de Québec, qui, avant de présenter l'hôte d'honneur à l'assemblée, profita de cette première réunion de l'année courante pour offrir à tous, en son nom personnel et au nom de notre Comité Exécutif, ses meilleurs souhaits de bonne et heureuse Année.

M. Larivière voulut aussi signaler la nomination récente de l'un de nos membres, M. Louis Beaudry, à la position d'Ingénieur en Chef du Port de Québec; M. Beaudry, qui est à l'emploi de la Commission du Havre de Québec depuis plusieurs années, est un ingénieur laborieux, intègre et compétent qui était tout désigné pour remplir la position laissée vacante par le Brig. Gén. T. L. Tremblay, A.M.E.I.C., membre distingué de notre section.

En présentant M. Gaby, l'hôte distingué du jour, M. Larivière en fit une biographie succinte et lui souhaita la plus cordiale bienvenue parmi nous.

Le Dr Gaby, après avoir mis l'assemblée au courant des affaires de l'Institut en général nous fit une allocution qui peut s'intituler: "Regulation of Highway Transport and its Co-ordination with Railway Facilities in Quebec."

Dans cette causerie, M. Gaby souligne d'abord l'importance des chemins de fer dans la province de Québec, province où le millage des routes est moins considérable que dans l'Ontario, où les cultivateurs sont plus éloignés des marchés urbains et où existent d'importants ports maritimes.

Le conférencier dit que depuis quelques années les grandes routes font une concurrence sérieuse aux chemins de fer qui sont déjà dans une situation difficile; il affirme qu'il serait temps d'adopter une réglementation convenable de la route de façon à ce que les chemins de fer ne souffrent pas d'une concurrence déloyale et puissent eux aussi avoir la chance de prospérer.

M. Gaby fait ensuite une saine critique du mode actuel d'accorder les permis de camionnage public dans la province, et suggère que les camionneurs publics soient assujettis à des taux et des itinéraires fixes.

Ces quelques notes ne donnent qu'une pâle idée de la causerie du Dr Gaby qui fut remercié par le Dr A. R. Decary, M.E.I.C., président honoraire de notre section et ancien président de l'Institut. L'assistance était de 48.

Sault Ste. Marie Branch

N. C. Cowie, Jr.E.I.C., Secretary-Treasurer.
H. O. Brown, A.M.E.I.C., Branch News Editor.

The annual meeting and dinner of the Sault Ste. Marie Branch was held at the Windsor hotel, Friday, January 3rd, 1936.

The report of the nominating committee giving the results of the recent election of officers for 1936 was announced.

The Secretary's report for 1935 was presented and approved for forwarding to Headquarters. This report showed a decrease in membership during the past year of eight, owing to transfers, resignations, and deaths.

The financial statement showed a surplus on the year's activities. The number of general meetings of the Branch was, however, reduced as difficulty was experienced in finding papers to be presented.

The question of new members was discussed and the general feeling was expressed that special efforts should be made by the incoming membership committee to obtain applications from several engineers now resident in the district and who are not members.

The retiring officers were tendered a vote of thanks for their work during their term of office.

Superintendent of the Algoma Steel Corporation's roll department for twenty-six years, and a veteran of forty-five years' experience in roll turning, John B. Singer died at the Plummer Memorial Public Hospital, Sault Ste. Marie, Ont., on December 26th, 1935.

Since Mr. Singer's advent, all rolls used by Algoma have been designed in its own roll shop, including those for the five new heavy structural sections produced in 1935 for the first time in Canada.

The Ingersoll-Rand method of air lift pumping of water, oil, or other fluids is described in a recently issued 24-page bulletin, No. 9042.

The advantages of air lift pumping over other methods for certain field conditions are brought out, several applications are illustrated and described, the theory of air lift pumping is set forth in detail, and a number of different compressors for supplying the air are shown.

Preliminary Notice

of Applications for Admission and for Transfer

January 25th, 1936

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, 1936.

R. J. Durley, Secretary.

*The professional requirements are as follows.—

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

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

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

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

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

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

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

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

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

FOR ADMISSION

BALMFORTH—HAROLD, of Strasbourg, Sask., Born at Castleford, Yorks., England, June 3rd, 1895; Educ., B.E., Univ. of Sask., 1924; 1913-14, ap'tice, power house, Strasbourg; 1915-18, wireman, Royal Navy; 1918-19, electrn., Royal Candn. Navy; 1924-25, instructor, Univ. of Sask.; With A. Reyrolle & Co., Elect'l. Engrs. and Switchgear Mfrs., Hebburn-on-Tyne, England, as follows: 1925-27, engr. in training; 1927-29, representative at Tokyo, Japan; 1929-32, constrn. supt., western Canada. (No definite employment since 1932).

Reference: C. J. Mackenzie, A. R. Greig, R. A. Spencer, J. J. White, W. G. Dyer.

COOPER—JOHN SIDNEY, of New Liskeard, Ont., Born at Toronto, Ont., Oct. 14th, 1913; Educ., B.A.Sc., Univ. of Toronto, 1934; With Sutcliffe Co. Ltd., New Liskeard, Ont., as follows: 1934-35, misc. survey work; 1935, Kirk Lake drainage tunnel; 1935 (Oct.-Dec.), So. Porcupine waterworks and sewers; and at present engr. with same company.

References: H. W. Sutcliffe, J. M. Gilchrist, C. R. Young, W. J. Smither, C. H. Mitchell.

DIXON—KEITH, of North Bay, Ont., Born at Tickhill, Yorks., England, July 10th, 1898; Educ., Univ. of Sheffield, 1932. Special classes covering 1st and 2nd years civil engrg.; 1922, rodman, Columbia River Logging Co., Golden, B.C.; With the C.P.R., as follows: 1923, rodman, 1924-29, asst. dftsman., dftsman., instr'man., and transitman; 1929-30, res. engr., 1930, locating engr., 1931, res. engr.; 1934, res. engr., highway constrn., 1935 to date, divnl. engr., highway location and constrn., Ontario Dept. of Northern Development. (R.P.E. of Ont.).

References: T. F. Francis, R. A. Campbell, T. C. Macnabb, J. N. Finlayson, W. N. Cann, J. A McCoubrey.

FLOOK—SAMUEL EVERT, of Port Arthur, Ont., Born at Willowdale, Ont., March 12th, 1887; Educ., B.A.Sc., Univ. of Toronto, 1911; O.L.S., D.L.S., LL.B.; 1911-13, articled to W. S. Gibson, O.L.S.; 1916-27 (part time), and 1928-30, with C. D. Howe & Co.; 1913-35, private practice as Ontario Land Surveyor and Civil Engineer, Port Arthur, Ont.; At present, city engineer, Port Arthur, Ont.

References: H. G. O'Leary, F. C. Graham, C. D. Howe, J. M. Fleming, P. E. Doncaster.

FRASER—WILLIAM THOMAS, of 2020 West 35th Ave., Vancouver, B.C., Born at Abercrombie Point, N.S., Oct. 11th, 1883; Educ., I.C.S., mech'l. dwg. 1902-07; 1907-10, mach. design and mech. dwg. under Prof. W. B. Hampson, Univ. of Wash.; 1908-11, mach. design and marine engine constrn. under A. K. Allan, ex-Naval Instructor, U.S. Navy, Seattle; R.P.E. of B.C.; 1902-07, machinist ap'tice; 1907-11, machinist dftsman., Northwestern Iron Works; 1911-16, salesman, and 1916 to date, manager, Vancouver Machinery Depot Ltd., and also 1927 to date, manager, Vancouver Iron Works Ltd., Vancouver, B.C.

References: G. A. Walkem, P. Sandwell, J. Robertson, E. A. Wheatley, P. H. Buchan.

GREEN—JOHN, of Vancouver, B.C., Born at Manchester, England, Dec. 6th, 1881; Educ., 1903, Manchester College of Technology; R.P.E. of B.C.; 1896-1900, ap'tice with Peter Green & Son, Engrs. and Contractors, Manchester; 1903-10, partner with same company, responsible for design and constrn. of many industrial plants; 1910, with Canadian Inspecting and Testing Labs., Montreal, as inspecting engr. at Montreal, Three Rivers, Shaw. Falls, etc.; 1911-16, res. engr. for C.P.R. during constrn. of Vancouver Hotel, Annex, Power Plant, etc.; 1916-19, Lieut., Royal Navy, in command of anti-submarine craft; 1919-20, with Hodgson, King & Marble, Engrs. and Contractors, Vancouver; 1920-23, res. supt., engrg. branch, D.S.C.R.; 1923-26, with Northern Constrn. Co. Ltd., and J. W. Stewart, Vancouver; 1927-34, chief engr. and director, Pacific Engineers, Ltd., Vancouver; At present consltg. engr., Vancouver, B.C.

References: W. H. Powell, W. O. Marble, J. Robertson, E. A. Wheatley, P. H. Buchan

HOUSTON—DAVID WATERS, of Regina, Sask., Born at Bathurst, N.B., Jan. 3rd, 1879; Educ., B.Sc., Queen's Univ., 1907; 1904 (summer), rly. location survey; 1907, inspection of mining claims, Ont. Govt.; 1914 to date, supt., street railway dept., City of Regina, in charge of all mtce. and constrn.

References: H. S. Carpenter, D. A. R. McCannel, J. W. D. Farrell, A. P. Linton.

JOHNSEN—HAGBART, of 1821 Lincoln Ave., Montreal, Que., Born at Bodo, Norway, Oct 7th, 1899; Educ., Mech. Engr., Norges Tekniske Hoskole, Norway; 1921-22, ap'tice, machine shop and shipyards, Bodo; 1928 to date, designing engr., Montreal Locomotive Works, Ltd., Montreal.

References: W. F. Drysdale, F. E. Sterns, A. Olsen, H. L. Steenbuch.

JOYCE—ALEXANDER GEORGE, of Arvida, Que., Born at Inverness, N.S., April 23rd, 1909; Educ., First year Arts. 1925-27, Private engrg. class, Inverness; 1925-27, firing and engine work, Inverness Rly. & Coal Co.; 1927 to date, steam power plant operation and mtce., and at present, chief operator, boiler plants, Aluminum Company of Canada, Arvida, Que. (Applying for admission as an Affiliate of the Institute.)

References: M. G. Saunders, J. W. Ward, A. C. Johnston, J. R. Hango.

LONGWORTHY—WARD ODELL, of 645 Winnipeg St., Regina, Sask., Born at Regina, June 18th, 1896; Educ., B.A.Sc., Univ. of Toronto, 1923; 1920-22 (summers), inspr., bridge dept., Sask. Govt. Highways; 1923-27, inspr. of power house constrn. work, H.E.P.C. of Ontario; With the Imperial Oil Refinery, Regina, as follows: 1927-28, instr'man. on new constrn ; 1928-33, inspr. of cracking coil; 1933-35, refinery foreman, and at present asst. chief engr.

References: J. N. Stanley, A. P. Linton, H. R. MacKenzie, E. A. Duschak.

LOW—DAVID DUNCAN, of 2320 Atkinson St. ,Regina, Sask., Born at Regina, July 26th, 1897; Educ., B.Sc., Univ. of Sask., 1923; With Candn. National Rlys. as follows: 1921-23, rodman, engrg. dept., 1923-24, instr'man., 1924-26, dftsman., engrg. dept., and 1927 to date, instr'man.

References: P. C. Perry, A. M. Macgillivray, C. J. Mackenzie, D. A. R. McCannel, J. J. White.

LUKE—EDWARD CORBUS, of Squamish, B.C., Born at Chicago, Ill., Oct. 29th, 1903; Educ., Grad. R.M.C., 1924. R.P.E. of B.C., Passed Final Exams. Civil Assn. Prof. Engrs. B.C., 1932, later obtaining struct'l. licence also; 1924-25, dftsman., C.N.R., Montreal; 1925-28, engaged as officer, R.C.A.F., and later in commercial aviation; 1928-29, dftsman., Northern Constrn. Co., Vancouver; 1929-30, dftsman and designer, L. T. Alden, Consltg. Engr., Stuart Cameron & Co., B.C. Elec. Rly. Co., Vancouver; 1930 to date, chief dftsman. and asst. to mtce. of way engr., Pacific Great Eastern Rly., Squamish, B.C.

References: E. A. Wheatley, J. Robertson, H. N. Macpherson, G. M. Gilbert, A. S. Wootton, J. P. Mackenzie, P. Sandwell, P. H. Buchan, E. C. Thrupp.

MACKENZIE—DANIEL CAMPBELL, of Wingdam, B.C., Born at Wishaw, Lanarkshire, Scotland, April 9th, 1880; Educ., Diploma, Hamilton Technical School (Scotland), 1902; First Class Colliery Manager's Cert., Edinburgh, 1902; Member, Inst. Mining and Metal. (London); R.P.E. of B.C.; 1902-06, asst. gen. mgr. and surveyor; 1907-23 (except 1915-19, overseas, Lieut., Royal Engrs.), Govt. Inspector of Mines and Machy., Dept. of Mines, Victoria, Australia; 1922-23, gen. mgr. Coorahin Coalfields, N.S.W. (loaned from Mines Dept.); 1924-26, gen. mgr., Catamaran Collieries, Tasmania; 1926-34, consltg. mining and industrial engr, Victoria, Australia; 1934 to date, gen. mgr. and technical adviser, Consolidated Gold Alluvials of B.C. Ltd., Wingdam, B.C.
References: J. Robertson, P. H. Buchan, E. A. Wheatley, A. S. Wootton, H. N. Macpherson.

MACKENZIE—JOHN ALEXANDER, of Vancouver, B.C., Born at Kincardine, Ont., Jan. 28th, 1881; Educ., Grad. S.P.S. Univ. of Toronto, 1906; R.P.E. of B.C.; 1906-07, engrg. staff, Coniagas Mine; 1907-08, mgr., Nipissing Reduction Co.; 1908-11, res. engr., C.P.R.; 1911, engr., Foundation Co., Montreal; 1911-21, private practice, Vancouver; 1921-25, C.P.R., Dept. of Natural Resources; 1926, rly. location, Wardner, B.C.; 1926-29, private practice; 1930, engr., Can. Nat. Docks, Victoria, B.C.; 1931, Quatsino Gold Co.; 1933, engr., Prem. Border Mines; 1935, supt., Congress Gold Mines; 1935, supt., Pilot Gold Mines; At present, mgr., Minto Gold Mines.
References: E. A. Wheatley, J. Robertson, H. N. Macpherson, P. H. Buchan, A. S. Wootton.

MATHESON—MURRAY ALEXANDER, of 1120 Retallack St., Regina, Sask., Born St. Peters, N.S., Sept. 30th, 1907; Educ., B.Sc. (Mech.), Univ. of Sask., 1933; With the Imperial Oil Company Ltd., Regina, as follows: 1933-34, meter mtce., 1934-35, dftsman., and at present, engr. in charge of mtce. and constrn.
References: C. J. Mackenzie, E. A. Duschak, D. A. R. McCannel, R. A. Spencer.

MOLONEY—JAMES GRANT, of 506 Chester St., London, Ont., Born at London, Ont., June 1st, 1908; Educ., B.Sc. in Civil Engrg., Tri-State College, Indiana, 1935; 1925-27, gen. dfting, etc., Erie Constrn. Co.; 1927-28, engrg. divn., Metropolitan Stores, bldg. survey, planning, constrn., supervision, reinforced concrete detailing; 1928-31, gen struct'l. dfting. and detailing, supervision of constrn., location survey work, Watt & Blackwell, Architects; 1931, property survey, etc., City Gas Co., London; 1931-32, constrn. engr., Putherbough Constrn. Co.; At present, designing, detailing, estimating, reinforced concrete, asst. to S. W. Archibald, O.L.S., M.E.I.C., London, Ont.
References: S. W. Archibald, H. A. McKay, H. L. Hayman, J. S. Mitchell, J. Ferguson.

McGUINNESS—THOMAS, of 1925 Athol St., Regina, Sask., Born at Wrexham, Wales, Dec. 21st, 1881; Educ., 1897-99, Sience and Art School, Wrexham. (Evenings); R.P.E. of Sask.; 1897-98, ap'tice, engrg. shops, Great Central Rly., and Wrexham, Mold & Connays Quay Rly.; 1902-07, with R. W. Blackwell & Co., Electr'l. Engrs., London, England, in charge of various contracts for constrn. of tramways, etc.; 1907-12, elect'l, dept., City of Winnipeg. Electrolysis inspector. In charge of all return circuits and testings, etc.; 1912-16, street railway dept., City of Regina. Gen. foreman on constrn. and mtce. of trolley wires, pole lines, overhead and underground feeders; 1916-19, overseas, Can. Rly. Troops; 1919, asst. supt., street rly. dept., and 1921 to date, asst. supt., Regina Municipal Railway.
References: L. A. Thornton, D. A. R. McCannel, A. C. Garner, J. J. White, H. R. MacKenzie, H. S. Carpenter.

O'NEILL—GEORGE WILLIAM, of Winnipeg, Man., Born at Amherst, N.S., Nov. 21st, 1898; Educ., 1914-15, extension course, N.S. Tech. Coll.; 1915-18, and 1919-21, ap'ticeship in mech. engrg., Robb Engrg. Works Ltd., Amherst, N.S.; 1918-19, overseas, C.G.A.; R.P.E. of N.S., 1925. R.P.E. of Man., 1935; Member, A.S.M.E., 1934; 1922-1934, chief dftsman., in charge of design and detail, Robb Engrg. Works, Ltd., Montreal, and Amherst N.S. Covering design and detail of steam boilers, steam engines, farm tractors, saw mill machy., highway machine and gen. machine, boiler and tank work; June 1934 to date, pricer, Manitoba Bridge & Iron Works Ltd., Winnipeg, Man.
References: H. M. White, R. R. Murray, D. W. Robb, N. S. Walsh, H. W. McKiel, E. Avery.

RICHARDS—HILARY JOHN BREWERTON, of 515 Raglan Road, Winnipeg, Man., Born at Winnipeg, Jan. 13th, 1912; Educ., B.Sc. (C.E.), Univ. of Man., 1934; Summer work; 1928, chainman, C.P.R.; 1930, rodman, 1931, gravel inspr., 1935, inspr. on asphalt hard surfacing work, Manitoba Good Roads Board; 1928-29, gravel, cement and concrete testing, National Testing Lab., Winnipeg.
References: J. N. Finlayson, G. H. Herriot, N. M. Hall, J. F. Cunningham, E. P. Fetherstonhaugh.

SMITH—WILLIAM CHESTER, of 204 Glen Rd., Toronto, Ont., Born at Strathroy, Ont., Oct. 3rd, 1886; Educ., Diploma, 1910, B.A.Sc., 1912, C.E., 1917, Univ. of Toronto; 1910-11, asst. engr., Oliver Iron Mining Co.; 1912-13, asst. city engr., Victoria, B.C.; 1913-17, engr., water rights br., Govt. of B.C.; 1917-19, chief engr, Sumas Reclamation Project for Govt. of B.C.; 1919-21, consltg. engr., Vancouver, B.C.; 1921-22, engr, car shops, Toronto Transportation Comm.; 1922-31, city engr., Oshawa, Ont.; 1931 to date, chief engr. ,and at present, mgr. engrg. divn., The Cooksville Co. Ltd., Toronto, Ont.
References: E. Viens, A. B. Crealock, H. W. Tate, T. T. Irving, A. D. LePan, A. E. Berry

SIMPSON—FREDERICK JOHN, Lieut. Col., of 236 Third Ave., New Westminster, B.C., Born at Birmingham, England, June 19th, 1889; Educ., 1903-08, articled pupil, F. Urry and Percival H. Smith, Architects and Engrs., Birmingham; R.P.E. of B.C.; 1908-09 (intermittent) asst. field work. Work on sugar refinery; 1909-10, constrn. work, Canadian Westinghouse Co., Hamilton, Ont.; 1910-14, chief dftsman and designing engr., Wilkie & Brice, New Westminster, B.C.; 1914-19, overseas, C.E.F ; 1919-20, designing engr., Sumas Reclamation Scheme. Fraser Valley; 1920-25, private practice and teaching in technical high school, New Westminster, B.C. (½ time); 1925 to date, teaching full time as head of dfting. dept., T. J. Trapp Technical High School, New Westminster, B.C.
Refetnces: J. P. Mackenzie, F. O. Mills, P. H. Buchan, E. A. Wheatley, J. McHugh, W G. Swan.

TOVEE—EDWARD HAROLD, of 301 Charlton Ave. W., Hamilton, Ont., Born at Hamilton, July 5th, 1910; Educ., B.A.Sc., Univ. of Toronto, 1934; 1935 to date engr. in charge of radio tube mfg. unit, West Plant, Canadian Westinghouse Co. Ltd., Hamilton, Ont.
References: F. W. Paulin, W. Hollingworth, G. Moes, E. A. Allcut, R. W. Angus.

VIBERG—ERNEST FREDERICK, of 5757 Cote St. Antoine Rd., Montreal, Que., Born at Bellevue, Penna., Oct. 9th, 1905; Educ., B.Sc. (Mech.), 1929, McGill Univ.; 1926-27-28 (summers), ap'tice, Ford Motor Co., Aluminum Co. of Canada. C.P.R. Angus Shops; 1929-30, sales engr., Canadian S.K.F. Co., Montreal; With Canadian Car & Foundry Co., steel casting divn., Montreal, as follows: 1930, research dept., 1931, asst. estimating engr., 1932-35, asst. and acting plant engr., Dec. 1935 to date, foreman, dry sand steel casting dept.
References: J. B. D'Aeth, C. M. McKergow, F. Newell, W. S. Atwood, J. Morse.

WATERS—WILLIAM, of 230 Angus Crescent, Regina, Sask., Born at Balbriggan, Ireland, May 6th, 1890; Educ., 1907-09, Dublin Technical School (evenings). 1907-11, articled engrg. pupil, Dublin; 1911-12, rodman on constrn., N.T.Ry.; 1912-13, rodman, topog'r., dftsman., location and constrn., C.N.R.; 1913-14, dftsman., G.T.Ry.; 1914-19, overseas, C.E.F.; With the C.N.R. as follows: 1919-28, and 1930-33, transitman on mtce., Melville, Sask. (1926, acting divn. engr.); 1928-30, res. engr. on constrn., Willowbank N.W. and Unity S.W. branches; 1933 to date, transitman, Regina, Sask.
References: P. C. Perry, A. M. Macgillivray, A. J. Sill, T. C. Main, H. M. Bailey, J. N. De Stein, J. J. White, H. R. MacKenzie.

YOUNG—WILLIAM HUGH, of Cornwall, Ont., Born at Ottawa, Ont., Feb. 16th, 1909; Educ., B.Sc. (Mech.), Queen's Univ., 1934; 1934 to date, dftsman., Howard Smith Paper Mills Ltd., Cornwall, Ont.
References: H. E. Meadd, A. L. Farnsworth, A. E. MacRae, L. T. Rutledge, L. M. Arkley.

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

ADAMS—WALTER DOUGLAS, of 63 Blythwood Rd., Toronto, Ont., Born at Saint John, N.B., Aug. 3rd, 1887; Educ., Grad., R.M.C., 1908; 1906-07-08 (summers), instr'man., city surveys., Speight & Van Nostrand, Toronto; 1909 (6 mos.), asst. engr., G.T.R., middle divn.; 1909-10, engrg. dept., Can. Buffalo Forge Co., Montreal; 1910-14, and 1919 (7 mos.) asst. engr., grade separation, works dept., City of Toronto; 1914-19, overseas. Major, M.C.; 1921-22, asst. engr., Toronto Transportation Commission; 1922 (6 mos.), asst. engr., Walter J. Francis & Co., and 1923-25, principal asst. engr. for same company; 1925-28, res. engr., Toronto waterfront viaduct, City of Toronto; 1929 (7 mos.), asst. engr., A. Bentley & Sons, contractors, Toledo, Ohio; 1929-30, supt. installn., Libby-Owens Plate Glass Co., Toledo; 1930 (3 mos.), asst. engr., Frederick B. Brown, M.E.I.C., Montreal; At present, Toronto Manager, H. E. McKeen & Co. Ltd., of Montreal, and Electric Tamper & Equipment Co of Canada, handling constrn. equipment and supplies. (*St. 1908, Jr. 1912, A.M. 1922.*)
References: H. W. McAll, J. R. W. Ambrose, A. E. K. Bunnell, N. D. Wilson, G. G. Powell, T. Taylor, D. W. Harvey.

GODSON—REGINALD GILBERT, of 28 Summerhill Gardens, Toronto, Ont., Born at Pietermaritzburg, Natal, South Africa, May 7th, 1897; Educ., 1916, School of Military Engrg., Chatham, England, Capt., Royal Engrs. 1922-24, special course, Cambridge Univ., and Sch. of Mil. Engrg., Chatham; 1916-18, Section Officer, Royal Engrs., Field Co., Instructor, Anzac Corps Schools, Hazebrouck; 1919-22, Divnl. Officer, Royal Engrs., So. Palestine and Egypt; 1924-26, Garrison Engr., Northwest Frontier Province, India, supervision of office staff, organization of labour, roadmaking, design, erection and care of bldgs., prep. of estimates and cost accting. 1926-29, half pay list, war disability, Capt., Royal Engrs.; 1926-29, detailing and designing engr., Dominion Bridge Co. Ltd., Lachine and Montreal; 1929-34, designing engr., Robb Engineering Works, Amherst, N.S. (Subsidiary of Dominion Bridge.); R.P.E. of N.S.; At present, private practice, Toronto Ont. (*A.M. 1935.*)
References: C. R. Young, J. M. Oxley, D. C. Tennant, C. S. Kane, J. F. F. Mackenzie.

GOEDIKE—FREDERICK BERTRAM, of 578A Indian Rd., Toronto, Ont., Born at Toronto, July 4th, 1878; Educ., B.Sc., Queen's Univ., 1910; 1907, instr'man., C.N.R.; 1909, timber limit surveys, Kenora; 1910, topog'r., 1911, res. engr., C.P.R. irrigation, Calgary; 1912, instr'man. and chief of party, survey, Toronto Harbour; 1912-15, res. engr., sewer dept., City of Toronto; 1915, chief of party on location, and estimator, Rapid Transit Commn.; 1915-18, res. engr., Harbour Headwall, Toronto Harbour Commn.; 1918-22, H.E.P.C. of Ontario; 1922, res. engr., tunnel sewer, City of Hamilton, Ont.; 1923-31, township engr. and commissioner of work, Township of York; 1931-33, city engr., City of Oshawa; 1933-34, consultant, Public Utilities Commission, Paris, Ont. (*St. 1910, A.M. 1913.*)
References: W. L. McFaul, W. Storrie, N. D. Wilson, E. L. Cousins, W. E. Bonn, T. Taylor, A. B. Crealock, H. A. Babcock.

HAY—ADAM, of 479 Dovercourt Road, Toronto, Ont., Born at Aberdeen, Scotland, Dec. 25th, 1883; Educ., Robert Gordon's College, Aberdeen; Ap'tice dftsman., with J. M. Henderson & Co., Engrs., Aberdeen. Course of Mech'l. Dfting. at Inst. for Royal Engrs., Chatham, England; Dftsman. with Messrs. Vickers & Maxim, London, England; 1908-11, designing dftsman., Dominion Bridge Co., Montreal; 1911, design of power house, Shawinigan Water & Power Co., Montreal; 1911-13, plant constrn. engr., Canadian Car & Foundry Co., Montreal; 1913, bridge engr., Lake Erie & Northern Rly., Brantford; 1913-16, works dept , City of Toronto, on design and in charge of inspection of Bloor St. Viaduct; 1916-18, with F. G. Engholm, A.M.E.I.C., as res. engr. on reinforced concrete structures and preparing plans for bridges; 1918 (July-Dec.), checker, Canadian Aeroplanes Ltd.; 1919 to date, with Dept. of Highways of Ontario. on design of bridges and culverts, and in 1922 promoted to present position of chief dftsman., and asst. engr. (*A.M. 1921.*)
References: T. Taylor, F. G. Engholm, R. M. Smith, A. A. Smith.

KINNEAR—CLIFFORD RUTHERFORD, of 209 Strathallan Blvd., Toronto, Ont., Born at Halifax, N.S., Jan. 26th, 1882; Educ., Kings Collegiate School, Windsor, N.S., L.C.S.; 1902-06, Halifax Electric Tramways Co.; 1907-12. Pittsburgh Railways Co., office and field engr.; 1912-21, asst. engr., Montreal Tramways Co., Montreal; 1921-29, office engr., and 1930 to date, asst. engr. of way, Toronto Transportation Commission. (*A.M. 1921.*)
Reference: W. McG. Gardner, F. H. C. Sefton, J. Grieve, D. W. Harvey, M. A. Stewart, J. B. Carswell, G. H. Cartwright, D. E. Blair.

MACPHERSON—HAROLD NOLAN, of Vancouver, B.C., Born at Carleton Place, Ont., Nov. 29th, 1889; Educ., B.A.Sc., Univ. of Toronto, 1914; R.P.E. of B.C.; 1912-14, bridge inspr., Sask. Govt.; 1915, shell inspection, Imperial Ministry of Munitions; 1920, chief engr., O'Connor Bros. Ltd., Huntingdon, Que.; 1920-23; contacted bldg. of bridges in Sask. for Sask. Govt. and C.P.R.; 1923-31, managing director, Regina Creosoting Products Co. Ltd., engr. and sales mgr., Alberta Wood Preserving Co. Ltd., Calgary. Asst. to vice-president, Canada Creosoting Co. Ltd.; 1931-35, president and manager, Permanent Timber Products Ltd., Vancouver, and at present general manager of this company and in private practice. (*A.M. 1917.*)
References: J. Robertson, A. S. Wootton, J. P. Mackenzie, E. A. Wheatley, C. T. Hamilton, G. L. Tooker.

MENGES—EDWIN A. H., of Forest Hill, Ont., Born at Baden, Ont., May 4th, 1882; Educ., 1902-05, Toronto Technical and Univ. of Toronto; 1907-10, engr., city architect's dept.; 1910-25, chief engr., Reid & Brown Structural Steel & Iron Works Ltd.; 1926 to date, chief engr., Disher Steel Construction Co. Ltd., Toronto, Ont. (*A.M. 1930.*)
References: J. Hole, F. M. Byam, A. H. Harkness, C. S. L. Hertzberg, W. E. Bonn, S. W. Hall.

MILES—EDGAR STUART, of 200 Riverside Drive, Toronto, Ont., Born at Upper Maugerville, N.B., May 10th 1883; Educ., B.A.I., Univ. of N.B., 1904; 1904-07, asst. engr., Georgian Bay Canal Survey; 1907-11, asst. res. engr., St. Andrews Lock and Dam.; 1911-14, supervising engr., Dept. Public Works, Ottawa; 1914-18, engr. for O'Brien & Doheny and Quinlan & Robertson, Section 3, Welland Canal; 1918-21, local mgr., Matane Lumber & Development Co.; 1921-29, representative of A. W. Robertson Ltd., Welland Ship Canal; 1929-35, res. mgr., Rayner Construction Ltd., tunnel divn., building Toronto waterworks tunnel; At present, engr., A. W. Robertson Ltd. (*A.M. 1911.*)
References: C. R. Coutlee, E. A. Forward, A. J. Grant, E. G. Cameron, A. U. Sanderson.

McNEICE—LEONARD GALBRAITH, of Orillia, Ont., Born at Ready, Muskoka District, May 31st, 1890; Educ., B.Sc. (C.E.), Queen's Univ., 1913; 1913-14, transitman, Algoma & Hudson Bay Rly.; 1914-16, asst., Chipman & Power, Consltg. Engrs., Toronto; 1916-31, with Town of Wallaceburg. Mgr and sec. treas., Wallaceburg Hydro Electric System, supt., waterworks, town engr., mgr. and treasurer; 1931 to date, engr., Orillia Water Light & Power Commission, Orillia, Ont. (*St. 1913, A.M. 1919.*)
References: R. L. Hearn, F. A. Gaby, J. B. McRae, W. B. Redfern, E. V. Buchanan, E. M. Proctor, R. L. Dobbin, H. R. Sills.

O'GRADY—BRIAN TERENCE, of 411 Dunsmuir St., Vancouver, B.C., Born at Madras, India, Apr. 13th, 1883; Educ., 1901-02, Royal School of Mines, London, England. 1903-04, special mining course, Rand Mines Ltd., Johannesburg; R.P.E. of B.C.; 1903-04, asst. surveyor, Jumper's Deep Mine, South Africa; 1904-06, chief sampler, Nourse Deep Mine, S.A.; 1907, ore sorter, machine-man, Drummond Mine, Cobalt, Ont.; 1908-09, asst. to engr., Hosmer Mines Ltd., Hosmer, B.C.; 1909-10, transitman, land surveying, Nor. British Columbia; 1910-13, city surveyor, Victoria, B.C.; 1914-18, overseas, Can. Engrs. Gen. Staff Officer i/c of survey of war area in Macedonia, 1916-17. M.C.; 1919-20, highway locating engr., B.C. Govt.; 1920-28, asst. res. mining engr., B.C. Govt. (reporting on mining properties for publication); 1929 to date, res. mining engr., B.C. Govt. (M.C.I.M.M.) (*A.M. 1920.*)
References: E. A. Wheatley, A. E. Foreman, J. C. MacDonald, P. H. Buchan, J. Robertson, A. S. Wootton.

RYAN—CHARLES CEDRIC, of Port Alice, B.C., Born at Sackville, N.B., May 4th, 1890; Educ., B.Sc., 1913, M.Sc., 1914, McGill Univ.; R.P.E. of B.C.; 1915-19, overseas, Capt., M.C.; 1919-24, asst. professor of mech'l. engrg., Univ. of British Columbia, Vancouver; 1924-28, mgr., Simplex Machine Co., Vancouver; 1928 to date, res. engr., B.C. Pulp & Paper Co. Ltd., Port Alice, B.C. (*St. 1913, A.M. 1924.*)
References: E. A. Wheatley, J. Robertson, H. N. Macpherson, P. H. Buchan, P. Sandwell.

SANGER—JOHN WILLIAM, of 251 Elm St., Winnipeg, Man., Born at Bristol, England, Dec. 19th, 1886; Educ., 1903-07, Faraday House, London, England; 1907-11, dist. supt., Midland Electric Power Corpn., Staffordshire, England; With City of Winnipeg Hydro-Electric System as follows: 1912-13, engr. and supt of distribution; 1915-22, power house supt.; 1922 to date, chief engr., and 1931 to date, also Commissioner, Manitoba Power Commission. (*A.M. 1921.*)
References: W. P. Brereton, E. V. Caton, J. N. Finlayson, E. P. Fetherstonhaugh, H. M. White.

SCOTT—WILLIAM ORVILLE CRAIG, of 1414 West 14th Ave., Vancouver, B.C., Born at Kenora, Ont., Aug. 13th, 1897; Educ., B.A.Sc., 1922, M.A.Sc., 1923, Univ. of B.C.; R.P.E. of B.C.; 1921-22 (summers), asst. in constrn., Coast Quarries Ltd., Granite Falls; 1923, mech'l. and sales Diesel engines, John W. Thompson & Co.; 1924-25, asst. in water works dept., and 1925-26, smoke inspr., City of Vancouver; 1927 (Jan.-Aug.), sales, Diesel engines, 1927-28, erector on Diesel unit, Scott-Foster & Co.; 1928, sales, elect'l. franchise, Canadian Utilities Ltd.; 1928-29, designing engr., Coast Quarries Ltd.; 1929-30, chief inspr., Gr. Vancouver Water District; 1927 (Sept.-Oct.), erector on Diesel unit, and 1930 (Apr.-Aug.), asst. inspr., B.C. Elec. Rly. Co.; 1930, chief inspr. on pipe line fabrication, and 1930-31, survey of supply and distribution system of Point Grey, for City of Vancouver; 1931-33, chief inspecting engr., incl. some design and appraisal equipment, Gr. Vancouver Water District; 1933, Reno Gold Mines Ltd.; 1933-34, shopwork, Dominion Bridge Co.; 1934, design and inspection, Shell Oil Co.; 1934-35, Mining Corpn. of Canada, Engineer Mine, B.C. Not employed at present. (*St. 1922, Jr. 1926, A.M. 1931.*)
References: W. H. Powell, E. A. Cleveland, R. Rome, C. Brakenridge, E. A. Wheatley, J. Robertson, A. S. Gentles, E. W. Bowness.

WADE—MARK LEIGHTON, of Kamloops, B.C., Born at San Francisco, Calif., Sept. 22nd, 1889; Educ., B.Sc. (E.E.), McGill Univ., 1912. R.P.E. of B.C.; 1913, installn. mill machy., Monarch Lumber Co., timber limit surveys, etc., 1914, erecting engr., W. Poole Dryer Co. Ltd., Vancouver, B.C.; 1915-17, municipal engr., Duncan, B.C.; 1917-18, erecting engr., Canadian Westinghouse Co., Montreal and Hamilton; 1918-19, sales engr., with same company in Winnipeg; 1919-21, private practice, Regina, Sask.; 1921-23, associated with Can. Gen. Elec. Co., Vancouver, as service engr., etc.; 1923-24, supt., generating stns., and 1924-30, gen. supt., East Kootenay Power Co. Ltd.; 1930-31, constrn. supt., Adams river site investigation, West Kootenay Power & Light Co.; 1931-34, unattached—brief engagements with munics. of Salmon Arm and Cranbrook, B.C., constrn. of waterworks, reservoir, report on proposed water power development, etc.; 1934 to date, asst. district engr., Dept. of Public Works of B.C., Kamloops, B.C. (*Jr. 1914, A.M. 1917.*)
References: E. E. Carpenter, P. Sandwell, A. L. Carruthers, R. S. Trowsdale, E. A. Wheatley, A. S. Wootton.

WALKER—JOHN, of 12 Dunlop St., Barrie, Ont., Born at Ovalle, Chile, Sept. 27th, 1881; Educ., 1897-1900, West of Scotland Tech., Glasgow; 1900-1905, Heriot Watt College, Edinburgh; 1897-1900, Caldwell's engine works, Glasgow; 1900-05, chief engr's. office, North British Rly., Scotland; 1905-08, asst. engr., United Rlys. of Havana, Cuba; 1909-11, instr'man., 1911-13, res. engr., Allandale, Ont., and 1913-26 (except 1915-18, overseas, C.E.F.), asst. engr., G.T.P.Rly.; 1926 to date, divn. engr., C.N.R., Barrie, Ont. (*A.M. 1921.*)
References: W. T. Moodie, C. H. N. Connell, M. S. Blaiklock, T. T. Irving, W. Walker.

WHITE—HARRY MANNING, of Winnipeg, Man., Born in Kent County, Ont., June 2nd, 1888; Educ., Diploma with Honours (Mech. Engrg.), Univ. of Toronto, 1910; 1909 (summer), dfting., Buffalo Carburetor Co., Detroit; 1910 (summer), dfting, Packard Motor Car. Co., Detroit; With Dominion Bridge Co. Ltd., as follows: 1910-12, dfting., Montreal; 1912-13, checking, estimating and designing struct'l. steel, Montreal; 1913-14, in charge of detail drawing office; 1914-19, designing dept., struct'l. steel bridges, bldgs., tanks, towers, etc.; 1919-23, designing engr. in charge of designing and estimating for the Winnipeg Branch of the Company; 1923 to date, chief egrg., Western Division, Dominion Bridge Co. Ltd., Winnipeg, Man. (*A.M. 1920.*)
References: G. H. Duggan, F. P. Shearwood, F. Newell, J. W. Sanger, E. V. Caton, W. P. Brereton.

FOR TRANSFER FROM THE CLASS OF JUNIOR

ARMSTRONG—ARNOLD VICTOR, of 141 Deloraine Ave., Toronto, Ont., Born at Montreal, Oct. 9th, 1901; Educ., B.Sc. (E.E.), McGill Univ., 1923; 1919-22 (summers), with Shaw. Water & Power Co., rodman, Riordon Pulp Mills, dfting office, Dominion Bridge Co., inspr. of constrn, Montreal Tramways Co.; 1923-31, engr. in production (6 mos.), and mostly in sales divn., English Electric Co. of Canada, St. Catharines and Toronto; 1932-34, illumination engr., in charge of lighting and lighting equipment and lamp sales for Ontario, for Northern Electric Co. Ltd.; 1934 to date, engr. in charge of power apparatus sales, municipal signal system sales, police radio sales, special products sales, including P.A. Systems, broadcasting station equipment, audiphones, ultra high frequency point to point transmitting and receiving systems sales for Ontario, for Northern Electric Co. Ltd. (*St. 1920, Jr. 1929.*)
References: C. V. Christie, H. A. Moore, G. Morrison, H. M. Black.

BOWEN—JOHN ALFRED CLARKE, of 70 Thirty-sixth St., Long Branch, Ont., Born at Haverford West, South Wales, Apr. 5th, 1905; Educ., B.A.Sc., Univ. of Toronto, 1935. O.L.S. Prelim. Exam. 1925; 1923-25, asst. to land surveyor; 1925-26, articled to land surveyor; 1927, chainer, leveller, transitman; 1928-29, chief of parties, flooded areas, cross-sections, topog'l. and power line surveys, and power line location; 1930, engr., power line constrn., layoutman and inspr., concrete dam constrn.; 1931, transitman, road location; 1934, chief of party, mining claim surveys; 1935, res. engr., road constrn. (Above work with Messrs. Lang & Ross, Kerry & Chace, Algoma Power Corpn., Dufferin Paving Co.) (*St. 1932, Jr. 1934.*)
References: J. G. G. Kerry, J. L. Lang, K. G. Ross, E. M. MacQuarrie, A. E. Pickering, H. W. Sutcliffe, C. R. Young, T. R. Loudon.

DUNLOP—RONALD WILLIAM, of Calgary, Alta., Born at Hamilton, Ont., Sept. 28th, 1902; Educ., B.A.Sc., Univ. of Toronto 1927; 1924-25 and 1927-29, dftsman,. and 1929 to date, mech'l. engr., mfg. dept., Imperial Oil Ltd., Calgary, Alta. (*Jr. 1928.*)
References: J. J. Hanna, H. B. LeBourveau, R. S. L. Wilson, F. J. Heuperman, J. Dow, H. H. Bell.

HARBERT—EDWARD THOMAS, of Sherbrooke, Que., Born at Toronto, Ont., May 22nd, 1901; Educ., B.Sc., McGill Univ., 1923; 1923-25, dftsman., Canadian Ingersoll Rand Co., pulp and paper dept., Sherbrooke, Que., 1925-28, sales engr., same company, pulp and paper dept., Montreal, and 1929 to date, engr., same company, Sherbrooke. Gen. engrg., including testing, estimating and supervision of constrn. of air compressors, and pulp and paper machinery. (*St. 1920, Jr. 1928.*)
References: S. R. Newton, W. J. S. Dormer, E. Winslow-Spragge, G. M. Dick, G. P. Cole.

MARTIN—FRANK JOHN ELLEN, of Saskatoon, Sask., Born at Brighton, Sussex, England, Sept. 10th, 1904; Educ., B.Sc. (C.E.), Univ. of Sask., 1928; Post-graduate work in arch'ture and arch'l. engrg., at Univ. of Wash., Seattle; 1928-31, struct'l. design and constrn. supervision of reinforced concrete and steel bldgs. (grand-stand, schools, warehouses, commercial bldgs., etc.) for F. P. Martin, Architect; 1932 to date, architect, 315 Avenue Building, Saskatoon, Sask. (*Jr. 1931.*)
References: J. J. White, W. M. Stewart, W. G. Worcester, R. A. Spencer.

MORRISON—CARSON F., of Toronto, Ont., Born at File Hills, Sask., Aug. 23rd, 1902; Educ., B.E., Univ. of Sask., 1925. M.Sc., McGill Univ., 1927; 1922-25 (summers), rodman and instr'man. Sask. Dept. Highways; Summers: 1926-27, asst. Geodetic Survey of Canada; 1928, asst., Research Council of Canada; 1929-30, dftsman., Dominion Bridge Co., Winnipeg; 1927-28, lecturer in civil engrg., Univ. of Alberta; 1928 to date, lecturer in civil engrg., Faculty of Applied Science, University of Toronto, Toronto, Ont. (*Jr. 1929.*)
References: C. R. Young C. H. Mitchell, T. R. Loudon, C. J. Mackenzie, R. S. L. Wilson.

PENNOCK—WILLIAM B., of 326 Waverley St., Ottawa, Ont., Born at Ottawa, Aug. 23rd, 1893; Educ., B.Sc., McGill Univ., 1915; 1915-18, overseas, Lieut., Can. Engrs.; 1918-20, D.S.C.R., District Vocational Officer, London and Toronto, Ont.; 1920-24, motor car agent and field representative, Gray Dort Motor Car Co.; 1924-25, dept. mgr., Canadian Fairbanks Morse Co. Ltd., Windsor, Ont.; 1925-35, mfgrs. agent and engr. contractor, heating and ventilating, power plant equipment and pumping machy., Windsor, London, and Hamilton; At present, senior mech'l engr., heating and ventilating, Dept. of National Defence, Ottawa, Ont. (*Jr, 1919.*)
References: A. J. M. Bowman, J. B. C. Keith, G. C. Storey, D. Blair, E. Schmidlin.

RIDDELL—WILLIAM FORREST, of 42 Dundurn Place, Winnipeg, Man., Born at Smiths Falls, Ont., Apr. 25th, 1897; Educ., B.Sc. (C.E.), 1924, M.Sc., 1931, Univ. of Man.; 1923-24, instr'man., C.P.R.; Summers, 1925, asst. engr., Backus Brooks Co., Kenora; 1926, dftsman.-topog'r., C.P.R.; 1930, asst. engr., Manitoba Power Co.; 1929, designer, Dom. Bridge Co., Winnipeg; 1924-25, demonstrator, 1925-29, lecturer, and 1929 to date, asst. professor, Dept. of Engrg., University of Manitoba, Winnipeg, Man. (*St. 1922, Jr. 1928.*)
References: J. N. Finlayson, G. H. Herriot, A. Campbell, J. R. Paget, J. D. Ruttan.

YOUNG—JOHN DOUGLAS, of 2162 Sherbrooke St. W., Montreal., Born at Boston, Mass., Nov. 30th, 1900; Educ., B.Sc., Queen's Univ., 1927; 1915-26, various machine shops for short periods. Diesel engine operation and hydro power stn. constrn.; 1927 to date, sales engr., Bailey Meter Co. Ltd., Montreal, Que. (*Jr. 1931.*)
References: W. G. Scott, H. G. Thompson, N. E. D. Sheppard, J. G. Hall, R. E. MacAfee.

FOR TRANSFER FROM THE CLASS OF STUDENT

ADAMS—PHILIP REGINALD, of 252 Prospect St. So., Hamilton, Ont., Born at Brantford, Ont., June 18th, 1907; Educ., 1923-25, Hamilton Technical Institute. Private study; 1925-28, ap'tice (tool-maker), 1928-32, designer, air brake engrg., 1932-34, chief ins. on ass'y. line of refrigerator units, and 1934 to date, designer, air brake engrg. dept., Canadian Westinghouse Co. Ltd. (Design of special A.B. apparatus, test equipment, tools, supervision of processing). (*St. 1929.*)
References: W. F. McLaren, L. W. Gill, J. R. Dunbar, D. W. Callander, J. C. Nash.

BILLIE—FRANK ROBERT V., of Smiths Falls, Ont., Born at Cosenza, Italy, Nov. 29th, 1903; Educ., B.Sc., McGill Univ., 1927; 1927-35, office manager, estimator and constr'n. supt. for contracting firm engaged in concrete constrn., gen. highway and rly. constrn., bridges, sewers. At present, manager and partner, constrn. firm of Chas. V. Billie & Son, Contractors, Smiths Falls, Ont. (*St. 1927.*)
References: R. M. Smith, A. A. Smith, R. DeL. French, E. Brown.

BROWN—WILLIAM BOUGHTON, of 489 King St., Peterborough, Ont., Born at Clark's Harbour, N.S., Nov. 16th, 1910; Educ., B.Sc. (E.E.), N.S. Tech. Coll., 1931; 1931-34, students test course, and Oct. 1934 to date, switchboard engrg. dept., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*St. 1931.*)
References: E. R. Shirley, T. E. Gilchrist, W. M. Cruthers, V. S. Foster, A. L. Dickieson.

BURNS—EDWARD THOMPSON, of 256 Dunn Ave., Toronto, Ont., Born at Toronto, July 11th, 1907; Educ., B.A.Sc., Univ. of Toronto, 1930; Summers: 1927-28, mtce. and constrn., Toronto Hydro-Electric System; 1929, asst. operator, H.E.P.C. of Ontario; With Canadian Gen. Elec. Co. Ltd., as follows: 1930-31, testing elect'l. equipment, 1931-32, engrg. design D.C. machines, 1932-34, cost and estimating, and at present, sales engrg., Toronto, Ont. (*St. 1930.*)
References: H. A. Morrow, B. Ottewell, W. E. Ross, A. B. Gates, W. M. Cruthers.

CURRIE—GEORGE J., of 840 Robie St., Halifax, N.S., Born at Halifax, N.S., Jan. 7th, 1907; Educ., B.Sc., N.S. Tech. Coll., 1931; Summers 1926-29, Halifax Shipyards, steel work, constrn. timekeeper, junior dftsman.; 1929, hydro-electric power investigation; 1930, res. engr. during constrn. Digby Co. Power Co.; 1931 to date, engr., Nova Scotia Light & Power Co., gen. engrg. work, including hydraulic design and investigation; laying out transmission line, right of way, constrn. engr., hydro power investigation, rate analysis, etc. (*St. 1931.*)
References: J. B. Hayes, F. R. Faulkner, W. G. Macdonald, C. A. D. Fowler, G. H. Burchill.

DODDRIDGE—PAUL WILLIAM, of Toronto, Ont., Born at Quebec, Que. June 29th, 1904; Educ., B.Sc. (E.E.), Univ. of N.B., 1928; 1923-24, rodman, chainman, timber cruiser; Summers 1925-26-27, instr'man., and head of survey party; With Can. Gen. Elec. Co. Ltd., as follows: 1928-29, test dept.; 1929-32, apparatus sales dept.; 1935, engrg. dept., and at present sales engr., apparatus sales dept., Toronto. (*St. 1928.*)

References: L. DeW. Magie, D. L. McLaren, S. E. M. Henderson, R. L. Seaborne, J. Stephens.

DRUMMOND—ROBERT, of Port Credit, Ont., Born at Glasgow, Scotland, Nov. 21st, 1903; Educ., Verdun High School. 8 years private tutoring in struct'l. engrg.; 1921-29, estimating, surveying, dfting., on constrn. work for Anglin-Norcross Ltd.; 1929-32, asst. supt. and office mgr. in constrn. of head office bldg. for Can. Bank of Commerce, Toronto, for Anglin-Norcross Ltd.; 1932 to date, asst. mgr., Anglin-Norcross Ontario Ltd., Toronto, Ont. (*St. 1922.*)

References: H. A. Bodwell, C. D. Fleming, P. N. Gross, R. Henham, J. W. Falkner.

FRASER—NORMAN INNES, Capt., R.C.E., of Regina, Sask., Born at Brockville, Ont., Apr. 20th, 1907; Educ., Grad., R.M.C., 1928. B.Sc. (Civil), McGill Univ., 1930; 1930-31, School of Military Engrg., School of Anti-Aircraft Defence, etc., England; 1928-29, Dist. Officer Mtce. and Rep., Outforts, Halifax; 1932, Inst., S.M.E., Halifax; 1932-33, camp engr., Citadel Relief Camp, Halifax; 1933 (Apr.-Nov.), Dist. Works Officer, M.D. No. 6; 1933 to date, Dist. Engr. Officer, M.D. No. 12, including supervision of all engrg. at relief projects in M.D. No. 12. (*St. 1930.*)

References: J. L. Gordon, W. S. Lawrence, J. J. White, R. H. Murray, T. G. Tyrer.

GOLD—WILLIAM JOHN, of 11208-126th St., Edmonton, Alta., Born at Vegreville, Alta., July 24th, 1906; Educ., B.Sc. (E.E.), Univ. of Alta., 1933; Summers: 1929-30, chainman and instr'man., on D.L. Surveys; 1931, rodman, City of Edmonton engrg. dept.; 1934-35, rodman on highways, Dept. of Public Works, Alta.; April 1935 (and prev. years), instructor in survey school, Univ. of Alta.; May 1935 to date, student course, Calgary Power Company Ltd., at present floorman in hydro plant, Seebe, Alta. (*St. 1933.*)

References: H. J. McLean, H. J. MacLeod, R. S. L. Wilson, H. R. Webb, H. B. Sherman.

McCANN—WILLIAM NEIL, of Swift Current, Sask., Born at Peterborough, Ont., June 16th, 1907; Educ., B.Sc. (C.E.), Univ. of Man., 1934; 1931-32, instr'man., Dept. of Northern Development, Ont. Govt.; July 1935 to date, instr'man., Dept. of Agriculture, Dominion Govt., on Water Development Committee, P.F.R.A. (*St. 1934.*)

References: B. Russell, A. W. P. Lowrie, C. J. McGavin, S. Young.

McKEEVER—JAMES LAWRENCE, of 550 Homewood Ave., Peterborough, Ont., Born at Edinburgh, Scotland, Apr. 27th, 1907; Educ., B.A.Sc. (E.E.), Univ. of B.C., 1930; 1930-31, test course, 1931-34, asst. engr. in design and development of single-phase motors, and 1935 to date, asst. engr., A.C. and D.C. machine design, Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*St. 1930.*)

References: B. L. Barns, L. DeW. Magie, R. L. Dobbin, E. R. Shirley, V. S. Foster.

McLACHLIN—HUGH FREDERICK, of 30 Gladstone Ave., Hamilton, Ont., Born at Arnprior, Ont., Nov. 8th, 1907; Educ., Grad., R.M.C., 1930; 1930, Petewawa Military Camp; 1930-33, ap'tice, test floor, drawing office, engrg. dept., and at present sales dept., Canadian Westinghouse Co. Ltd., Hamilton, Ont. (*St. 1931.*)

Reference: H. U. Hart, W. F. McLaren, J. R. Dunbar, G. W. Arnold, D. W. Callander, V. S. Thompson.

ROY—LEO, of Montreal, Que., Born at Montreal, Dec. 23rd. 1907; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1930. B.Eng., McGill Univ., 1932; 1928 (summer), Bureau of Mines, Quebec; 1929 (summer), geol. survey; 1930-33, ap'tice course, 1934-35, elect'l. and civil engr., and at present asst. engr., power sales divn., Shawinigan Water & Power Co., Montreal, Que. (*St. 1931.*)

References: A. Frigon, C. V. Christie, E. Brown, A. Duperron, O. O. Lefebvre, F. S. Keith, R. H. Mather, J. Morse.

SCHOFIELD—WILLIAM, of Cornwall, Ont., Born at Birkenhead, England, Jan. 10th, 1911; Educ., B.Eng. (Mech.), McGill Univ., 1933; Summers: 1927, line mtce. helper, Beauharnois Electric Co.; 1928-30, shop helper; 1930-33 (summers), dftsman., and 1933 to date, mtce. dftsman., Howard Smith Paper Mills Ltd., Cornwall, Ont. (*St. 1931.*)

References: H. E. Meadd, D. deC. Ross-Ross, A. L. Farnsworth, C. M. McKergow, J. K. Ashworth, C. H. Champion, A. R. Roberts.

SIMMONS—HERBERT JOHN, of 517 William St., London, Ont., Born at Kingston, Ont., Dec. 20th, 1906; Educ., B.Sc., Queen's Univ., 1931; 1931-32, instr'man., Dept. of Highways; 1933-34, foreman, constrn. work; 1934 to date, time study engr., General Steel Wares Ltd., London, Ont. (*St. 1928.*)

References: L. M. Arkley, L. T. Rutledge, R. H. Cooper, G. J. Smith, D. S. Ellis.

WALTER—JOHN, of Dundurn, Sask., Born at Madison, Sask., May 28th, 1910; Educ., B.Sc., Queen's Univ., 1933; 1935 to date, office foreman, Dundurn Camp, Dundurn, Sask. (*St. 1933.*)

References: J. J. White, C. J. L. Sanderson, J. W. D. Farrell, D. A. R. McCannel, S. Young, W. P. Wilgar, A. Macphail.

WILLIS—RALPH RICHARD, of West Bathurst, N.B., Born at Youghall, West Bathurst, N.B., June 28th, 1908; Educ., B.Sc. (C.E.), Univ. of N.B., 1931; 1929 (3 mos.), estimating and cruising for Bathurst Power & Paper Co.; 1930-32 (summers), student asst., Geol. Survey of Canada; 1933-34, asst. engr., pipe line and filter plant constrn.; 1935 (June-Oct.), asst. Geol. Survey of Canada; 1934-35, laying off new farm lots for Dept. of Lands and Mines, also private survey work; At present, land surveyor, West Bathurst, N.B. (*St. 1931.*)

References: J. V. Butterworth, J. Stephens, G. Stead, W. J. Johnston, D. Hutchison.

The Transatlantic Air Mail Service

On Thursday, December 5th, at a conference attended by representatives of the five nations—Great Britain, the United States, the Irish Free State, Canada, and Newfoundland—at Washington, tentative approval was given to the projected scheme for a Transatlantic air mail service. The Postmaster-General of the United States of America, Mr. Farley, declared that he intended to ask the funds necessary. Two alternative routes are to be used, the most favoured being the shorter northern route—London, Ireland, Newfoundland, Montreal, New York, Washington—at all of which places landing stations will be provided. The southern route, favoured originally by the American spokesmen on account of its more favourable weather conditions, is London, Paris, Lisbon, Azores, Bermuda, New York. The first experimental flights will be made between March 15th and May 15th next year, and mail cargoes are to be carried by the surveying planes. It is estimated that the value of the mail contracts will defray the entire cost of the service during the first year of operation. Pan-American Airways and Imperial Airways will be joint operators, sharing the preliminary expenses and each receiving the mail contract for one direction, westbound flights being handled by Imperial Airways. It has been decided that two radio beacons are to be anchored in the Atlantic to serve as guides to the planes.—*The Engineer.*

Errata.—The World's Airway System, by J. A. Wilson appearing on page 55 of this issue of The Journal:

Page 61—Fig. 5—"D. R. Draco" should read "D. H. Draco."

Page 64—Right-hand column, fourth paragraph, fifth line, for "manifold pressure of twenty-eight pounds" read "manifold pressure of twenty-eight inches of mercury."

The rail and structural mill of the Algoma Steel Corporation Limited, Sault Ste. Marie, Ont., recently turned out the first 12-inch I-beam to be produced in Canada.

Last March the same mill rolled the first Canadian-made 15-inch beams and channels, in April the first steel sheet piling, and in August the first centre-sill zee bars for use in the construction of railway cars.

Since production of the new sections began, sales have mounted to upwards of 5,000 gross tons. Five hundred tons of the piling sold was alloyed with copper to resist the corrosive effect of sea water.

EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada

2050 Mansfield Street, Montreal

Situations Vacant

CONTROL ENGINEER, experienced in pulp and paper problems. Duties would include investigation of problems in connection with groundwood and sulphite pulps, etc. Apply giving full particulars of experience to Box No. 1253-V.

INDUSTRIAL ENGINEER with a number of years experience in time study work and production control methods, with an abundance of tact and capable of original thinking; must be university graduate and preferably one with Bedeaux or Point system experience. The position offers ample room for advancement to the right man. Apply to Box No. 1268-V.

Situations Wanted

PURCHASING AGENT. Graduate mechanical engineer, Canadian, married, age 36, with fourteen years experience in industrial field, including design, construction and operation, eight years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on sale of surplus construction equipment. Full details on request. At present employed. Apply to Box No. 161-W.

SALES ENGINEER, S.E.I.C.; B.Sc. C.E., 1930 (Univ. N.B.), P.E.N.B. Age 28. Experience includes building inspection, structural detailing, road construction, and chemical operation. Interested in sales work on the sales staff of some manufacturing or wholesale concern. Apply to Box No. 225-W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

ENGINEER AND ACCOUNTANT, Jr.E.I.C., (Capt. Can. Engrs., reserve). Age 35, Canadian. Experienced in mechanical and civil engineering, Diploma; general office, draughting and instrument work; assistant engineer erection Royal York hotel; assistant resident engineer T. & N.O. Ry. const. Desires position in Toronto where combination of technical and business experience will be of value, as have been director and accountant last three years. Apply to Box No. 377-W.

ENGINEER, A.M.E.I.C. Age 30. Single. Employed. Civil and mining experience, capable of designing and superintending construction of timber, concrete and steel structures, rock crushing and ore plants. Would consider position with mining or engineering company designing and building mills. Apply to Box No. 431-W.

CIVIL ENGINEER, B.A.Sc. and C.E.; A.M.E.I.C., A.M. A.S.C.E., age 32, married. Experience over twelve years as assistant and resident engineer on the construction of hydro-electric, railway, and aerodrome works. Also office and teaching work on hydraulic designs and investigations, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

MECHANICAL ENGINEER, B.Sc. Age 31. Married. Last ten years includes:—Mechanical structural and reinforced concrete design in pulp and paper mills, industrial plants, hydro-electric, mine, sewers and sewage disposal plant construction. My experience also includes shop production, steam plant combustion, fuel analysing, inspecting, supervising and instrument work on industrial construction. Permanent position preferred. Apply to Box No. 521-W.

CONSTRUCTION ENGINEER, age 26, unmarried, graduate C.E. Experience includes hydro-electric, railroad, highway, and industrial plant construction, both field and office, including cost accounting, estimating, stores, layout, general engineering and supervision, as well as practical work in mechanical trades. Apply to Box No. 567-W.

MECHANICAL ENGINEER, experienced in mechanical and structural design, and plant maintenance. Apply to Box No. 571-W.

Situations Wanted

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aero-photographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

ELECTRICAL ENGINEER, McGill '31, desires permanent position in engineering field. Experience includes draughting, designing and testing of induction motors, radio supervision and test, and some construction. Available immediately. Apply to Box No. 626-W.

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office experience including general design and plant layout. Also two years general shop work including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer, estimator. Available on short notice. Apply to Box No. 676-W.

Employment Service Bureau

This bureau is maintained by The Engineering Institute of Canada for the benefit of members and organizations employing technically trained men.

An enquiry addressed to 2050 Mansfield Street, Montreal, will bring full information concerning the services offered. Details can also be obtained from Branch secretaries who are located in the larger centres throughout Canada.

Brief announcements of men available and positions vacant will be published without charge in The Engineering Journal and the Bulletin. Replies addressed in care of the required box number will be forwarded to the advertiser without delay.

An additional service also offered those who are unemployed or wish to change their positions, is the opportunity of placing their names and records on file at 2050 Mansfield Street for consideration by employers wishing to employ engineers. This is of great assistance as many employers will not advertise or wish to locate a suitable man on short notice. If desired the information contained in these records can be kept confidential.

Forms for registration purposes may be obtained from The Institute Headquarters or Branch secretaries.

ELECTRICAL AND RADIO ENGINEER, B.Sc. '30. Variously engaged on receiver development work, testing, and transformer development, under direction. More recent experience includes transmitter test room procedure and short wave beam transmission engineering. For further information apply to Box No. 680-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.Sc., Elec., '29, B.Sc., Civil '33. Age 27. Jr.E.I.C. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

Situations Wanted

MECHANICAL ENGINEER, B.Sc., '27, Jr.E.I.C. Four years maintenance of high speed Diesel engine units, 200 to 1,300 h.p. Also maintenance of d.c. and a.c. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.Sc. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER, M.Sc., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering. Read, write and talk French. Married. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

RADIO AND ELECTRICAL ENGINEER, B.Sc. '31, S.E.I.C. Age 27. Experience in installation of power and lighting equipment. Temporary operator in radio station; studio experience with part time announcing. Two summers in switchboard and installation department of telephone company, eight months on extensive survey layouts. Interested in sales work of electrical or radio equipment. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, B.Sc. '29, A.M.E.I.C. Married. One year building construction. One year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

MANAFACTURERS' REPRESENTATIVE, at present doing business with leading industrial organizations in Canada, wishes to represent manufacturers of mechanical equipment. Such work as would involve technical data, and the preparation of plans where necessary, would be handled by an engineer whose experience with outstanding firms and projects, would be valuable to those seeking representation. Apply to Box No. 764-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ. '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

PLANT ENGINEER or SUPERINTENDENT, capable of supervising all phases of industrial plant operation, graduate electrical, eleven years diversified industrial experience including test course, four years on large Quebec industrial development, on construction and operation, also six years with prominent consulting firm supervising electrical and mechanical engineering projects. Age 31, single. Apply to Box No. 795-W.

Situations Wanted

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.A.SC., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, S.E.I.C., B.SC. '32 (Univ. of N.B.). Age 25. Married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.SC. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

STRUCTURAL ENGINEER, B.A.SC., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.SC. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

SALES ENGINEER, A.M.E.I.C., graduate engineer, age 34, practical experience in the manufacture of power plant equipment, thoroughly conversant with Canadian power plant practice and equipment for the metal working industries. Available on short notice. Apply to Box No. 860-W.

CHEMICAL ENGINEER, B.SC. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

AGENCIES WANTED. Young engineer, B.A.SC. in C.E., with business and sales experiences, speaking fluent French, would consider representing a firm as agent for Montreal or the province of Quebec. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.SC., JR.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

CIVIL ENGINEER, B.SC., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

Situations Wanted

CIVIL ENGINEER, B.SC. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, S.E.I.C., B.SC., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No. 1010-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.SC. (Queen's, '14), A.M.E.I.C., Dominion Land Surveyor, 5 months special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply to Box No. 1035-W.

ENGINEER, JR.E.I.C., E.E. '29, is very interested in applying electrical methods to cement testing and research work. Apply to Box No. 1062-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.SC. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

CIVIL ENGINEER, B.SC., Sask. '30. S.E.I.C. Age 24 years. Experience in municipal engineering, including sewer and water construction, sidewalk construction, paving, storm sewer design, draughting, precise levelling, and reinforced concrete bridge construction. Unmarried. Available at once. Will go anywhere. Apply to Box No. 1115-W.

ELECTRICAL ENGINEER, B.SC.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

MECHANICAL ENGINEER, B.A.SC. (Univ. of B.C. '29); M.S. Age 27. Single. Four years experience in research work in applied mechanics and materials testing. Desires position involving analytical work in design, development or testing. Available on short notice. Apply to Box No. 1023-W.

PETROLEUM CHEMIST, B.SC. in Chem. Eng. Age 25. Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

ELECTRICAL ENGINEER, B.SC., Queen's '33. Single, age 23. Anxious to gain experience. Present experience installing small private hydro-electric plant. Location immaterial. Available at once. Apply to Box No. 1137-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

Situations Wanted

CIVIL ENGINEER, B.A.SC., S.E.I.C., age 26, single. Experience includes one year in bridge construction, plain and reinforced concrete, pneumatic caissons and surveying. Available at once. Any location. Apply to Box No. 1204-W.

PHYSICIST ENGINEER, B.Sc.Mech. (Queen's 1913), M.Sc., Ph.D.Physics (McGill 1929, '30). Experience in municipal engineering, producer gas installation and operation, university plant maintenance. Experienced teacher of college physics. Industrial and pure physical research experience. Age 42. Married. Apply to Box No. 1207-W.

MECHANICAL ENGINEER, B.SC. (Queen's Univ. '28), age 36, married, desires position of trust and responsibility. Experience includes fitting and assembly of machine tools, production, draughting, and maintenance. Five years teaching draughting and mathematics. Available on reasonable notice. Location immaterial. Apply to Box No. 1210-W.

CIVIL ENGINEER, B.A., B.A.SC., S.E.I.C., Canadian, age 27, single. Experience includes eighteen months in general building construction. Writes and speaks both French and English fluently. Available at once for any suitable position in general engineering. Apply to Box No. 1211-W.

CIVIL ENGINEER, B.SC. '34 (Univ. of N.B.), age 24. Experience includes construction and highway engineering. Desires position with contracting or manufacturing firm. Interested in design. References. Will consider any location. Apply to Box No. 1214-W.

ENGINEER, with twenty years experience in industrial, pulp and paper mill, and general engineering and design. Age 41. Last five years chief engineer of paper mill making newsprint specialties and toilet tissues. Apply to Box No. 1246-W.

ELECTRICAL ENGINEER, B.SC. '34 (Univ. of N.B.), S.E.I.C. Age 21, single. Desires any kind of electrical work. Will consider any location. Apply to Box No. 1262-W.

CIVIL ENGINEER, Univ. Toronto '33, age 24, married. One year as instrumentman with provincial department of highways. Experience in concrete and retread construction grading, culverts, etc. Also draughting, estimating and general office practice. Apply to Box No. 1265-W.

ELECTRICAL GRADUATE, S.E.I.C., B.SC. '32, M.SC. '34. Experience includes four years as part time operator and announcer for a radio broadcast station. At present employed in radio repair dept. of a large wholesale firm. Apply to Box No. 1283-W.

ELECTRICAL ENGINEER, B.SC., E.E., A.M.E.I.C. University of Manitoba '28. Age 32. Married. Experience one year power line construction, five years resident and assistant district engineer on highway construction; two years highway traffic regulation in charge of district office. Good connections in Manitoba and Saskatchewan. Excellent references. Available at once and will go anywhere. Located in Winnipeg. Apply to Box No. 1316-W.

ENGINEER AND DRAUGHTSMAN, JR.E.I.C., age 33, married. Diplomas from Mtl Tech. Inst. in R.C. and Structural Design. 11½ years experience in civil engineering, draughting and instrument work. This includes 7 years with M.L.H. & P. Cons. as field engineer on construction and maintenance of gas mains. Present location Montreal. Available at once. Apply to Box No. 1326-W.

GRADUATE ENGINEER, (McGill), in responsible charge of design, construction and operation of hydro-electric plants. Also power design and mechanical maintenance of industrial plants. Apply to Box No. 1328-W.

MECHANICAL ENGINEER, recent grad. University of Toronto, B.A.SC. in mech. engrg, 24 years old, S.E.I.C., now managing a chain store, desires engineering work. Present location So. Ontario. Location immaterial. Best of references. Apply to Box No. 1348-W.

CIVIL ENGINEER. A.M.E.I.C. Married. Age 38. Twenty years experience in organization, design and estimating, and cost accounting. Active service in France. Apply to Box No. 1367-W.

ENGINEERING PHYSICIST, B.SC., M.SC. (McGill), S.E.I.C. Age 26. Single. Summer experience power house maintenance, draughting and general work in small shop. Interested in development and research in radio or electrical work requiring more advanced theoretical training than usual electrical degree. Apply to Box. No. 1387-W.

THE ENGINEERING JOURNAL

THE JOURNAL OF THE ENGINEERING INSTITUTE OF CANADA

Published monthly at 20 0 Mansfeld Street, Montreal, by The Engineering Institute of Canada, Incorporated in 1887 as The Canadian Society of Civil Engineers.

Entered at the Post Office, Montreal, as Second Class Matter.

"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."

March, 1936 — Volume XIX, No. 3

CONTENTS

Price 50 cents a copy, $3.00 a year, in Canada, British Possessions, United States and Mexico. $4.50 a year in Foreign Countries. To Members and Affiliates, 25 cents a copy, $2.00 a year.

Published Monthly at 2050 Mansfield St., Montreal

THE ENGINEERING INSTITUTE OF CANADA

Incorporated in 1887 as The Canadian Society of Civil Engineers

BRANCHES:

Halifax Branch, Halifax, N.S.
Cape Breton Branch, Sydney, Cape Breton.
Moncton, Branch, Moncton, N.B.
Saint John Branch, Saint John, N.B.
Saguenay Branch, Kenogami, Que.
Quebec Branch, Quebec, Que.
St. Maurice Valley Branch, Three Rivers, Que.
Montreal Branch, Montreal, Que.
Ottawa Branch, Ottawa, Ont.
Kingston Branch, Kingston, Ont.
Peterborough Branch, Peterborough, Ont.
Toronto Branch, Toronto, Ont.
Hamilton Branch, Hamilton, Ont.
Niagara Peninsula Branch, Niagara Falls, Ont.
London Branch, London, Ont.
Border Cities Branch, Windsor, Ont.
Sault Ste. Marie Branch, Sault Ste. Marie, Ont.
Lakehead Branch, Port Arthur, Ont.
Winnipeg Branch, Winnipeg, Man.
Saskatchewan Branch, Regina, Sask.
Lethbridge Branch, Lethbridge, Alta.
Edmonton Branch, Edmonton, Alta.
Calgary Branch, Calgary, Alta.
Vancouver Branch, Vancouver, B.C.
Victoria Branch, Victoria, B.C.

Members of Council 1936

PRESIDENT
E. A. CLEVELAND, Vancouver, B.C.

VICE-PRESIDENTS

*E. V. CATON, Winnipeg, Man.
†R. L. DOBBIN, Peterborough, Ont.
†H. W. McKIEL, Sackville, N.B.
†A. B. NORMANDIN, Quebec, Que.
*P. L. PRATLEY, Montreal, Que.

PAST-PRESIDENTS

F. A. GABY, Montreal, Que.
O. O. LEFEBVRE, Montreal, Que
F. P. SHEARWOOD, Montreal, Que.

COUNCILLORS

*C. G. R. ARMSTRONG, Windsor, Ont.
†Y. C. BARRINGTON, Sydney Mines, N.S.
*C. B. BROWN, Montreal, Que.
†G. S BROWN, Lethbridge, Alta.
*G. H. BURBIDGE, Port Arthur, Ont.
†H. CIMON, Quebec, Que.
*A. COUSINEAU, Montreal, Que.
†A. B CREALOCK, Toronto, Ont.
†T. H. DICKSON, Moncton, N.B.
†A. FRIGON, Montreal, Que.
†A. B. GATES, Peterborough, Ont.
*For 1936

*L. F. GOODWIN, Kingston, Ont.
*B. GRANDMONT, Three Rivers, Que.
†A. K. HAY, Ottawa, Ont.
‡F. S B. HEWARD, Montreal, Que.
*G. H. KIRBY, Riverbend, Que.
*H. S. JOHNSTON, Halifax, N.S.
†T. C. MAIN, Winnipeg, Man.
†E. P. MUNTZ, Hamilton, Ont.
†E. P. MURPHY, Port Colborne, Ont.
†H. J. McLEAN, Calgary, Alta.
‡F. NEWELL, Montreal, Que.
†For 1936-37

†E. A. RYAN, Montreal, Que.
†F. SMALLWOOD, Sault Ste Marie, Ont.
*R. E. SMYTHE, Toronto, Ont.
*E. W. STEDMAN, Ottawa, Ont.
†H. L. SWAN, Victoria, B.C.
*J. A. VANCE, Woodstock, Ont.
*G. A. VANDERVOORT, Saint John, N B.
*H. R. WEBB, Edmonton, Alta.
*A. S. WOOTTON, Vancouver, B C.
*S YOUNG, Regina, Sask.
‡For 1936-37-38

TREASURER
J. B. CHALLIES, Montreal, Que.

SECRETARY
R. J. DURLEY, Montreal, Que.

OFFICERS OF BRANCHES

HALIFAX
- *Chairman,* C. S. BENNETT
- *Vice-Chair.,* C. SCRYMGEOUR
- *Sec.-Treas.,* R. R. MURRAY, 87 Cambridge St., Halifax, N.S.
- *Executive,* J. R. KAYE, I. P. MACNAB, J. D. FRASER, J. F. F. MACKENZIE, W. H. NOONAN, J. W. McLEOD, J. B. HAYES
- *(Ex-Officio)* H. FELLOWS, H. S. JOHNSTON

CAPE BRETON
- *Chairman,* W. E. BOWN
- *Sec.-Treas.,* SYDNEY C. MIFFLEN, 60 Whitney Ave., Sydney, N.S.
- *Executive,* M. R. CHAPPELL, W. S. WILSON, C. M. ANSON, W. E. CLARKE
- *(Ex-Officio)* Y. C. BARRINGTON

SAINT JOHN
- *Chairman,* V. S. CHESNUT
- *Vice-Chair.,* J. R. FREEMAN
- *Sec.-Treas.,* F. A. PATRIQUEN, 19 Horsfield St., Saint John, N.B.
- *Executive,* S. HOGG, C. S. MACLEAN, G. H. THURBER
- *(Ex-Officio)* E. J. OWENS, G. A. VANDERVOORT

MONCTON
- *Chairman,* H. B. TITUS
- *Vice-Chair.,* G. L. DICKSON
- *Sec.-Trans.,* V. C. BLACKETT, Engrg. Dept., C.N.R., Moncton, N.B.
- *Executive,* F. O. CONDON, JAS. PULLAR, T. H. DICKSON, C. S. G. ROGERS, A. S. GUNN, G. C. TORRENS
- *(Ex-Officio)* H. W. McKIEL, J. G. MACKINNON

SAGUENAY
- *Chairman,* J. SHANLY
- *Vice-Chair.,* S. J. FISHER
- *Sec.-Treas.,* L. R. BEATH, P.O. Box 211, Kenogami, Que.
- *Executive,* W. L. YACK, E. LAVOIE, H. B. PELLETIER, M. G. SAUNDERS
- *(Ex-Officio)* G. E. LAMOTHE, J. W. WARD, G. H. KIRBY

QUEBEC
- *Hon. Chair.,* A. R. DECARY
- *Chairman,* ALEX. LARIVIERE
- *Vice-Chair.,* J. T. F. KING
- *Sec.-Treas.,* J. JOYAL, Quebec Public Service Comm., Court House, Quebec, Que.
- *Executive,* R. B. McDUNNOUGH, L. P. METHE, L. BEAUDRY, A. G. SABOURIN, J. G. O'DONNELL, A. ROBERGE
- *(Ex-Officio)* A. B. NORMANDIN, HECTOR CIMON

ST. MAURICE VALLEY
- *Chairman,* B. GRANDMONT
- *Vice-Chair.,* J. E. FLEURY
- *Sec.-Treas.,* J. A. HAMEL, 642 Notre Dame St., Three Rivers, Que.
- *Executive,* F. W. BRADSHAW, C. L. ARCAND, H. J. WARD

MONTREAL
- *Chairman,* J. B. D'AETH
- *Vice-Chair.,* H. MASSUE
- *Sec.-Treas.,* C. K. McLEOD, 1440 St. Catherine St. W., Montreal, Que.
- *Executive,* R. H. FINDLAY, C. C. LINDSAY, B. R. PERRY, T. C. THOMPSON, J. A. LALONDE, J. A. E. GOHIER
- *(Ex-Officio)* F. S. B. HEWARD, A. COUSINEAU, C. B. BROWN, F. A. GABY, O. O. LEFEBVRE, P. L. PRATLEY, F. NEWELL, E. A. RYAN, F. P. SHEARWOOD, A. FRIGON

OTTAWA
- *Chairman,* E. VIENS
- *Sec.-Treas.,* F. C. C. LYNCH, Dept. of Mines, Victoria Memorial Museum, Ottawa, Ont.
- *Executive,* E. M. DENNIS, T. A. McELHANNEY, N. B. MACROSTIE, G R TURNER, B. F. HAANEL
- *(Ex-Officio)* E. W. STEDMAN, R. W. BOYLE, A. K. HAY

PETERBOROUGH
- *Chairman,* A. L. DICKIESON
- *Sec.-Treas.,* W. T. FANJOY, 223 Crescent St., Peterborough, Ont.
- *Executive,* V. R. CURRIE, A. L. KILLALY, E. J. DAVIES, E. R. SHIRLEY
- *(Ex-Officio)* J. W. PIERCE, H. R. SILLS, R. L. DOBBIN, A. B GATES

KINGSTON
- *Chairman,* R. A. LOW
- *Vice-Chair.,* Lt.-Col. N. C. SHERMAN
- *Sec.-Treas.,* Major L. F. GRANT, Royal Military College, Kingston, Ont.
- *Executive,* G. G. CARR-HARRIS, S. STEPHENSON, J. E. GOODMAN
- *(Ex-Officio)* W. CASEY, L. F. GOODWIN

TORONTO
- *Chairman,* W. E. BONN
- *Vice-Chair.,* O. HOLDEN
- *Sec.-Treas.,* W. S. WILSON, Mining Bldg., University of Toronto, Toronto, Ont.
- *Executive,* N. MACNICOL, W. G. CHACE, A. M. REID, J. M. OXLEY, C. E. SISSON, A. U. SANDERSON
- *(Ex-Officio)* R. E. SMYTHE, A. B. CREALOCK

HAMILTON
- *Chairman,* W. HOLLINGWORTH
- *Vice-Chair.,* E. G. MACKAY
- *Sec.-Treas.,* A. LOVE, 40 Paisley Ave. S., Hamilton, Ont.
- *Executive,* W. J. W. REID, A. R. HANNAFORD, V. S. THOMPSON, D. W. CALLANDER
- *(Ex-Officio)* E. P. MUNTZ

LONDON
- *Chairman,* JAS. FERGUSON
- *Vice-Chair.,* A. O. WOLFF
- *Sec.-Treas.,* D. S. SCRYMGEOUR, London Structural Steel Co. Ltd., London, Ont.
- *Executive,* E. V. BUCHANAN, W. C. MILLER, H. A. BRAZIER, H. A. McKAY
- *(Ex-Officio)* S. W. ARCHIBALD, S. G. JOHRE, J. A. VANCE

NIAGARA PENINSULA
- *Chairman,* P. E. BUSS
- *Vice-Chair.,* G. H. WOOD
- *Sec.-Treas.,* P. A. DEWEY, 1224 Ontario Ave., Niagara Falls, Ont.
- *Executive,* C. G. MOON, E. P. MURPHY, C. W. WEST, C. S. BOYD, S. HAIRSINE, J. H. JACKSON, J. C. STREET, L. C. McMURTRY, H. WELLWOOD
- *(Ex-Officio)* W. R. MANOCK

BORDER CITIES
- *Chairman,* T. H. JENKINS
- *Vice-Chair.,* C. F. DAVISON,
- *Sec.-Treas.,* BOYD CANDLISH, 170 Rankin Blvd., Sandwich, Ont.
- *Executive,* E. M. KREBSER, D. T. ALEXANDER, C. G. WALTON
- *(Ex-Officio)* C. G. R. ARMSTRONG, H. J. COULTER

SAULT STE. MARIE
- *Chairman,* J. L. LANG
- *Vice-Chair.,* W. SEYMOUR
- *Sec.-Treas.,* N. C. COWIE, 15 Hearst St. Sault Ste. Marie, Ont.
- *Executive,* H O. BROWN, C. W. HOLMAN, T. FOULKES, H. W. SUTCLIFFE
- *(Ex-Officio)* F. SMALLWOOD, A. E. PICKERING

LAKEHEAD
- *Chairman,* R. J. ASKIN
- *Vice-Chair.,* F. C. GRAHAM
- *Sec.-Treas.,* G. R McLENNAN, 80 High St., North, Port Arthur, Ont.
- *Executive,* H. G. O'LEARY, K. A. DUNPHY, G. R. DUNCAN, G. ERICKSEN
- *(Ex-Officio)* G. H. BURBIDGE, GEO. P. BROPHY

WINNIPEG
- *Chairman,* G. E. COLE
- *Vice-Chair.,* A. E. MACDONALD
- *Sec.-Treas.,* J. F. CUNNINGHAM, 918 Somerset Ave., Fort Garry, Man.
- *Executive,* F. W. ALEXANDER, H. L. BRIGGS, W. D. HURST, R. W. McKINNON, W. F. RIDDELL
- *(Ex-Officio)* E. V. CATON, F. V. SEIBERT, T. C. MAIN

SASKATCHEWAN
- *Chairman,* A. P. LINTON
- *Vice-Chair.,* W. E. LOVELL
- *Sec.-Treas.,* R. J. FYFE, 618 Broder Bldg., Regina, Sask.
- *Executive,* J. W. D. FARRELL, W. E. LOVELL, H. S. CARPENTER, J. J. WHITE, S. R. MUIRHEAD, H. C. RITCHIE
- *(Ex-Officio)* R. A. SPENCER, S. YOUNG

LETHBRIDGE
- *Chairman,* W. L. McKENZIE
- *Vice-Chair.,* J. M. CAMPBELL
- *Sec.-Treas.,* E. A. LAWRENCE, 207-7th St. S., Lethbridge, Alta.
- *Executive,* G. S. BROWN, R. F. P. BOWMAN, J. HAIMES
- *(Ex-Officio)* C. S. DONALDSON, J. B. DEHART

EDMONTON
- *Chairman,* F. K. BEACH
- *Vice-Chair.,* E. STANSFIELD
- *Sec.-Treas.,* R. M. HARDY, University of Alberta, Edmonton, Alta.
- *Executive,* C. E. GARNETT, A. J. GAYFER, R. J. GIBB, H. P. KEITH, C. A. ROBB
- *(Ex-Officio)* H. R. WEBB

CALGARY
- *Chairman,* J. HADDIN
- *Vice-Chair.,* J. DOW
- *Sec.-Treas.,* JAS. McMILLAN, Calgary Power Co. Ltd., Insurance Exchange Bldg., Calgary, Alta.
- *Executive,* F. J. HEUPERMAN, H. W. TOOKER, J. R. WOOD
- *(Ex-Officio)* G. P. F. BOESE, F. M. STEEL

VANCOUVER
- *Chairman,* JAS. ROBERTSON
- *Vice-Chair.,* H. N. MACPHERSON
- *Sec.-Treas.,* T. V. BERRY, 3007-36th Ave. W., Vancouver, B.C.
- *Executive,* E. C. THRUPP, P. SANDWELL, G. L. BOOKER, J. P. MACKENZIE, P. H. BUCHAN, C. P. HAMILTON, F. O. MILLS
- *(Ex-Officio)* G. M. GILBERT, E. A. CLEVELAND, A. S. WOOTTON

VICTORIA
- *Chairman,* I. C. BARLTROP
- *Vice-Chair.,* J. C. MACDONALD
- *Sec.-Treas.,* KENNETH REID, 1336 Carnsew St., Victoria, B.C.
- *Executive,* G. M. DUNCAN, G. M. IRWIN, G. M. TRIPP, C. D. SCHULTZ
- *(Ex-Officio)* D. MACBRIDE, H. L. SWAN

THE
ENGINEERING JOURNAL

THE INSTITUTE as a body is not responsible either for the statements made or for the opinions expressed in the following pages.

VOLUME XIX | MONTREAL, MARCH, 1936 | NUMBER 3

Advance Through Adversity

An Explanation of Trends in Railway Equipment Design which have Developed through Modern Demands

L. K. Sillcox, D.Sc., M.E.I.C.,
Vice-President, The New York Air Brake Co., Watertown, N.Y.

Paper presented before the General Professional Meeting of The Engineering Institute of Canada, at Hamilton, Ontario, on February 6th, 1936.

(Abridged)

SUMMARY.—The author discusses some of the problems confronting the railways as a result of the changing aspect of transportation. The necessity for co-ordination and the utilization of the present investment leads to the consideration of the effect of traffic factors on equipment design. The topics dealt with include the adaptation of the conventional steam locomotive to meet new demands, the limitations of the internal combustion locomotive, speed possibilities as affected by balancing difficulties, equipment weight reduction, the value of streamlining, the characteristics of modern high speed trains and the problems of signalling and braking under the new conditions.

CHANGING APPROACH TO TRANSPORT PROBLEMS

From its inception, railway transport has been vitalized by a spirit which combines courage, initiative, and enterprise.

This is the atmosphere in which railway men have lived and worked. They still possess that same strong ambition and energy to forge ahead, but are confronted by a barrier, namely, the depressing forces of unequal and non-uniform treatment of transport agencies which react, almost invariably, to the disadvantage of the railways.

We had supposed it was settled that railways were the proper agencies to deal with mass transport, whether that involves the rendering of passenger service or the carrying of freight. What is startling in the world of transport today is that large groups of men have come to believe that arbitrariness, rather than lawful and orderly advance, is the means by which they must achieve their destinies. It is in this sense that transport itself is challenged. It is not easy to grasp clearly, much less put into words, the meaning of this challenge, for it touches matters which few persons, brought up to know a rational scheme of transport endeavour, have learned to discuss.

There is no doubt regarding the nature and magnitude of the task which must be faced.

Whether the railways must go on, as now, striving to retain their traffic despite the discouraging circumstances which surround them, or whether the proof of their superiority, as mass transport carriers, will attract to them the lion's share of the tonnage and passenger traffic which may be eventually divided, depends entirely upon operation of a carefully planned co-ordination which will respect, without prejudice, the capabilities of competing carriers in matters of service, convenience, reliability, and safety.

It is not as easy to make vital changes in railway operation as the layman is apt to assume. It requires co-operative effort by every section of a railway system and only those fully experienced in railway operation are in a position to visualize what is involved in, say, a demand for a reduction of four hours in a trip of one thousand miles.

According to the statements released by the Federal Co-ordinator of Transportation, the outstanding attack on railway revenues has been made by the private automobile, with the farm truck a close second. Freedom to go where he pleases and when he pleases is an outstanding desire of each of our citizens and he is reluctant to rely for transport upon any unit which offers less convenience than his own highway vehicle. Moreover, the average citizen will pay but little more than the mile by mile out-of-pocket cost of automobile operation for transportation, irrespective of the means of conveyance.

A successful transport programme embraces so many unfamiliar services, some incompatible with the physical limitations of railways, that, after all has been done to increase rail-borne traffic, there still remains the need for a rational plan for adapting other transport agencies to perform the terminal and off-line functions of which railways are incapable. The railway industry must broaden the scope of its service to become a transport industry.

The problems arising in the administration of a twenty-six billion dollar enterprise are manifold indeed. Add to this investment in the railway plant, the complement of subsidiary carriers which modern conditions require in the interest of superior service and ultimate convenience and it is not difficult to understand the delay which is suffered in the institution of a complete service on a nation-wide basis. Without losing sight of the ultimate requirement for complete co-ordination, an aim which will be the more readily realized as regulatory measures are gradually extended to direct the operations of the railways' competitors, the outstanding current motive of the railways is that of rehabilitating their plant and time-honoured operating practices.

Adaptability of Steam Locomotive

So many men of long experience in the technical and economic aspects of railway equipment express confidence in the ability of the steam locomotive to maintain its position as the chief motive power unit operating on our railways, that it may be taken as reasonably certain that, in the absence of some development of which we at present have no knowledge, the process of generating steam in locomotive boilers will continue far into the future. One important qualification must be observed, however —the future locomotive will be of a greatly improved efficiency. There is no misinterpreting the general attitude of mind among railway mechanical officers and others concerned as to the general status of the steam locomotive in its present stage of development. Confidence in it is not based upon failure to appreciate the claims of alternative forms of traction, but the steam locomotive will endure because it provides a relatively economical, reliable, and effective means of hauling traffic under widely divergent conditions, which call for an elasticity of service which the steam locomotive is admirably suited to fulfil.

In common with all steam engines, the conventional steam locomotive does that which it is called upon to do with the greatest directness and with the least multiplication of parts. To this simplicity it owes its reliability under conditions which would severely try a more complex mechanism. Through its simplicity, it has been able, in spite of a low thermal efficiency, to compete with more efficient but more complex designs, since it contributes more in overall economy than is suffered in the cost of coal consumed.

Service Limitations of Internal Combustion Locomotives

The internal combustion engine must, for economy, be operated in accordance with a code which its characteristics dictate. It must either depend upon a special transmission or work at a disadvatage whenever requirements differ appreciably from those for which it is specifically designed. It is neither easy nor economical to provide for an occasional, sustained overload. Not only are power requirements continually varying on any single run, but no two runs altogether correspond and an important consideration today is that a locomotive engine shall be competent, when required, to undertake duties other than those for which it is expressly designed. It is, in fact, this elasticity in service, so characteristic of steam locomotive practice and so essential under modern operating requirements, that constitutes the greatest obstacle to the introduction of the internal combustion engine as a factor in main line railway operation.

Locomotives, propelled by internal combustion engines, requiring carburetion of the fuel mixture prior to admission to the cylinders, could hardly be expected to supplant the steam locomotive. Such an engine may claim a higher thermal efficiency than the steam locomotive and it may largely eliminate standby losses. Among the primary disadvantages in any comparison with steam are numbered: its higher initial cost per unit of power installed, the light distillates of petroleum are relatively expensive, and an operating hazard is involved in the handling of an explosive fuel.

The Diesel engine has the distinction of offering the highest thermal efficiency which can be obtained in any practicable heat engine. This, together with the fact that the Diesel engine burns a low cost fuel, is an important element in permitting the Diesel to compete successfully with the steam locomotive in railway service.

The comparative thermal efficiencies of the Diesel-electric and steam locomotive are very prominent in switching service. Were both locomotive types operated at capacity, the overall thermal efficiency of the Diesel, including the operation of auxiliaries, ranging from twenty-one to twenty-six per cent in modern units of improved design, compares with corresponding figures of seven and eight per cent for modern steam locomotives. In switching service the margin widens still further. A steam switcher often employs no more than five per cent of its capacity and its thermal efficiency under such light load conditions, often extending over long periods of time, will not exceed two per cent, while a Diesel, designed for the same service, will operate at perhaps fifteen per cent thermal efficiency, due to its lower rated capacity and flat efficiency curve.

Once it was presented in acceptable form for railway service, the failure to more rapidly adapt the Diesel principle to railway traction was due, to some extent, to the fact that railways cannot undertake the necessary experimental work, while manufacturers have not the opportunity for experiment and trial under service conditions. Furthermore, a railway cannot consider the introduction of motive power units of any type, particularly for road service, until their reliability and satisfaction are assured. There is the added difficulty that, until radically different types of units are introduced in considerable numbers, the necessary supervising staff and well adapted maintenance equipment cannot be contemplated on a working scale.

It has not yet been found possible to produce the Diesel locomotive at a cost which will reduce, by a substantial margin, the four to one cost ratio as compared with steam, based upon equal horse power capacity. In so far as the characteristics of the engine itself are concerned or, more accurately, the characteristics of the engine and transmission unit, they afford well defined low speed zones wherein Diesel capacity is notably superior to that

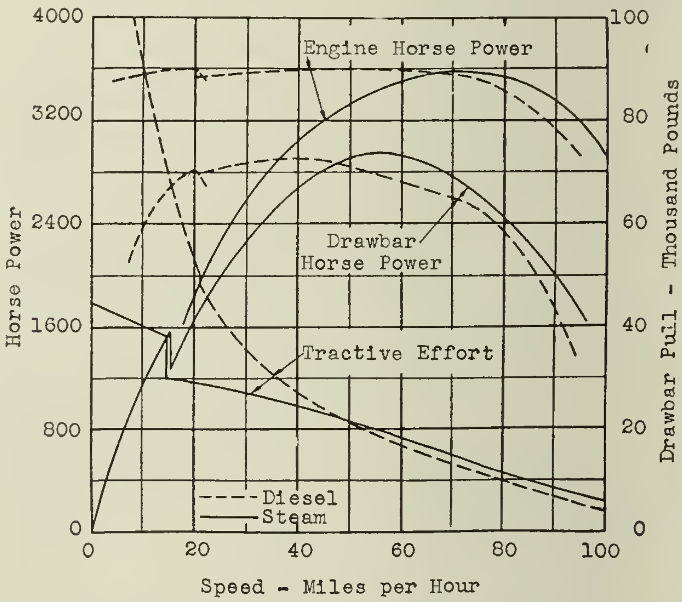


Fig. 1—Characteristic Curves of Steam and Diesel-Electric Road Locomotives.

of an equivalent steam locomotive, but this advantage can never be maintained throughout the entire speed range in which either type is capable of operating. This is illustrated in the accompanying chart, Fig. 1, which presents typical capacity curves for steam and Diesel locomotives designed for road passenger service. From the chart it is evident that, even though the steam locomotive is equipped with a trailer booster to increase the rate of acceleration at low speeds and to increase the tonnage that can be started from rest, still the Diesel-electric offers a much higher tractive capacity and its advantage is maintained at all speeds up to forty-eight miles per hour. Above that speed, however, the advantage resides with the steam locomotive.

All steam and all Diesel-electric locomotives which will deliver approximately 3,600 h.p. need not present these same relationships, however. Traction motor gear ratios and motor characteristics for the Diesel-electric may be combined in infinite combinations and steam locomotive proportions and arrangements may be varied. Such alterations would have the immediate effect of modifying the shapes of the curves and changing the margin of advantage in capacity which each enjoys through various speed ranges. One effect will be noted in every case, however—the capacity of the Diesel-electric at starting and at very low speed will exceed that of any comparable steam design. Diesel engine speed, being independent of driving wheel speed, can be readily adjusted to deliver maximum output at all times. The actual maximum starting effort is, of course, governed by traction motor and control characteristics but the real limiting factor is found in the adhesive resistance between wheels and rails.

As the normal operating speed of a locomotive is reduced in any service, the advantage of the Diesel is increased. Thus, in heavy, slow speed freight service, the Diesel might be more economically applied than if it were assigned to high speed passenger work. In relatively short transfer hauls, it is better adapted than in any road service, but it is in terminal switching with short moves and frequent acceleration cycles that it can most readily compete with steam. Two locomotives may be compared, either of which might reasonably be selected to perform light switching service, the one a 1,300 h.p. steam locomotive, the other a 600 h.p. Diesel-electric, rated at 60,000 pounds tractive effort at thirty per cent adhesion, four traction motors, one per axle, driving the forty-inch wheels through single, 4.25 to one, reduction gearing. The characteristics of these two designs are shown in Fig. 2 and are such that, as long as the speed does not exceed four miles per hour, the Diesel-electric offers a higher accelerating force and the overall time of its acceleration will be less to a speed of seven miles per hour. Consequently, when moves are short and frequent, a single, 600-h.p. Diesel-electric can often accomplish more work in a stated period than can its equivalent steam locomotive of twice the installed horse power capacity.

The road Diesel is still too new to permit presentation of cost data which might be considered representative of the type. Even the costs for 600 h.p. switching locomotives may yet be subject to revision as further service is derived from those already installed and units of modern design pass through several major repair cycles. However, data, which may be considered representative of those obtained to date, will fix hourly operating costs for the two types of switching power described above as follows:

Table No. I

Comparative Operating Costs for Steam and Diesel-Electric Switching Locomotives

	0-6-0 steam	600 h.p. Diesel-Electric
Engineman	$0.810	$0.802
Fireman	0.600	.....
Fuel	1.540	0.458
Water	0.090	.....
Lubricants	0.018	0.050
Miscellaneous	0.016	0.020
Repairs	1.015	0.500
Enginehouse expense	0.420	0.200
Total	$4.509	$2.030

These figures indicate important economies arising from the substitution of the Diesel for steam switching power and these economies can actually be realized in many cases. As evidence of this fact we need only to review the record of steam and Diesel switching power installed in recent years. Operating costs alone cannot be considered. There are the fixed charges which must be taken into account, the facilities and personnel avail-

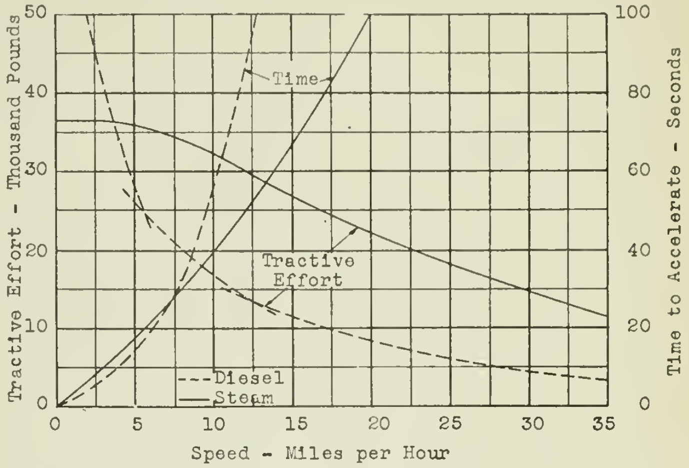


Fig. 2—Characteristic Curves of Steam and Diesel-Electric Switching Locomotives.

able for Diesel-electric maintenance, the relative costs of oil and coal for fuel, and the peculiar nature of the service. A Diesel-electric, for most economical operation, requires constant demand and uniform service functions.

With Diesel-electrics available at approximately four times the cost per horse power for which a modern steam locomotive can be purchased, the cost ratio is reduced to two to one when installed capacity can be halved. Then, when the service can be arranged to operate a minimum number of Diesel-electrics to obtain full utilization, there can be little question regarding the advisability of the replacement programme. Such situations seldom exist, however, and the analysis cannot be so easily and conclusively carried out. There are as yet no data available describing the capacity of the strictly modern steam locomotive for continuous and economical service and it is unfortunate that this is so, since analyses, which compare the average costs of selected Diesel-electric motive power, no unit of which is more than four or five years old, with costs of existing operation, conducted with steam locomotives having an average age of perhaps twenty to twenty-five years, are apt to be misleading.

No one will question the fuel economy of the Diesel. Repair costs are still debatable, although there are many who appear satisfied that the Diesel engine, the only part of the equipment for which long period costs are not available, can be kept in good condition at a cost which will display real economies over steam. Enginehouse expense may vary widely with the method of accounting. The Diesel itself can be served with very modest accommodations. If, however, a few steam units are retained, and these are burdened with the overhead costs of permanent equipment, installed and adequate to serve many times the number of steam locomotives remaining, the actual situation is distorted. While it may be argued with reason that such an allocation of charges is entirely consistent, economies expected to accrue to the operating company on the basis of such comparisons will not be realized and the final result may be disappointing. When the wages of one man can be saved by the substitution of Diesel power, the relative benefit which may be derived is improved. There is little justification for requiring a second man in the cab if it can be shown that considerations of safety do not require it.

While the trend is definitely toward the acceptance of Diesels for switching power, neither the railways nor the steam locomotive builders are yet convinced that it is necessary to suffer the high first cost of internal combustion locomotives in order to realize much of their advantage in economical operation. To provide operating characteristics similar to those of the Diesel, several jack shaft designs for steam switching locomotives have been prepared, and to permit practicable one man operation of a steam switcher, fully automatic oil burners are now offered. The manufacturers of steam locomotives are of the opinion that, specially designed for a specific assignment, a condition required for the Diesel, the steam locomotive can be constructed to offer as high a degree of availability as the internal combustion engine driven unit affords.

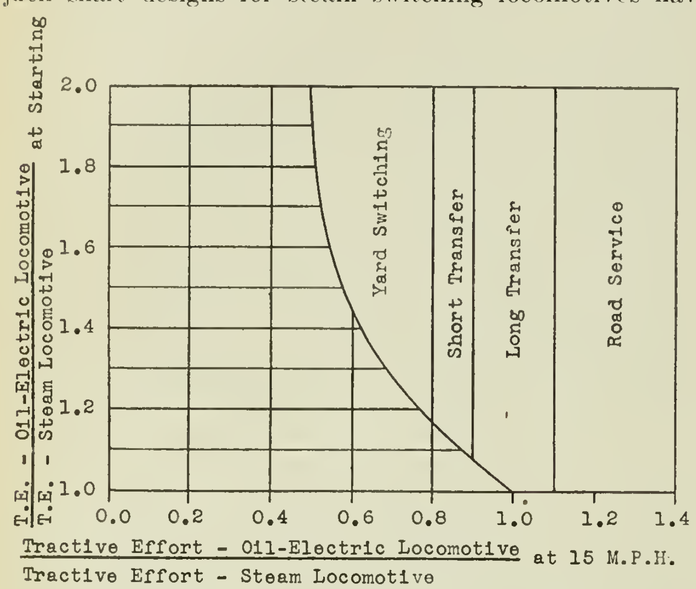


Fig. 3—Relative Tractive Effort Capacities of Steam and Oil-Electric Locomotives for Various Services.

Based upon a review of the general characteristics of a number of locomotives, both Diesel-electric and steam, the accompanying diagram, Fig. 3, was prepared and presented before the transportation group of the American Institute of Electrical Engineers about a year ago by Mr. A. H. Candee. The chart recognizes first, the high starting effort of the Diesel as well as the rapid reduction in its tractive effort as speed increases; second, the consistency in the general operating characteristics of modern locomotives, both steam and Diesel driven; and third, the requirements of the various basic railway services. The ratios of tractive effort values at zero speed are much less indicative of Diesel locomotive characteristics than are those which relate to the same values at fifteen miles per hour. As the tractive effort capacity of the Diesel (and consequently its horse power) approaches and then exceeds that of the steam locomotive, a locomotive of rapidly increasing size is suggested. Since the tractive effort of the steam locomotive is better maintained throughout any reasonable operating range, it is evident that, as the sustained speed of operation increases, so also must the tractive effort ratio increase. If, for example, a Diesel-electric locomotive is to be selected for main line service and a high average speed with infrequent stops or speed restrictions maintained, the installed horse power capacity would have to be approximately that of the steam locomotive which it would replace. Quite unusual circumstances would then probably have to obtain in order that the high initial cost of the Diesel might be justified.

The application of Diesel locomotives in main line service serves the primary purpose of affording some of the advantages of electrification with relatively low initial investment. Straight electrication permits an increase in track capacity, thus removing or postponing the necessity for installing additional tracks. It is sometimes required for compliance with city ordinances. When air rights are developed over railway trackage, the smoke of steam locomotives is not permissible. Where long tunnels or long heavy grades are encountered, there is a real advantage in electrification. One of the principal arguments for electrification in the past, that of cleanliness, has been effectively removed with the introduction of air conditioning.

There is need for a locomotive type which can move from terminal to terminal without change or intermediate attention—one that can pass over electrified territories and serve centres where steam locomotive operation is forbidden. A locomotive with electric drive can be constructed with a lower centre of gravity than a steam locomotive of similar capacity and its maximum speed on curves of given superelevation can be safely increased over that of its steam equivalent. Districts within which water or fuel is difficult and costly to obtain or where they are of inferior quality invite the Diesel. And so it is that the justification of the road Diesel invariably involves more than a comparison of its total annual costs as compared with those of alternative motive power types. Were it not for the presence of these special circumstances, the steam locomotive would suffer little competition.

Steam Locomotive Capabilities

While radical changes have not yet been witnessed in steam locomotive design, it may be safely predicted that the introduction of the Diesel in the railway field will have a stimulating effect upon refinements in steam locomotive construction. The direct-driven, turbine locomotive is being experimentally operated in England. A turbo-electric design also may be in prospect. Multi-cylinder arrangements will probably regain popularity as boiler pressures increase and valve gear arrangements are improved.

The steam locomotive has exhibited its capacity for sustained high speed running in everyday service and has surprised many railway officers who were unacquainted with its capabilities in this respect. To raise train speeds to new high levels for short distances is quite a different matter from the attempt to maintain very high speeds for prolonged periods. There has probably been no passenger locomotive type constructed in the past fifteen years which, given a suitable right of way, could not operate 300 to 500 miles regularly on a seventy miles per hour schedule if worked within its capacity and fitted to carry a sufficient quantity of fuel to relieve the necessity for frequent service stops.

When the average steam locomotive is compelled to attain speeds for which it is not designed, however, it may operate less efficiently and involve greater cost of maintenance, both with respect to the locomotive itself and the right of way, than would a similar locomotive, specially prepared. The first requirement, then, is for arrangements which will relieve locomotive maintenance costs. The second is for advanced methods of counterbalancing revolving and reciprocating weights to preserve the safety and smoothness of operation which is characteristic of slow speed services and to assist, at the same time, in holding locomotive and right of way maintenance costs at a minimum. Lastly, improved means of lubrication are essential if extended, continuous runs are to be secured with a minimum loss of power at high speed and with reliability against failed bearings.

There is a limit of speed beyond which any locomotive is unable to operate at a given cut-off without incurring a drop in boiler pressure. Before this speed is reached, cut-off must be shortened in order that speed may be increased without a corresponding increase in the demand for steam. Thus, cylinder tractive effort may be plotted as a series of similar curves with co-ordinates, tractive effort and speed, each curve corresponding to a fixed cut-off value and parallel to the speed axis except that a drop will be observed due to the transmission losses which prevail. There is a point on each cylinder tractive effort curve corresponding to the speed which may not be exceeded without taxing the boiler beyond its capacity at the selected firing rate. By joining these points on successive curves, an envelope is produced which represents the limits of maximum tractive effort obtainable for the various speeds in continuous operation. The desirability of employing the highest practicable boiler pressure and the advantage of liberal superheat are thus evident. The curves in Figs. 4 and 5 illustrate typical relationships between tractive effort, cut-off, and speed.

Between piston speeds of 300 and 1,200 feet per minute, with constant throttle opening and given cut-off, the approximate values of mean effective pressure in the cylinders of steam locomotives may be expressed by the equation:

$$p = P\,(c - bs) \quad \text{.......... (1)}$$

Where p = mean effective pressure in pounds per square inch
P = boiler pressure in pounds per square inch
c = a constant, variable with the mean effective cylinder pressure obtainable at very low speeds
b = a constant governed by characteristics of design
s = piston speed in feet per minute

Also $$IHP \text{ (per cylinder)} = \frac{p\,l\,a\,n}{33{,}000} \quad \text{.......... (2)}$$

Where IHP = indicated horse power
p = mean effective pressure, as above
l = length of stroke in feet
a = area of piston in square inches
n = number of strokes per minute

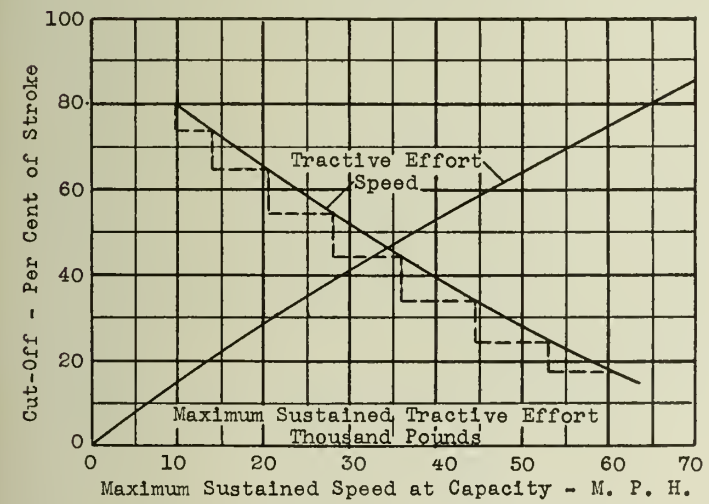


Fig. 4—Tractive Effort, Cut-Off, and Speed Relation.

Then $$IHP = \frac{(c-bs)\,P\,l\,a\,n}{33{,}000} = \frac{(c-bs)\,Psa}{33{,}000} = \frac{Pa\,(cs-bs^2)}{33{,}000}$$

and when $s = \dfrac{c}{2b}$, the value of IHP is at its maximum since

then, $$cs - bs^2 = \frac{c^2}{2b} - \frac{c^2}{4b} = \frac{c^2}{2b}(1 - 0.5) = \frac{c^2}{4b}$$

and $$IHP_{max} = \frac{Pc^2a}{132{,}000\,b} \quad \text{.......... (3)}$$

The relation between mean effective pressure and piston speed, as expressed in the above equation, is a straight line function, and there is actually a well defined relationship between the two. The method of derivation is fully shown by the curves, Figs. 6 and 7, which relate to the Pennsylvania Railroad, 4–6–2 (Pacific) type, Class K4s, passenger locomotive, the testing plant data for which are contained in P.R.R. Test Bulletin No. 29. From these test data,

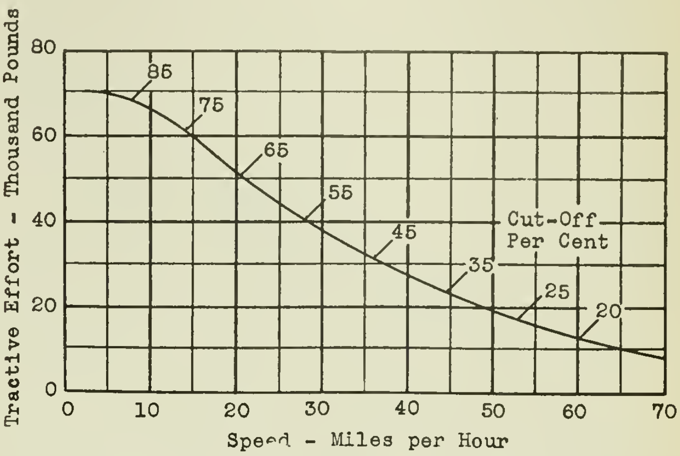


Fig. 5—Steam Locomotive Tractive Effort—Speed Relation.

covering mean effective cylinder pressures and boiler pressures at corresponding rotative speeds and at various cut-offs (all cut-offs are actual cut-offs obtained from indicator cards), the ratio of mean effective cylinder pressure to boiler pressure may be calculated and this may be plotted with the cut-off, all points pertaining to the same rotative speed being joined as shown in Fig. 6. By taking the vertical intercepts of curves on the first chart at any cut-off, and plotting these points to form a constant cut-off curve, the relation between the ratio of mean effective cylinder pressure to boiler pressure and speed is derived as shown on the second series of curves, Fig. 7. Speed may be expressed in terms of revolutions per minute of the driving wheels, in miles per hour, or in piston speed in feet per minute, as shown. By joining the points thus obtained, a very definite trend is observed and for each cut-off a straight line may be drawn to express the average relationship without appreciable error. Each of the straight lines may be expressed by the general equation,

$$\frac{p}{P} = c - bs \quad \text{.......... (4)}$$

where all symbols have the same significance as before.

The numerical values for the four straight lines thus constructed for the particular locomotives in question are listed in Table No. II:

Table No. II

Equations of Curves Showing Piston Speed — Mean Effective Pressure Relation (Fig. 7)

Cut-Off — Per Cent	p/P
50	$.655 - .000242\,s$
40	$.534 - .000184\,s$
30	$.406 - .000128\,s$
20	$.300 - .000101\,s$

From equation (3) it is observed that the maximum horse power at any given cut-off is equal to:

$$IHP_{max} = 2 \times \frac{P \times c^2 \times a}{132{,}000\,b} \text{ for a two-cylinder locomotive. . . (5)}$$

For the P.R.R., Class K4s locomotive, where
P = 205 pounds per square inch, and
A = 572.55 square inches,
equation (5) produces the values listed in Table No. III.

Table No. III

Cut-Off — Piston Speed Relation Pennsylvania Railroad Company Class K4s, Pacific Type Locomotive

Cut-Off Per Cent of Stroke	Piston Speed at which Maximum Indicated Horse Power is Produced	Maximum Indicated Horse Power
50	1352 feet per minute	3250
40	1452 feet per minute	2760
30	1585 feet per minute	2290

Such data are of importance in proportioning high

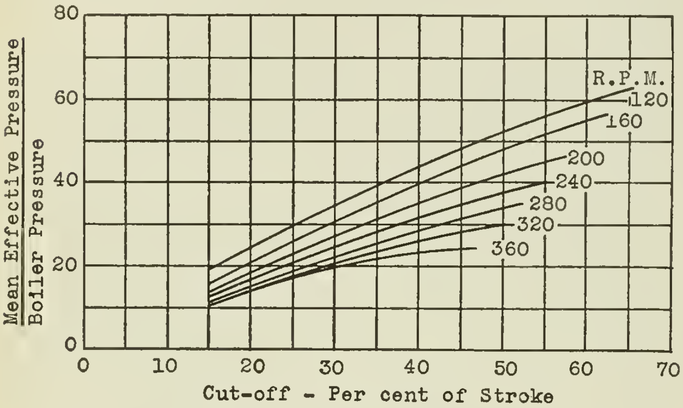


Fig. 6—Mean Effective Pressure—Cut-Off Relationship.

speed steam locomotives of conventional type to economically fulfil known minimum assignments.

After determining the piston speed at which the maximum horse power is produced, the succeeding steps are:

1. To ascertain the speed at which the maximum horse power is required to haul the train load,
2. Based upon the stroke of the cylinder, to calculate the rotative speed of the driving wheels required to produce the maximum piston speed,
3. To calculate the diameter of the driving wheels which will produce a suitable rotative speed at the locomotive speed required.

For example, if it were desired to operate the Class K4s locomotive at a speed of sixty-nine miles per hour and if the boiler would sustain a cut-off of fifty per cent at that speed, the calculated maximum piston speed would be 1,352 feet per minute. The stroke of the cylinder is twenty-eight inches; therefore the driving wheels must make:

$$1{,}352 \div \frac{2 \times 28}{12} = 290 \text{ revolutions per minute.}$$

Since the desired locomotive speed is sixty-nine miles per hour and the required rotative speed is 290 revolutions per minute, the diameter of the driving wheels will be:

$$\frac{69 \times 5{,}280 \times 12}{290 \times \pi \times 60} = 80 \text{ inches.}$$

For any given locomotive speed, there is a best cut-off to be used in conjunction with the corresponding speed of rotation from which it follows that, if a locomotive is designed for running at a definite mean speed, there must be a most suitable diameter for the driving wheels. Furthermore, if the speed is changed, so also must be the cut-off. While all locomotives have a best cut-off for any one speed of rotation, it does not always follow that the shortest cut-offs are the most economical so far as steam consumption is concerned. In fact, it seems that it is only at the higher speeds that the very short cut-offs produce low steam rates. No design expedient can be effective in producing an efficient locomotive, particularly at high speed, unless the anticipated valve performance is actually obtained. Problems of steam distribution are perplexing and there is yet much that can be accomplished in designing the mechanism for steam admission and release in high speed units.

Little is known of the effect of the variations in design as they relate to the form of ports, passages, and valves. Poppet valve gears are gradually coming into use and long lap piston valves have done much to improve steam distribution at all speeds of rotation, more especially when associated with short maximum ratios of cut-off, for then much better port openings are attained at the shortest of running cut-offs. Greatly increased valve travel with proportionately increased steam lap economically augments the cylinder power. It should be realized that an increase in valve travel, without a proportionate increase in steam lap, has no effect whatever on the short cut-off valve action, since, without increased lap, it merely adds to the over-travel of the valve in full gear and gives a later maximum cut-off. Increased travel is utilized to extend the steam lap, as a result of which, the short cut-off valve events are much improved. This is due to the wider port opening and higher valve velocity.

Test plant experimental data show that, for any given cut-off, an increase in rotational speed is accompanied by a decrease in the mean effective cylinder pressure and this drop in pressure is greater for a given increase in speed at the lower ratios of expansion than for the earlier cut-offs, while, at the shortest cut-offs, an increase in speed between quite wide limits has little influence upon mean effective pressures. That such should be the case is clear since, under the latter conditions, the volume displaced by the pistons during the period of admission is relatively small and the piston speed is at its lowest.

The result of locomotive improvement has been to elevate the tractive effort curve throughout its entire range. Larger boilers in relation to cylinder capacity have produced a divergence of the tractive effort curves for old and new locomotives as higher speeds are approached, without necessarily introducing any considerable increase in capacity at starting. In order that the modern locomotive may be capable of accelerating its train at a rate in keeping with its higher sustained speed, the locomotive booster or the auxiliary locomotive under the tender has been widely adopted, a measure which permits of a relatively high utilization of locomotive weight at starting and at low speeds, even though the percentage of locomotive weight

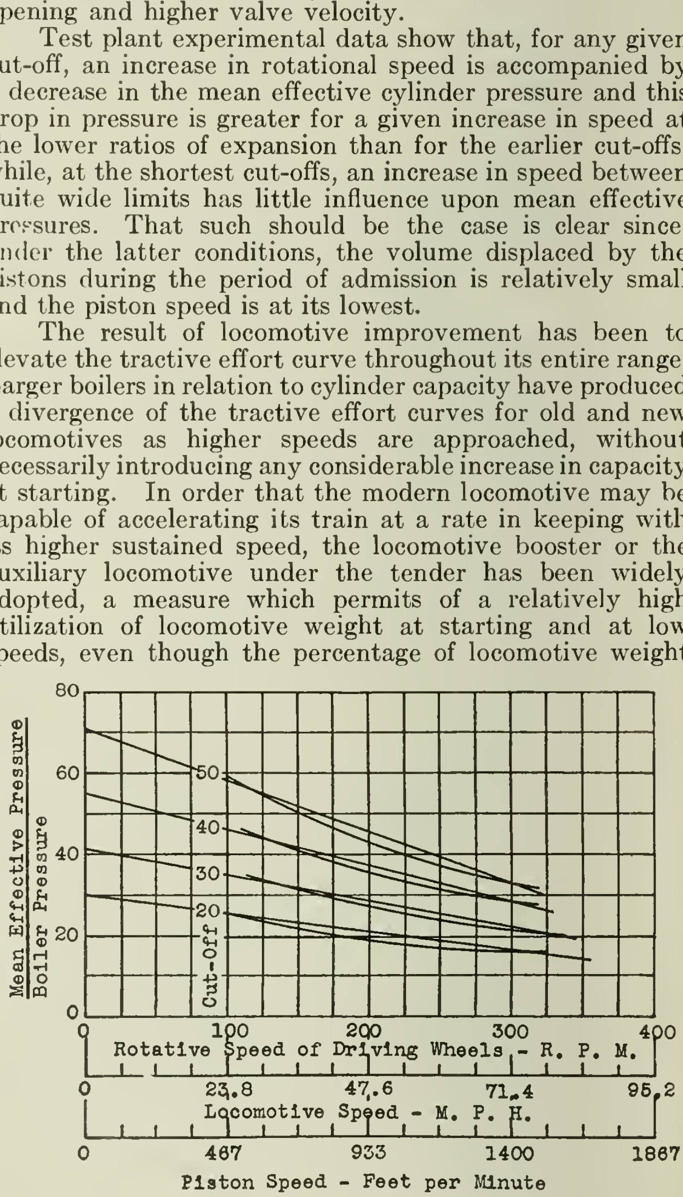


Fig. 7—Mean Effective Pressure—Speed Relationship.

on drivers has become lower as additional wheels have been added beneath the firebox.

Problems of Counterbalance

Inadequate counterbalance, especially in the main driving wheels, has been found to create severe stresses in the rails, and, under certain conditions, this additional loading exceeds one hundred per cent of the stresses produced at five miles per hour. The balance in question resolves itself into a compromise, because the designer is compelled to counterbalance the effects of reciprocating masses by means of revolving balance weights.

It must be borne in mind that the extent of balance must be limited by the fact that approximate balance of the horizontal forces creates unbalanced vertical forces and couples tending to turn the locomotive about a horizontal axis and these forces must be resisted by reactions at the rails. This wide variation in pressure between the wheel and rail gives rise to the hammer blow which is transmitted to the rails at high speeds. Since this hammer blow effect depends upon the effective centrifugal forces acting, it varies as the square of the speed and balance at high speeds becomes vitally important. If the revolving masses alone were balanced, there would remain the horizontal forces and couples due to the unbalanced reciprocating masses. This condition would be rather favourable to the permanent way, though there would be an undue variation in the effective tractive effort. On the other hand, if too large a proportion of the reciprocating masses be balanced horizontally by revolving weights which are unbalanced themselves in a vertical direction, the vertical forces introduced would be very destructive to the cross-girders of a bridge as well as to the permanent way and might prove to be dangerous, especially if the effect were sufficiently great to lift the wheels from the rails.

In ordinary cases of counterbalancing (conventional or straight balance), the balance for the revolving weights on each driving wheel is contained in the wheel itself and the reciprocating balance is divided evenly between all wheels. Then the amount of overbalance is equal on all driving wheels and the amount borne by each wheel is equal to that portion of the weight of the reciprocating parts which it is desired to balance, divided by the number of drivers. (This condition cannot be obtained when the balance applied to the main driving wheels to compensate for the revolving weights is so large as to make the proper degree of reciprocating balance on these wheels impossible to obtain. In such a case, the main driving wheel is underbalanced and all the other driving wheels are overbalanced to compensate for the condition. This is only common, however, in heavy freight locomotives which have driving wheels of relatively small diameter.)

The maximum permissible speed is specified as the speed at which the dynamic augment does not exceed a certain percentage of the static weight on the driving wheels. When the dynamic augment characteristic of any particular locomotive type is reduced, either by devising a more perfect plan of balancing or by effecting a reduction in the weight of reciprocating parts, the maximum permissible speed at the specified dynamic augment may be increased and the importance of designing reciprocating parts for minimum weight in high speed service is realized. Just to what extent a reduction in reciprocating weight will permit of higher safe speeds, or speeds equivalent to a stated dynamic augment, may be demonstrated by the following simple analysis:

$$\left(\frac{S'}{S}\right)^2 = \frac{1}{1 - C} \quad \text{.......... (6)}$$

Where S' = Maximum permissible speed at which the maximum allowable dynamic augment is reached after reduction is made in reciprocating weight.

S = Original maximum permissible speed at which the maximum allowable dynamic augment is reached.

$S' - S$ = Increase in the maximum permissible speed.

C = Percentage of reduction in dynamic augment.

Then,

$$\frac{S'}{S} = \frac{1}{\sqrt{1 - C}} \quad \text{.......... (7)}$$

$$S' = \frac{S}{\sqrt{1 - C}}$$

$$S' - S = S\left(\frac{1}{\sqrt{1 - C}} - 1\right)$$

$$\frac{S' - S}{S} = \frac{1}{\sqrt{1 - C}} - 1 \quad \text{.......... (8)}$$

or the percentage of increase in maximum permissible speed is equal to:

$$\frac{1 - \sqrt{1 - C}}{\sqrt{1 - C}}$$

Regardless of any refinements which may be introduced to modify the severity of the blows which are dealt the track by the driving wheels of a conventional steam locomotive, it can never be possible to entirely eliminate this effect so long as the reciprocating principle is maintained and the plan is carried out to balance the inertia effect of reciprocating weights. This fact has caused those familiar with the problem to recognize the advantages of the balanced wheels of electrically propelled locomotive types.

It is only in recent years that the scientific study of the movement of vehicles on the track and the forces at work between wheel and rail have received some of the attention they deserve. The complexity of the problem and the difficulty of measuring the forces involved in any particular case have been responsible for the failure to arrive at a definite appraisal of the facts. Of late, however, practical trial results have been applied to the problem. From time to time derailments have occurred for which no satisfactory explanation was heretofore forthcoming but now new avenues of approach are being followed.

Even when perfectly balanced wheels are employed, periodic lateral oscillations are set up at high speeds and may tax the capacity of the track structure, in some cases resulting in the lateral displacement of the rails and their supports. To correct this condition, attention must be given the system of spring suspension in order to increase lateral stability. The moment arm of the guiding force is of great importance since this governs the angle through which locomotive direction can deviate from the line of the rails. In other words, as the moment arm of the guiding force is increased, the magnitude of both the inertia effect, and of the force required to resist it, is increased.

Electric traction does possess some advantage over the reciprocating drive in simplifying the forces acting, although symmetrical loading upon a symmetrical wheelbase, a characteristic of the electric locomotive, is unfavourable to the elimination of lateral oscillation. In general it may be said that the reciprocating steam locomotive is the more difficult to deal with in the control of vertical wheel loading, whereas the symmetrical electric locomotive offers more trying problems in the elimination of resonant lateral oscillation. The most successful high speed electric locomotive designs have a body mounted upon articulated frames. This may be likened to two individual locomotives, which have neither symmetrical wheel arrangement nor loading, although the locomotive itself is perfectly symmetrical. Adoption of this type of construction, with proper weight distribution, carefully selected lateral resistance upon leading and trailing trucks, a suitably arranged truck centering mechanism, and a spring arrangement well adapted to the locomotive, has contributed to the attainment of favourable riding qualities.

The conventional, reciprocating steam locomotive is not readily adaptable to operation in either direction or to a symmetrical arrangement of loading and disposition of driving and idle wheels. Although some steam locomotives have been serious offenders with respect to lateral effects upon track, it has not been difficult to correct this tendency, once the cause has been discovered. In so far as the variation in vertical load is concerned, however, the steam locomotive creates a real problem, since, in addition to the effect of vertical oscillation upon its springs to vary the intensity of wheel load, there are also the vertical component of piston thrust and the centrifugal effect of unbalanced driving wheels to be considered. The latter effect, the one which predominates at high speed, is occasioned by the presence of excess balance to compensate for reciprocating weights.

No expedient can be more effective in improving the high speed operation of reciprocating steam locomotives than measures to reduce the weight of parts comprising the driving train from piston to main rod. As an illustration of what can now be accomplished in this direction by the use of improved materials for the various parts, at the same time adapting the design to take advantage of their particular properties, it was recently possible to remove one thousand pounds of weight from the driving assembly on each side of a modern passenger locomotive of conventional pattern, itself a typical example of high speed main line motive power, being frequently called upon to operate at speeds up to ninety-five miles per hour before the piston, rod, and crosshead changes were made.

Equipment Weight Reduction

It is sometimes argued that present day railway equipment is too heavy in proportion to capacity. The contention is, that, as in the automotive industry, much might be achieved by using lighter materials or welded instead of bolted and riveted connections. The haulage of unnecessary weight naturally entails waste of energy, but the term, "unnecessary," itself gives rise to further argument, for there are definite limits below which it is inadvisable, if not unsafe, to go in the construction of modern locomotives and cars. It can be shown that much can yet be done towards reducing weight without taking any such risk or interfering with stability and satisfactory operating characteristics. Higher grade steels, for instance, make possible a reduction in the weight of frame and motion details and boiler plates without sacrifice of strength.

There is little opportunity for reducing the total weight of locomotives, since good use is made of all the weight carried on driving wheels to increase the drawbar pull without wheel slipping. A four-wheel engine truck, bearing sufficient weight to make it an effective guiding unit, is essential in high speed service; the driving wheels must bear a weight which will provide the desired pull at the drawbar; the wide fireboxes of modern locomotives require the installation of wheels, smaller than any practicable driving wheel diameter, for their support. There is then no opportunity for weight economy without diminishing tractive capacity except in the axle loading of the trailing truck and the adhesive weight at this location is frequently utilized in starting by the installation of a trailing truck booster. Sometimes it is desired, in the interest of economy of operation, to increase the boiler pressure of a steam locomotive and maximum permissible rail loading prevents an increase of weight upon the driving wheels. Then special boiler materials can be used for weight reduction, with the incidental advantages of corrosion resistance and lower maintenance costs. In car construction, however, there are no minimum weight requirements for adhesion and the effect of each pound of weight saved is reflected in a lower cost for movement of the car.

Practically, it matters little whether a train is comprised of ninety-nine or one hundred cars, in so far as the cost of its operation over a mile of track is concerned. At twenty miles per hour, a car with a gross weight of fifty tons will offer approximately 240 pounds resistance on smooth, level, and tangent track. This represents about 12.8 horse power.

If the locomotive is delivering two thousand horse power, an increase in output of less than one per cent is involved. A modern steam locomotive will produce 12.8 drawbar horse power hours at an expenditure of thirty gallons of water and no more than forty pounds of coal. The water and coal consumption required to haul the single car one mile is then 12.5 pounds of water and two pounds of coal, representing a cost of a little less than one-half cent. To accomplish a saving of this order by reducing car weight rather than by limiting the number of cars hauled, would mean a reduction of one thousand pounds per car, a ratio of approximately two per cent.

An open top freight car, in the service of hauling coal, moves about 10,000 miles per year. At the above rate, a saving of one thousand pounds per car would result in an annual net economy, by requiring less locomotive fuel and water, of approximately forty-five cents. With interest and depreciation at ten per cent, this saving would justify an additional investment in the car of only four dollars and a half, and a little less than one-half cent per pound could be paid for weight saved without incurring an actual loss. In other words the weight would, of necessity, be saved through car design rather than substitution of more costly materials.

The real economy of weight reduction is introduced by a number of factors; first, cars move on level, tangent track a relatively small proportion of the total time that they are in service; second, many cars produce much more than 10,000 car miles per year; third, with standard axle journal sizes and capacity loading, each increment of weight reduction will increase car capacity an equal amount; and fourth, for a given speed and net capacity per train, lighter and less costly motive power may be employed. With reference to item three above, an increase in car capacity will have an immediate effect upon car inventory and the number of trains required to handle a given net tonnage and, indirectly, upon locomotive inventory, train operating costs, and yard expenses.

Opposing grades and curvature have an important influence in adding to the effect of deadweight of equipment upon motive power requirements. If the grade is one foot per mile, that is, one foot in 5,280 feet, or approximately 0.02 per cent, the extra pull necessary to raise each ton one foot vertically while propelling it one mile, horizontally, will be:

$$\frac{2{,}000}{5{,}280} = 0.3788 \text{ pounds.}$$

Therefore, to obtain the total resistance due to grade in pounds per ton of 2,000 pounds, the rise in feet per mile must be multiplied by 0.3788. If the grade is expressed in feet per hundred or as per cent, the resistance in pounds per ton will be:

$$\frac{2{,}000}{100} = 20 \text{ pounds per ton for each one per cent of grade.}$$

The resistance caused by curvature amounts to from seven-tenths to one pound per ton per degree of curvature, the lower figure being used with large capacity, and the higher figure with small capacity or light weight cars. A six-degree curve would therefore require an increase in tractive effort of four to six pounds per ton. The general equation for train resistance, given in Bulletin No. 43, issued by the Engineering Experiment Station, University of Illinois, is:

$$p = aW + b \qquad (9)$$

in which, p = car resistance on level, tangent track, in pounds
W = gross weight of car in tons
a and b = numerical constants which vary with the speed.

By introducing a factor to recognize the effect of grade, the equation becomes:

$$P = (a + 20\,g)\,W + b \qquad (10)$$

Where P = car resistance in pounds, on adverse grade
g = grade in per cent.

Inserting the proper values for a and b the equations may be tabulated as follows:

TABLE No. IV

Effect of Increased Speed Upon Car Resistance, Modified to Recognize the Effect of Grade

Speed — m.p.h.	Car Resistance — pounds
5	$P = (1.53 + 20\,g)\,W + 111$
10	$P = (1.63 + 20\,g)\,W + 119$
15	$P = (1.74 + 20\,g)\,W + 128$
20	$P = (1.89 + 20\,g)\,W + 139$
25	$P = (2.12 + 20\,g)\,W + 150$
30	$P = (2.34 + 20\,g)\,W + 162$
35	$P = (2.68 + 20\,g)\,W + 174$

The values of a and b in the general equations have been derived experimentally and are plotted in Fig. 8.

The values of both a and b are functions of the second degree of the speed, V, the general equations for a and b assuming the form:

$$a = A' + B'V + C'V^2$$
$$b = A'' + B''V + C''V^2$$

The calculated values of P are as follows:

TABLE No. V

Variation, with Grade and Car Weight, in Resistance offered by Freight Train Cars

Wt. of Car tons	Level	0.2 per cent	0.4 per cent	0.6 per cent	0.8 per cent	1.0 per cent	1.2 per cent	1.4 per cent
	Total Resistance of Car on Various Grades — pounds							
20	227	307	387	467	547	627	707	787
30	254	374	494	614	734	854	974	1094
40	281	441	601	761	921	1081	1241	1401
50	308	508	708	908	1108	1308	1508	1708
60	335	575	815	1055	1295	1535	1775	2015
70	362	642	922	1202	1482	1762	2042	2322

These results demonstrate the particular importance of car weight in heavy grade territory.

The annual mileage of railway car equipment varies widely with car type and service. Hopper cars are subjected to delays at the mines, they move slowly in heavily loaded trains, and lie idle on sidings and in yards while preference is given perishable merchandise and that which commands a higher rate. They are not unloaded promptly and the empty return movement is retarded in the same way. Box cars regularly operate a mileage fifty per cent greater than the average for hopper cars while tank and refrigerator cars may produce several times the mileage of box cars. The highest annual mileage obtained from any car type is found, of course, in passenger service and, as schedules have been quickened in recent years, even greater utilization of equipment has been made possible without any reduction in the turning time at terminals.

Selection of axle size to conform with car weight and capacity has been completely standardized and, since 1920, there have been six sizes, as specified by journal dimensions, offering capacities of fifteen, twenty-four, thirty-two, forty, fifty, and sixty thousand pounds per axle, respectively, and cars have been designed to make full use of this maximum permissible weight when loaded, by adjusting cubic capacity to the commodity which the car is normally expected to carry. This restriction permits economy in such coal and ore carrying cars as are filled to the limit of their cubic capacity. For instance, if it were possible to reduce the weight of a fifty-ton hopper car by 1,250 pounds, its load limit, on 5.5 by 10-inch journals, being 169,000 pounds and car weight 44,000 pounds, the net capacity could be increased ten per cent without exceeding journal capacity. This would reduce the number of cars required for the

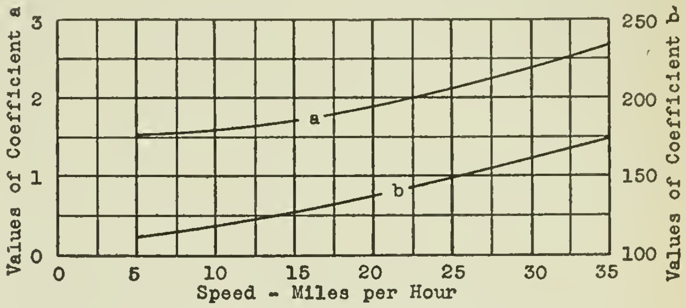


Fig. 8—Intermediate Values of *a* and *b* as Employed in Equation (9) and Table No. IV.

movement of a given net tonnage and, if trains were made up to utilize the full tonnage rating of the locomotives in every case, the number of trains would be reduced in proportion. Yard costs vary with the number of cars handled and so would be directly affected wherever these light weight, open top cars moved in great numbers. Opportunities for economies then extend beyond the fuel and water accounts to embrace crew wages, yard costs, car maintenance, and all items associated and varying with car miles or train miles.

The resistance offered by a car to motion over the track varies with car weight, not directly, since the lighter journal loads produce a higher unit resistance, but the relative rates of change are such that any weight reduction is to be earnestly sought. Only a small proportion of the total cars on our railways today are in a service which permits repeated capacity loading. Then there is no definite prospective saving to be obtained other than that in locomotive fuel. As already shown, the unit economy in fuel saving is not impressive and this must be multiplied by a high annual mileage to justify the accomplishment of weight reduction by substitution of materials of improved characteristics or by the adoption of fabrication methods which involve a higher initial cost. One would naturally look first to equipment operated in passenger service to find the place in which light weight might be most profitably employed.

Railway patrons are accustomed to progressive advance in the new equipment offered by competitive carriers and the fact that the railways operate the same cars, year after year, has been responsible, in part at least, for the prevailing attitude that the railways have reached their zenith in facilities and operating practices. If speed is to be greatly increased, the number of cars per train must be reduced and thus the earning power of the train is affected. The alternative is then to reduce train resistances and this can be done most effectively by weight reduction. Roller bearings assist to some extent, but their contribution is relatively unimportant at high speeds of operation, the real advantages of roller bearings being the lower starting resistance which they offer and the reliability of their performance when properly installed. The streamlining of trains, which will be further discussed later, can be arranged to indicate a real saving as long as the train moves directly into the wind but, with a strong beam or side wind, science has not yet shown the industry how to appreciably reduce the flange pressure and the eddy formation upon the leeward side.

Today, a Diesel road locomotive weighing 260 tons, is heavily loaded for a fast, main line run over average trackage when hauling eight, ninety-five-ton cars. Locomotives of this type have been built and they cost approximately four times as much as a steam locomotive of like horse power capacity. Weight reduction in car equipment could then be employed to increase the number of cars handled or to reduce the investment in the locomotive required for the service. In either case, important fuel savings would be realized. The Milwaukee and the New Haven have each introduced into service cars of standard size which weigh but little more than fifty tons. The Santa Fe has two experimental cars on order which, it is expected, will further reduce this weight. Air conditioned and fitted for de luxe service, a total weight on the rails of fifty-five tons may be realized.

A ninety-five-ton car, carried upon six-wheel trucks, represents an individual axle loading but little higher than that of a fifty-five-ton car on four-wheel trucks so the unit frictional resistance would be of the same order. Air resistance would be no different if the same cross sectional area were maintained in each case except that any new car would be constructed with windows as nearly flush with the car sides as practicable and some degree of shrouding would probably be practised. Modern vestibule diaphragms follow car contour more faithfully and these factors are all favourable to lower air resistance values. The same degree of locomotive streamlining is assumed in either instance. To examine the power requirements of the two trains of identical capacity thus produced, the Davis formula is employed.

$$R = 1.3 + \frac{29}{w} + 0.03\,V + \frac{KAV^2}{wn} \qquad (11)$$

where R = resistance in pounds per ton
w = weight per axle
V = speed in miles per hour
A = cross sectional area in square feet
n = number of axles per car
K = constant = 0.00034 for conventional passenger cars coupled within a train.

Then, at a speed of seventy miles per hour, each ninety-five-ton car of 120 square feet cross sectional area will introduce resistance as follows:

$$R = 1.3 + \frac{29}{15.8} + (0.03 \times 70) + \frac{0.00034 \times 120 \times 4{,}900}{95}$$

$$1.3 + 1.8 + 2.1 + 21.1 = 26.3 \text{ pounds per ton,}$$

$$26.3 \times 95 = 2{,}499 \text{ pounds per car, or}$$

$$19{,}992 \text{ pounds back of the tender.}$$

For the train of light cars, assuming flush windows and shrouding to the extent that the value of K is reduced to eighty per cent of its former value,

$$R = 1.3 + \frac{29}{13.8} + (0.03 \times 70) + \frac{0.000272 \times 120 \times 4{,}900}{55}$$

$$1.3 + 2.1 + 2.1 + 29.1 = 34.6 \text{ pounds per ton,}$$

$$34.6 \times 55 = 1{,}903 \text{ pounds per car, or}$$

$$15{,}224 \text{ pounds back of the tender.}$$

In the first instance the horse power requirements would be:

$$HP = \frac{19{,}992 \times 70}{375} = 3{,}730$$

and for the light weight train:

$$HP = \frac{15{,}224 \times 70}{375} = 2{,}860$$

This would provide for a reduction in initial investment and fixed charges of approximately twenty per cent, improving the competitive position of the Diesel as compared with steam and there would likewise be an approximate twenty per cent reduction in fuel cost, irrespective of the type of motive power employed.

Modern High Speed Trains

The first trains introduced upon this continent in anticipation of sustained speeds approaching one hundred miles per hour were of novel and effective design. Nothing less would have satisfied the popular demand since a quite definite opinion had been formed as to just what appearance a high speed train should present. The contour was made to conform to that of the model which caused the least distortion to the air currents in the wind tunnel of any tested. The sides were extended downward nearly to the rails to make the train appear low. The bullet shape form served the double purpose of pleasing the public eye and utilizing the body effectively as a load carrying girder, thus reducing weight. Having gone so far in an original design for advertising purposes, the railways which first installed these trains seriously attacked train resistances by adopting every measure known to the art of car construction. The cars were articulated, reducing the number of trucks nearly one half. Roller bearings were used throughout. The truck sides and under portions of the cars were shrouded to minimize turbulence above the rails. The cross section was cut down to what was considered the practicable minimum, reducing the space allotted per passenger to approximately that afforded by bus. A Diesel engine was selected for motive power since it could be hidden away inside the streamlined body and there was no necessity for an outside driving mechanism, requiring ready accessibility for inspection, adjustment, lubrication, and repair. The lower centre of gravity obtainable was also desirable.

There can be no question as to the operating economy of trains of this type. The installed power capacity is no more than one-third that of a steam locomotive of the type which would be placed at the head of a conventional passenger train offering the same accommodations. The following cost data have been offered by one railway which is operating a light weight, articulated, Diesel-electric, three-car train, submitting actual recorded costs for comparison with equivalent cost items as they relate to service with a five-car, conventional train with steam locomotive.

Table No. VI

Comparative Costs per Train Mile: Three-Car, Diesel-Electric Versus Five-Car, Conventional Train with Steam Locomotive

Account	Diesel-Electric	Steam
Maintenance:		
Steam locomotive		$0.1466
Diesel power plant	$0.0188	
Train	0.0356	0.0080
Fuel	0.0141	0.1190
Water		0.0068
Lubricants	0.0108	0.0034
Crew wages	0.1709	0.2360
Train supplies and expenses	0.0311	0.0468
Terminal charges	0.0351	0.0375
Locomotive supplies		0.0019
Enginehouse expense		0.0263
Lounge car attendant		0.0077
Total	$0.3164	$0.6400

Another railway administration, also operating a three-car train, presents a similar total cost per train mile but with a different apportionment among the several items which make up the total. For instance, power plant and train maintenance, elements of expense for which probable values are yet very imperfectly known, are assigned at twice the values given above. Crew wages are the same as is the cost of lubricants. Fuel expense is nearly twice the above figure due, at least in part, to the territory in which this train operates. Fixed charges arising from the initial investment are not included in the total, because representative figures for interest, depreciation, taxes and insurance cannot be assigned; these items are independent of the mileage operated, and any attempt to express fixed costs upon a mileage basis would be applicable only to the specific operation for which they were derived. Current depreciation rates for these new train types will undoubtedly be adjusted many times as experience is gained.

A potential high annual mileage and an operating cost half that of an equivalent steam train is an attractive outlook, particularly when it is realized that the lower costs apply to a greatly accelerated service. Furthermore, a sixty-four cent cost is a very moderate figure for the operating expense of a five-car, conventional train. Here again, fixed charges are omitted since the alternative equipment, available for substitution in the service of the high speed unit, is carried with a book value which is dependent upon the age and service of the equipment and the operating company's retirement policy.

Not long after the Union Pacific and Chicago, Burlington and Quincy Railways inaugurated their high speed services employing specially constructed, articulated trains, the Chicago and North Western announced its "400," a fast, daylight train hauled by a rebuilt steam locomotive, and still later, the Milwaukee hauled its "Hiawatha," a six-car train of welded, light weight cars, with an Atlantic type locomotive of new design. (See Fig. 11.) There is now a well equipped proving ground for the observation of modern train performance, extending from Chicago to Minneapolis and St. Paul. Comparative cost and operating figures have been published but the period of operation has been too short to lend confidence to the stated approximate results. Each of the railway administrations which has entered a train in this high speed, competitive, daylight run is pleased with the public response toward its effort and traffic results are encouraging. The "400" carried nearly 10,000 passengers per month during the first part of 1935; the Burlington's Zephyrs showed an increase in passenger traffic of 136 per cent compared with an eighteen per cent increase for the system as a whole; the Hiawatha carried an average of 21,000 passengers per month for three consecutive months.

The Chicago and North Western Railway Company, by operating its "400" with a standard steam locomotive, already twelve years old before conversion for high speed service by adapting the firebox for burning oil, raising the boiler pressure, and replacing the driving wheels with new ones of disc construction and larger diameter, has carried out its experimental work with the least initial investment and can show a high net return from the operation of the train for that reason. Whether or not a new train would be economically justified by the additional traffic which might be attracted, cannot be definitely determined but the fact remains that the Hiawatha is the better patronized. Consideration must be given the convenience of the public, particularly in the matter of time of departure, the Hiawatha probably having some advantage in this respect.

The introduction of the new series of high speed, streamlined trains was most enthusiastically received. The ultimate public reaction to the limitation in space allowed cannot yet be determined but there are many who remain of the opinion that the long distance passenger will require more commodious quarters both for day and night travel, if the trains are to receive repeated patronage. Some later designs afford more space per passenger while adhering to the general design of the earlier constructions. The experiences with articulated construction have proved its merit in relieving end shock due to interaction of coupled cars and the estimated reduced resistance of the less number of journals has been established, but the inflexibility in train consist will probably limit complete articulation to trains of short to moderate length.

The Gulf, Mobile, and Northern Railroad Company, by reason of the service which it was desired to operate, deviated from the precedent of articulated construction in order that the sleeping car which was purchased to supplement the accommodations of either of the three-car trains, could be introduced and withdrawn at will, serving first in one and then in another train unit. The latest of the Union Pacific Railroad Company's streamliners, not yet on the rails, will comprise an independent power unit or locomotive, with twin articulated car combinations whereby any two articulated cars can be switched from the train to adapt the train consist to the traffic offered and to permit withdrawal from service of a defective unit without interrupting the availability of the train as a whole.

The inauguration of new, substantially conventional, but entirely modern passenger train equipment, consisting of steam locomotive and trailing cars, could never have been as spectacular as was the initial service of the first streamlined, oil-electric trains. The railways which first installed equipment of this type have benefited greatly by the advertising value of the publicity which they received and the trains themselves have been very well patronized. Future trains of this type will not be received with the same degree of interest, and they must look to low operating costs and peculiar adaptability for their selection in preference to modern examples of steam locomotives and cars. The oil-electric drive must remain much more costly than the same capacity in a steam locomotive. Maintenance facilities must be appropriate, and the lack of such facilities and properly trained personnel has been responsible for the poor operating record of many a rail motor car or other special equipment type which has been entrusted to inexpert, and perhaps unsympathetic, hands. The economy of standardization in equipment types or maintenance operations has been repeatedly proved, and a confusion of machines, serviced by a single group, is generally unwarranted.

One established trend has been accepted by the public to the extent that all new railway passenger equipment should be designed to afford at least a superficially streamlined appearance. The development of the airplane is responsible for the public insistence upon faired contours. Acceptable design must have regard to the appearance of fitness for the work to be accomplished and the equipment employed must present an appearance which indicates ability to satisfy the requirements. This may be evidenced

Fig. 9—New York Central Hudson Type Streamlined Steam Locomotive.

by car side sheets which are extended below the side sills to conceal the under structure, flush windows, flush diaphragms, concealed steps, rounded top, or merely an artful combination of body colouring and trim. When streamlining is demanded, the designers of railway equipment must adapt their plans to respect this urge—and to do so economically.

Practically, the streamlining of railway equipment, particularly of trains having a high ratio of length to cross section, is of relatively little consequence. There are yet few trains operating over long distances within a speed range which introduces air resistance in a measure warranting any considerable expense to effect its reduction. It is only at speeds exceeding one hundred miles per hour that air resistance represents as much as forty-five per cent of the

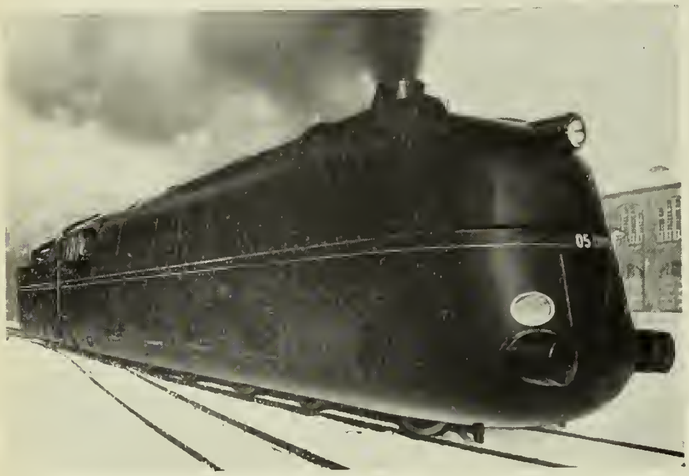


Fig. 10—German State Railways Streamlined Hudson Type Locomotive.

total resistance of a train consisting of a steam locomotive and ten 150,000-pound cars of conventional type, moving through still air. At eighty miles per hour, air resistance accounts for thirty-six per cent of the total, and at sixty miles per hour, approximately twenty-five per cent. At sixty miles per hour, the air resistance offered by an equivalent steam locomotive and train may be reduced approximately thirty-six per cent by adopting the streamline locomotive form illustrated in Fig. 9, together with well streamlined cars. This locomotive is the New York Central Railway Company's "Commodore Vanderbilt," a conventional passenger locomotive of the 4–6–4 wheel arrangement, to which has been fitted an enveloping shroud for the purpose of producing a novel appearance while affording some benefit in the direction of reducing the opposing force of the air through which it moves.

Wind tunnel tests have indicated the features which may be progressively adopted to secure the least possible air resistance. A round top, one which follows an unbroken arc, tangent to the extreme width, is preferable to a continuous shroud, just wide enough to cover the appurtenances on the boiler top, joining a semi-cylindrical jacket which is concentric with the boiler shell. Continuous shrouding along the sides from pilot to rear of tender, is preferred to one which is interrupted to provide accessibility to tender trucks or driving mechanism. It is very important that the gap be closed between locomotive cab and tender bulkheads and that the full width and height of shroud over the locomotive be continued to the rear of the tender for the best results. Similarly, the trailing cars should conform with the same contour and, this being impracticable to realize, the transition should be gradual and well faired. Locomotive running boards should not be exposed and all parts projecting beyond the shroud eliminated. Although these last mentioned measures are of relatively great moment, they are, of course, impossible to attain in steam locomotive practice in view of maintenance and specified standard disposition of safety appliances. As to the form of the front end, it may best be substantially semi-circular in plan and the front should taper forward from the top of the smokebox to the tip of the pilot. A forward curve near the bottom is superior to the straight profile of the Commodore Vanderbilt but the improvement is small. A front which curves inward toward the locomotive in the region of the ground has a greater and an adverse effect upon air resistance forces. With respect to the cars, a smooth and unbroken exterior is of greatest importance and this relates to the under side of the car bodies as well as to the visible surfaces. Shielding of the trucks further reduces air resistance and the last car should be given a well faired rear end, as long as can be provided, in order that the displaced air may be given an opportunity to close with the least turbulence.

No railway vehicle has yet been constructed which complies in every detail with these specifications for ideal streamlining. In fact, no operating vehicle can ever assume the ultimate in streamlining for reasons of the practical utility which it must display. Accessibility of all parts which require frequent inspection or servicing is essential. High labour costs and such other conditions of railway operation on our large systems make it impracticable to consider locomotive streamlining measures comparable with those employed by the German State Railways and illustrated in Fig. 10, which provide a continuous shroud to conceal the driving gear, with service openings along the sides which are covered when the locomotives are in service. Delays in completing repairs cannot be tolerated where labour charges dominate service charges. It is true that refinements are constantly introduced to meet such situations, but we need not look for developments in the streamlining of steam locomotives, carried far beyond the extent already practised by the New York Central.

Experience has shown that there may be no practical value in extending side sheets beneath the cars. It is appreciated more and more that the governing factor in the recommendation of streamlining is the viewpoint of the prospective railway patron, and any considerable expense incurred in an effort to reduce air resistance which does not, at the same time, attract public favour, will likely prove unjustified. When, however, appreciable expense is involved, streamlining by optical deception is the proper solution where it can be practised.

In the four illustrations, Figures 11, 12, 13 and 14, are shown examples of good streamlining practice, incurring no cost, conducive to some measure of reduction in air resistance, and distinctly pleasing to the eye. In Fig. 12, the Norfolk Southern Railbus carries a horizontal bus type engine beneath the car floor and complete latitude is thus afforded in the treatment of the body form. The appearance of streamlining is resultant upon a smooth exterior, flush doors, concealed steps, a sloping front, recessed lights, low side shrouding, a continuous roof folding over the car ends, and a beaver tail rear end, no single element of the above necessariy increasing the cost over that of a more prosaic alternative construction. Figure 13 illustrates the new, modernized coaches of the New York, New Haven, and Hartford Railroad Company. The predominant economy feature of these cars is their light weight. Any actual streamlining benefits resulting from the round car tops, square ends, and short side sheet extensions would be hard to distinguish but the cars present a pleasing appearance. While trucks and entrance steps are exposed and narrow diaphragms are employed, pronounced projections are lacking and most effective is the aluminum trim encircling two windows, giving the impression of extreme length and spaciousness. Figure 14 shows one of the new, type GG-1, articulated electric passenger locomotives used in the New York-Philadelphia-Washington service of the Pennsylvania Railroad. By providing round corners, low hood sheets at the sides, tapering up to the central cab, sloping the forward cab windows, and fairing the lights into the body, a decidedly streamlined aspect has been obtained. A decorative striping scheme conveys the impression of capacity for speed. Such thoughtful attention to detail can be of great publicity value, stimulating traffic by indicating a progressive spirit, at little if any added cost to the operating railway.

To the railway patron who awaits the delivery of important freight shipments or to the traveller to whom time en route is a burden which must be suffered in the conduct of his daily business, no counterfeit for actual road speed and a marked reduction of terminal to terminal time will suffice. He is inclined to patronize the railway which offers equipment appearing to have capacity for speed, but unless appearance is supported by performance, streamlines will not long hold his sympathies. To meet this demand, remarkably fast time of important main line services has become an established element in passenger train operation.

The attainment of any desired speed over a suitable roadbed is only a matter of adapting the equipment operated to the anticipated speed, and installing sufficient capacity in the power plant. While many fourteen-car, main line trains which are operated daily are capable of attaining speeds sometimes exceeding ninety miles per hour, it is usually the capacity of the steam locomotive to operate with a reasonable overload which makes this possible. As capacity for speed increases, the output of the power plant in relation to train weight becomes proportionately greater, as is evidenced by Table No. VII.

TABLE No. VII

Power — Weight Relation of Various Trains

Train	Total Wgt. Pounds	Horse Power Capacity	Weight Pounds per h.p.	Max. Speed m.p.h.
Conventional...	2,782,000	4400	633	90
"400".........	1,542,000	3025	510	97
Hiawatha......	1,353,000	3500	387	120
Zephyr.........	225,700	600*	376	115

*Installed engine horse power for traction.

SIGNALLING AND BRAKING

In considering the needs for high speed operation on railways, attention must be given to all details of the railway facilities which are affected by speed, foremost among which are signalling and braking.

Minimum signal spacing is governed by the ability to stop moving trains after receiving a restrictive signal and before passing the next succeeding signal which may bear a stop indication, and the effectiveness of a signal is measured, first, by its reliability in displaying the proper indication, and second, by the degree of visibility which it affords under all conditions of light, storm, fog, and background.

It is found that the sensitivity of the eye varies according to the intensity of the light source. For low intensities, green is the most sensitive colour, then yellow, then red; but for high intensities, the order is yellow, green, and red. The difference in intensity between the day and night indications of a colour light signal is more apparent than real and is due to the iris diaphragm of the eye being contracted in sunlight to 1.5 millimeters whereas in darkness it is extended to four millimeters. As the amount of light from a constant source which is perceptible to the eye depends upon the area of diaphragm opening, the ratio Day:Night = 0.14. In fog, the coloured haze is so distinct that the signal may be readily distinguished at a fair rate of speed and when used in conjunction with cab signals or train control, colour signals form a mighty element toward safe train services. When either or both of these latter elements are provided, they add to the ability of the locomotive crew to take advantage of available speed in many cases where a low rate would be enforced were less efficient control facilities provided.

A number of factors, other than that which has regard to visibility, are involved in problems dealing with the location of signals. The influence of retardation has already been mentioned. Altogether, the elements requiring primary consideration may be listed as:

1. The maximum speed practised
2. The rate of retardation obtainable
3. Track conditions (curvature and grade)
4. Intermediate speed restrictions
5. Length of trains
6. The visibility of signals (distance factor)
7. The rate of acceleration of trains

Of the foregoing, the effects of items 1, 2, and 7 are subject to general analysis, applicable to all calculations in which they are involved. Item 6 may be judged a constant, variable only with the type of signal installation locally employed. Items 3 and 4 must be considered separately for each installation, although they may modify conclusions which might otherwise be drawn with regard to a uniform practice in the disposition of signals. The length of trains, item 5, affects the problem chiefly as it bears upon the rate of acceleration, maximum speed, and rate of retardation obtainable with equipment of known characteristics.

Increased maximum train speeds have introduced the necessity for amplification of the brake equipment types heretofore furnished and the newer designs have provided for reductions of at least sixty per cent in the length of stops from ultra high speeds.

As a wheel rolls freely upon a rail, there is no relative movement between wheel and rail at the point of contact. In fact, the wheel occupies a minute depression in the rail since, under normal wheel loads, there is a measurable distortion of both wheel and rail.

The coefficient of wheel-rail adhesion is the factor which, multiplied by the weight upon the wheel, defines the force which resists movement of the wheel along the track without rotation. It is more difficult to determine its values as speed increases since many variables are introduced by conditions of weight transfer imposed by imperfect track surface, the interaction of different parts of the equipment, the effect of lateral forces imposed by guiding, and the vertical oscillation of car bodies and other sprung weights upon the yielding suspension system. Since it is impracticable to measure the instantaneous values of these variable forces or their resultant, the adhesion coefficient can best be determined by obtaining the average of results of repeated trials. Tests have now been conducted which verify the maintenance of the static value of approximately 0.25 under dry rail conditions for the coefficient, independent of speed.

Fig. 11—Milwaukee "Hiawatha" travelling at High Speed.

Although the behaviour of this single factor with increasing speed has been established as constant, it is the product of the weight supported and the coefficient of wheel-rail adhesion which resists wheel sliding, and, as speed increases, the influence of irregularities in the surface of track increases in like proportion, to the end that, upon encountering any slight obstruction, the vertical acceleration of the wheel and car body is higher with a greater momentary wheel load, and a subsequent greater reduction in the weight supported. During this brief interval, a high brake retarding force may decrease the rate of rotation, causing slipping of the wheel upon the rail and, once started, a condition of sliding can be continued with a lower wheel retarding force than otherwise, since, after

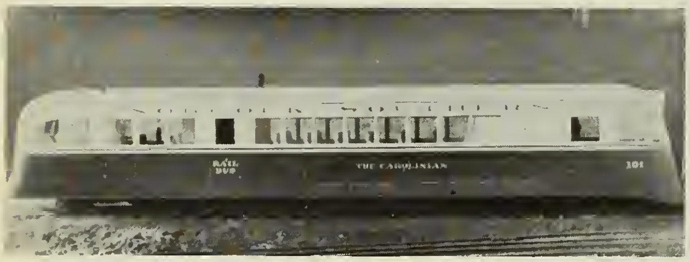


Fig. 12—Light Weight Rail Motor Car.

slipping occurs, the coefficient of wheel-rail adhesion is no longer static but kinetic and if rotation is arrested, the coefficient of brake shoe friction is no longer kinetic but assumes its higher static value. For this reason, the surface of track over which heavily braked, high speed trains operate must be carefully maintained and the spring suspension system arranged to insure, as far as possible, a uniform and constant load upon the rails.

While tests have proved the existence of a constant coefficient of wheel-rail adhesion, the variable nature of the kinetic coefficient of brake shoe friction has also been established. Its value decreases as brake shoe pressure increases and is further diminished with each increment of speed. In view of these facts, it has been customary to so limit the maximum brake shoe pressure that the friction developed at low speed should not be sufficient to cause injurious wheel sliding. A uniform brake shoe pressure offers much less resistance to the motion of a high speed train at the beginning of a stop than at the subsequent low speed. It is for this reason that a greater brake shoe pressure may be applied to the wheels at high speed than at lower rates of travelling without causing them to slide. This has been the principle respected in the design of all high-speed brakes.

The first approach to this variable shoe pressure problem obtained a diminishing brake shoe pressure as the retardation progressed by the use of a reducing valve, adjusted to relieve brake cylinder pressure at a predetermined rate. The more modern basis has been to use an inertia governor, not subject to any time element but responsive only to the longitudinal inertia effect of the train when being brought to a stop.

The brake which was fitted with a high-speed reducing valve was essentially a quick-action air brake operating under high pressure. In emergency applications, it first created a high brake cylinder pressure and this was gradually and automatically reduced as the speed decreased. This scheme offered no selection of change in brake cylinder pressure with initial speed or other conditions which might affect the stop and did not permit the utilization of maximum retarding force at any time. Obviously, since the coefficient of brake shoe friction varies in a very definite manner with the rubbing speed of the brake shoe over the wheel tread, an attachment at the axle to measure the change in the factor causing variation in retarding force could be the only practicable alternative for the inertia principle which measures the effect of brake shoe friction variation and automatically adjusts the mechanism to preserve the effect at a predetermined level.

The device employed for control by inertia consists of a housing within which a heavy weight is mounted in such a manner that it is permitted displacement in the direction of car movement. With its movement from normal position resisted by carefully calibrated springs, a force of known intensity will change its position by a predetermined amount. Upon initiation of a brake application, the brake cylinders of the car, the retardation of which is under the automatic control of this device, will receive pressure, extending the pistons and pressing the brake shoes against the wheels. A rate of retardation is thus impressed upon the car which, if of sufficient magnitude to cause the weight to thrust forward against the opposing forces of the springs, brings the retardation control device into action. The function of the weight is that of operating a valve or, indirectly, a circuit, which gradually releases pressure from the brake cylinder if the rate of retardation attains a selected maximum. This rate, fixed by the factor of wheel-rail adhesion, cannot be exceeded without introducing the hazard of wheel sliding.

If the weight upon the wheels were constant at all times and rail conditions were always the same, the wheel-rail adhesion factor of 0.25 could be utilized to obtain a maximum rate of retardation. Since retardation is negative acceleration, the fundamental equation,

$$F = Ma \quad \text{(12)}$$

can be used for determining the maximum rate of retardation which may be impressed. In the above equation,

F = retarding force in pounds
M = mass in slugs
a = rate of acceleration in feet per second per second

Since $$M = \frac{W}{g} \quad \text{(13)}$$

W = weight in pounds
g = acceleration due to gravity = 32.2 feet per second per second,

equation (12) may be written $F = \frac{Wa}{32.2}$

Then, to determine the maximum permissible rate of retardation, a, which may be impressed with security from wheel sliding with a coefficient of wheel-rail adhesion of 0.25,

$$a = \frac{32.2\,F}{W}$$

With the weight, W, taken as unity, the equation reduces to,

$a = 32.2 \times 0.25 = 8.05$ feet per second per second, or 5.50 miles per hour per second.

Actually, a factor of 0.25 may not be available in every case or the weight on any axle may be momentarily relieved. In the interest of security from possible damage to the wheels, a coefficient of 0.16 is selected on no other basis than that of judgment governed by experience in high speed braking. The maximum retardation rate is then,

$a = 32.2 \times 0.16 = 5.15$ feet per second per second, or 3.50 miles per hour per second.

To the average railway mechanical officer, a suggested sustained retardation rate of 3.5 miles per hour per second, obtainable by the use of the pneumatic brake alone, would seem too optimistic even though he is constantly and earnestly seeking a reduction in the minimum stopping distances to conform with the needs of the operating department. His hesitancy is due to a fear that the attempt to secure such a marked improvement, providing the stopping distances tabulated below, would be attended by undesirable features to the extent that the advantage of minimum stops would be more than offset by other difficulties.

Table No. VIII

Stopping Distances Obtainable with a Retardation Rate of 3.5 Miles per Hour per Second, Sustained Throughout the Duration of Stop. (Average Speed = 55 per cent Initial Speed).

Initial Speed Miles per Hour	Stopping Distance Feet
100	2300
90	1870
80	1470
70	1130
60	830

If speeds must be increased beyond the point that stops, effected with a 3.5 miles per hour per second retardation rate, are no longer satisfactory, or do not fall within the limits imposed by signal spacing in localities where relocation would be particularly costly, or would cause undue occupation of track by prevailing slower moving trains, or if any combination of circumstances arises which demands a still higher retardation rate than can be obtained by the use of the pneumatic brake alone within the limits of wheel-rail adhesion, some supplementary braking method must be adopted. When a source of ample electrical energy supply is available, as when electric traction is employed, magnetic track brakes are suggested. If this is impractical or inadequate, opportunities for shorter stopping distances are presented by a wind resistance brake, an unproved expedient in so far as service tests are concerned but one which, producing the effect of increasing head end air resistance, will be most effective in the early stages of a brake application from high speeds, offering a positive retarding force, independent of wheel-rail adhesion.

The magnetic track brake is less effective than is generally believed and its use entails features which render its application impracticable in many cases. When car equipment is light, traffic congestion serious, demanding maximum acceleration and deceleration rates, and an unlimited supply of electrical energy available, all of which are conditions common to the multiple unit trains of important subway lines where the track brake has been most highly developed, the opportunities for justifying its cost, weight, and maintenance are much more favourable than on trunk line railways.

In any consideration of a magnetic track brake, several important factors must be recognized. First, to obtain an efficient track brake with predictable characteristics, perfect contact between rail and shoe must be obtained, it having been demonstrated that a twenty-one per cent reduction in shoe-rail pressure results from the introduction of an air gap of but 0.0156 inch. Perfect contact is impossible to maintain in railway work where both the gap and force are widely variable. Second, the use of a track brake makes the use of sand impracticable, since the abrasive action of a sanded rail introduces excessive wear on the shoes and, by wiping most of the sand off the rail, the shoes limit the permissible braking ratio which may be employed in connection with the wheel brake. Third, it is generally impossible to install sufficient length of track shoe, by reason of clearances between truck wheels, to provide a really effective track brake on any main line railway equipment. Fourth, the cost and weight of equipment required, including battery and generator, are disproportionately high. Fifth, there is no background of experience to define the measure of safety involved in thrusting track shoes upon the rails in front of wheels of units moving at high, main line speeds.

A typical magnetic track brake shoe will exert a pull of approximately 300 pounds per inch of shoe length on a 130-pound rail whenever perfect contact is obtainable throughout its length. This is obtained with an energy consumption of fifty watts per inch. Although only meagre data are available, it is improbable that instantaneous contact conditions will provide more than seventy-five per cent of the vertical pull obtainable under conditions of perfect contact. This would mean a unit pressure of not more than 225 pounds per linear inch. If 60 inches of track shoe are installed per truck (120 inches per car or 720 inches per six-car train), the total pressure would be 162,000 pounds. The coefficient of friction between track shoe and rail will probably seldom exceed a value of 0.07 throughout a stop from ninety miles per hour, in view of the very high unit pressure which may result from an equivalent magnetic attraction of three hundred pounds per linear inch. It is further indicated that instantaneous values at one hundred miles per hour do not exceed 0.02. Assuming an average value of 0.07 throughout the stop from ninety miles per hour, the retarding force derived would be 11,345 pounds for the entire train.

A retarding force of this order, however secured, is but twelve per cent of that obtained by the use of a standard pneumatic brake for conventional equipment, presenting a maximum emergency braking ratio of 150 per cent, which, unassisted by an auxiliary brake, will provide an average retardation rate throughout the stop of two miles per hour per second. Were a 3.5 miles per hour deceleration rate impressed by a pneumatic brake, electrically operated to accelerate the response of the individual valves and with retardation rate automatically controlled, the effectiveness of the track brake would be but seven per cent of that of the pneumatic system. Furthermore, with an energy input of fifty watts per inch of shoe, or 6,000 watts per car, the current consumption, with a thirty-two-volt system, will be at the rate of approximately 187 amperes, requiring not less than a thousand ampere hour battery per car for all trains which do not derive their energy from a central source, remote from the train. Adding to the weight and cost of this battery the weight and cost of the generator required to serve it in the event the train is not electrically propelled, and that of the mechanism itself, which will add not less than six hundred pounds per truck, the advantage to be gained will generally be more than offset by the cost involved and the extra weight required.

The wind brake utilizes the air resistance force which modern high speed trains are designed to reduce to a minimum. Head end streamlining of a conventional steam locomotive can, by proper application as developed by model tests conducted by the National Research Council,

Fig. 13—N.Y., N.H. & H.R.R. Light Weight Coaches.

reduce the coefficient of head end resistance (K_a in the equation, $R_a = K_a A V^2$) from 0.0024 to 0.0015,

R_a = head end air resistance in pounds
K_a = coefficient of head end air resistance
A = frontal area in square feet
V = speed in miles per hour.

The projected frontal area of a passenger train car of conventional proportions is approximately 124 square feet. This will produce an air resistance force, if streamlined to the extent that $K_a = 0.0015$, of $0.18525\ V^2$. If it were possible to present the equivalent of a flat surface of 160 square feet, nearly the maximum as defined by the A. A. R. clearance lines, normal to the direction of motion, to assist in decelerating from high speeds, the head end resistance would be defined by the expression:

$$R_a = 0.00324 \times 160\ V^2 = 0.518\ V^2$$

Then, when $V = 90$ miles per hour, the comparative resistances are:

Streamlined car = 1,500 pounds
Flat plate (160 square feet) = 4,200 pounds.

Fig. 14—P.R.R. Electric Locomotive with Streamline Striping.

The difference, or 2,700 pounds, would be available to assist in retarding the train by virtue of the provision of vanes which would take advantage of the potential force available in the air.

While it is not possible to anticipate the utilization of the entire clearance diagram for effective area to be presented to wind effects, there is nothing to limit the number of such collapsible vanes advantageously located along the train, operated pneumatically and automatically upon each emergency brake application, and receding into the car structure or folding back into recesses in the car sides, maintaining an unbroken surface contour when not in use. If retractable vanes were fitted to the front of the leading car of a streamlined, multiple unit train, providing an equivalent flat plate area of 140 square feet, with a vane of 25 square feet projected area fitted at the rear of each car, assuming that the vanes at the car ends offer a unit resistance equivalent to the head end value, there will be offered the equivalent of 290 square feet frontal area. This is probably too high a value to be used in view of the interference caused by successive interruptions of the air stream and a better value for estimate may be 250 square feet.

The resistance offered will then be,

$$0.00324 \times 250\ V^2 = 0.810\ V^2$$

and the added resistance to motion of the train will be,

$$(0.810 - 0.185)\ V^2 = 0.625\ V^2$$

The effect of this force at various speeds of travelling is given in Table No. IX.

Table No. IX

Resistance Introduced by Wind Brake

Speed m.p.h.	Added Resistance Afforded by Wind Brake — Pounds
90	5060
80	4000
70	3060
60	2250
50	1560
40	1000
30	560

Since the kinetic energy possessed by a moving train varies with the square of its speed, as does the resistance due to the wind brake, such a brake is especially desirable to be used in conjunction with the conventional air brake. From speeds of forty miles per hour to stop, it is not difficult to obtain, by the use of the conventional air brake alone, all the retarding force which can be safely impressed. At the higher speeds, when the coefficient of friction is materially reduced in value, the wind brake affords a practical means for supplementing the diminished retarding effect. The exact benefit that can be expected from the use of a wind brake such as that described, in the way of decreased stopping distance, is not immediately predictable. Its effect is dependent largely upon the measure of increase of car cross section, upon the degree of streamlining practised, the weight of the train, and the speed of operation.

Whatever expedient has yet been tried or suggested to increase the available rate of retardation from high speed beyond that obtainable with pneumatic brakes, electrically operated for simultaneous response throughout a train of coupled cars, none is offered which assumes the importance of the highly developed air brake which must be relied upon to form the basic retarding medium under all circumstances. The time has not yet arrived when the capacity of the air brake places a definite limitation upon the maximum speed which may be practised, even upon well constructed and maintained track, fitted with heavy rail sections and with curves of large radii, upon which the outer rail is properly elevated.

The maximum retardation rate of 3.5 miles per hour per second, obtainable by retarding the rotation of the wheels, is not yet utilized, due in part to imperfect rail surface, in part to inadequate control of weight transfer, and in part to the hesitancy of railway administrations to attempt radical innovations in practice. The increase to the maximum rate will be cautiously pursued and retardation rates will advance little by little, as they have in the past, with associated improvements to insure protection against discomfort within the trains and damage to wheels. Positive sanding of the rails at various points throughout the length of the train is required to insure the attainment of the minimum coefficient of wheel-rail adhesion of 0.16, irrespective of rail condition, since this value must be sustained if the maximum rate of retardation is to be obtained.

Fields of Progress

Any discussion of technical progress in the field of railway equipment design must necessarily be incomplete, so vast is the front along which advance is made. Only a few of the outstanding developments can be selected for review and these cannot be dealt with to the extent that their importance deserves. The railways have indicated an aggressive determination to improve their services and reduce the cost of transport production in the face of the most trying conditions with which they have ever been confronted. Nor is it in equipment design alone that their diligence is displayed. Freight handling methods, stores administration and control, equipment maintenance, and traffic solicitation methods are likewise being subjected to a most careful review.

Modern transport is in turmoil. Every aspect and activity of transport is changing rapidly. Extravagant assurances put forward by inventors of novel schemes do not alter the fact that conventional practices have not crept in at once but are the result of many generations of honest and earnest effort. Given the least opportunity to conduct their operations upon a plane of equal opportunity with their competitors, the railways will perpetuate their occupation of a position of leadership in transport, and they must, for, even after subsidies and grants to their transport rivals are withdrawn, they will still be required to acknowledge the ability of other carriers to perform some services more to the satisfaction of the public than they can themselves.

We are just beginning to discover that any particular form of transport cannot isolate itself from the world and round out its existence without due regard to what its neighbours are doing. To realize its highest success, each common carrier of the nation's traffic must base its plans and actions on a knowledge of what is transpiring, not only in the immediate territory within which its service is performed, but in the state and nation as well. It must find its place in the composite plan.

The business world has been quickest to realize the value of co-operation. Individuals have not tried to work out the principles of success alone. They have joined others of their group in conferences and open discussions, and have acted in unison to overcome threatening obstacles. The master hand, the guiding inspiration—the pilot, if you will—of modern business, is not so much the man who directs its destinies as an executive officer, but rather that invisible but important factor represented in the research and experimental departments. Science, covering the broad fields of biology, physics, chemistry, invention, experimentation and statistical research, has become a powerful ally, not only in disclosing numberless beneficial discoveries, but also in devising many new applications of old practices and in remedying defects in past methods.

The world in which we live is continually in a process of transition. The luxuries of yesterday become the necessities of tomorrow and future developments know no limitations. To the man of science all things appear possible. In this new order of things, gone is the day when the railway man could work hard for a period, obtain success, and then sit back complacently to reap the rewards of his effort. Today, he who works hard to achieve success, must work harder to retain it.

There are just three principal ways of conducting a business—first, by definite, formulated rules; second, by hunches; third, by facts. The first two, although by no means extinct, are being rapidly driven into discard. Some there are who adhere to unchangeable rules of thumb for shaping their policies while others act upon sentiment or impulse. The third group adopts the plan of the scientist by obtaining all the facts possible and examining them in their various relationships so that, as far as possible, guesswork and hazards may be eliminated. In this manner they foresee probable future demands and competition. In the aptitude for turning scientific discoveries to the account of industry, resides the measure of success of competitive enterprises of modern transport.

Advance through adversity may be reasoned as a policy which recognizes what is good in those who have so vitally upset the position of the railway transport industry and, in some fashion, one which gauges the task ahead, so that the railways may properly serve their purposes in that larger and more inclusive field which will be theirs if they will but measure up to the new and latent opportunities in the days to come.

Highways and Passenger Transportation

A. H. Foster,
President, Ontario Association of Motor Coach Operators, Toronto, Ontario.

Paper presented before the Annual General Professional Meeting of The Engineering Institute of Canada, at Hamilton Ontario, on February 6th, 1936.

SUMMARY.—Referring to the present highway system in Canada and its cost, the development and operation of the modern motor coach and its taxation are discussed. The author then deals with the relation between railway and highway passenger traffic. He deprecates further increase in motor coach taxation. The solution of our transport difficulties is to be found in co-operation and co-ordination not in restriction.

The modern world as we know it could not continue to function without those facilities for easy and rapid carriage of persons and goods overland which we take so much as a matter of course. And not the least important of those facilities is the modern highway with its corollary, the modern motor vehicle. No one can discuss intelligently the problems of highway transportation without relating them to the broader problems of overland transport in general. For that reason this paper will deal only briefly with the technical problems which confront the highway passenger carrier and devote most of the available space to a discussion of the place that motor coach services occupy in the general transportation scheme.

Incidentally, it is perhaps not inappropriate that this broader question should be considered from the point of view of a transportation agency which utilizes the highway. Much that has been said and written on the subject recently has expressed the point of view of those engaged in transportation by rail. It is not suggested that this has been done in any biased manner, but in dealing with any subject which may give rise to difference of opinion it is always well to consider all opinions before reaching any conclusion on the issues involved.

The Highway System

First, then, the highway system itself may be considered. When one visualizes the network of permanent-surfaced roads now lacing the more densely populated areas of the Dominion, it is difficult to realize that this type of highway has existed in this country only a little more than two decades. The first hard-surfaced road in Canada was the thirty-eight mile stretch of lakeshore highway between Hamilton and Toronto. Construction on this route commenced in 1914 and it is not without significance that much of the original concrete is still in use.

At the end of 1934 the Dominion had 409,269 miles of highway open for traffic. Of this mileage approximately 143,000 miles were unimproved earth roads and 172,000 were improved earth. Surfaced roads totalled 93,642 miles, of which 84,948 were gravel and 8,694 were hard-surfaced. These hard-surfaced roads were of four principal types—water-bound macadam (1,655 miles), bituminous macadam (3,214 miles), bituminous concrete (1,821 miles), and cement concrete (2,004 miles).

Various estimates have been made of the total long-term economic cost of the system but inasmuch as we have been building roads in Ontario since 1794 and in the older parts of the country since the seventeenth century, these estimates are at best conjectural. This paper, therefore, will deal only with current highway debt. Some authorities seem to believe that most, if not all of our national transportation difficulties are due to the existence of our highway system. Such authorities have even gone so far as to suggest that the entire long-term cost of the system should be assessed against the motor vehicle. This view, the author suggests, is unreasonable, since a great part of the system existed prior to the advent of the motor vehicle. Practically all the roads in eastern Canada, for instance, belong to this category.

Turning then to highway debt we find that in the

Dominion of Canada in 1934 there were provincial highway debts outstanding of $462,182,328. Annual interest payments totalled $22,301,035, which, with principal and sinking fund payments of $553,656 made in that year, resulted in a total capital carrying charge of $22,854,691. Maintenance, including an item of $1,867,377 for plant and equipment, totalled $15,382,969. Combining all these items we arrive at a total of $38,237,660 spent in maintenance and carrying charges on the provincial highway systems of Canada during the year 1934.

Later, the relation between highway costs and revenue from highway taxes will be examined in some detail, but for the moment this figure may be compared with the $50,622,683 which represents the total proceeds in 1934 of motor vehicle registration fees and gasoline taxes. Evidently the margin of provincial highway revenues over current expenditures is in excess of $12,000,000.

In regard to the question of modern highway design, it is recognized that great changes have taken place during recent years in the design of our permanent surfaced roads. Formerly, it was the custom—particularly in Ontario—to make the crown of concrete and concrete-base roads considerably thicker than the edges. Experience, however, has shown that greater strength and permanency results when the thickness of the edge is greater than that of the crown. This principle is now generally followed in the construction of these types of surfaces.

Considerable currency has been given to a fallacious belief that the design of any given highway is determined by the weight of the vehicles using that highway. On this basis it has been argued that the operation of heavy commercial vehicles has necessitated the building of a heavier type of roadway than would have sufficed for the operation of the private motor car, with attendant increased costs which, it is urged, should be charged against the commercial vehicle.

This belief overlooks entirely two fundamental principles. One: The effect of vehicle weight on a roadway is related not to the deadweight of the vehicle but to the distribution of that weight to the roadway. Two: The determining factors in highway design in a country such as Canada are not traffic but climate and soil conditions.

Mr. Thomas H. Macdonald, chief of the United States Bureau of Roads, after experiments conducted over a period of several years, has reported in detail on the question to the United States Interstate Commerce Commission. He finds that the modern design of heavy duty motor vehicles which utilizes multiple rear wheels and oversize balloon tires has so reduced the force of impact of this type of vehicle on the roadway as to make its weight, as compared with that of the private motor car, a relatively negligible factor in highway design.

In this connection R. M. Smith, A.M.E.I.C., Deputy Minister of Highways for the Province of Ontario, has said, "The determining factor in road construction in this country is not nature of use but climate. Even were there no trucks and buses operating we would still have to build the same type of roads we are building today to withstand temperature changes which range anywhere up to 100 degrees in the summer to 30 degrees below zero or even lower in the winter."*

The Motor Coach and Its Operation

Passing on to the subject of road users, and particularly to the common carrier motor coach, it may be observed that the problems involved in the operation of the public passenger vehicle and those involved in the operation of the commercial motor truck are entirely dissimilar. The two agencies differ not only in function but in their relation to the economics of the transportation scheme as a whole.

*From an address delivered by Mr. Smith to the Toronto Transportation Club, February 3rd, 1933.

There is no doubt that the motor coach industry came into being as the inevitable answer to a popular demand arising out of the development of good roads and the private motor vehicle. As motor travel increased the public was not slow to realize the many advantages of highway transportation. It was only natural therefore that the section of the public which was unable to use the private car should demand some form of highway transportation. Records of the industry will show that this was not a case of a new agency seeking for selfish reasons to lure patronage away from already existing agencies. It was simply that a new agency arose to meet an already existing demand which was not being met by existing agencies.

As was to be expected in an evolutionary development of the sort, the initial services provided were at first rudimentary. Almost invariably, they were operated by individuals with relatively little capital. The services offered covered only short distances between two adjacent urban or suburban points, filling a purely local need. The vehicle itself was the ordinary type of passenger car then in vogue. Because of the unreliability of the equipment, service was often intermittent. Despite these disadvantages the public were quick to avail themselves of the new agency. Encouraged by this support, the operators started to develop a more suitable type of vehicle by placing a crude bus body on a truck chassis.

And what make-shift conveyances these early buses were. The body was little more than a square box with windows and a door. Seats were ordinary benches with springless cushions. Endeavours to reduce the centre of gravity because of the height of the chassis frames from the ground resulted in low head room. Baggage, if any, was carried in the aisle of the coach or placed in crude containers on the roof.

Tires were in many cases of solid rubber. Due to road conditions springs were massive and inflexible. Engines of a low horse power necessitated the use of a low gear ratio with high engine speed. The resultant noise was something to shock even the most insensitive. Speed of operation was necessarily low and during the winter months little or no heat was available for the comfort of passengers.

Looking back one wonders how the vehicle—and its passengers—survived; but it was from this primitive contrivance of the early twenties that the modern motor coach was evolved.

Today's coach is built on a specially designed heavy-duty bus chassis. It is driven by a high-power engine specially designed for coach operation, permitting faster schedules and great flexibility in handling. Powerful air-operated or hydraulic brakes with enlarged braking areas provide quick and safe braking at high speeds. Safety glass, a low centre of gravity and heavier construction give a maximum of safety.

In comfort, the modern coach approximates the high priced private car. High head room permits easy access. Shock absorbers, oversize balloon tires, well upholstered, and in many cases, reclining seats, reduce riding fatigue to the minimum. Adequate heating facilities, double windows, and floor and side-wall insulation, ensure a comfortable temperature within the body of the coach during the severest weather conditions. Noise has been very greatly decreased by reason of improved engine design.

During the past two years, modified forms of streamlining have been adopted, resulting in lowered wind resistance and a more pleasing external appearance.

Still further changes are to be expected and at the present time considerable attention is being given to the coach with engine mounted in the rear. Some of the larger companies are adopting this type as standard equipment. One of the chief advantages of this type is that engine noise heard within the body of the coach is further minimized.

The short drive shaft also eliminates vibration noticeable in some of the larger types of vehicles at high speed.

In Europe there has been marked development in the use of commercial vehicles supplied with Diesel engines. Fuel economy is perhaps the principal factor operating here, as the Diesel will give a mileage per gallon practically twice that of the ordinary gasoline-driven engine. There is also the additional factor that fuel oil is normally cheaper than gasoline, although it is possible that this may be altered by changes in taxation. The Diesel engine also develops a high torque at low engine speed, which is highly desirable for city operation in dense traffic.

To date, the Diesel-powered coach has not been generally accepted on this continent as meeting all the requirements of high speed performance and cost, but no doubt its increased use is a possible development of the future.

Paralleling the changes in motor coach design there has been a marked change in the methods of organization of coach services. Except in sparsely settled areas or where the service is of a purely local type such as that of a school bus, the individual operator has given way almost entirely to the large company conducting multiple-unit operations. This process of consolidation and integration has been such that practically all major operations on the continent are now conducted by a comparatively small number of companies. Where formerly the typical operator was an individual possessing limited equipment and having next to no garage and maintenance facilities, today the typical operator is the financially stable company with resources ample to provide the most modern and efficient equipment. As a natural result have followed the establishment of highly trained staffs, the construction of adequate terminals, the compilation of a nation-wide tariff and the co-ordination of services to the point where they have become continent-wide in their scope.

It is now possible to purchase motor coach transportation between any two major points in the United States or Canada and to travel almost directly between these two points, transferring from one carrier's line to another. Frequency of service on almost all long distance runs is now such as to permit overnight stops at convenient intermediate points. Operating schedules provide also for frequent rest and lunch stops at suitable terminals. Such is the comfort and convenience provided that we now find continuous journeys well in excess of 1,500 miles are quite the normal thing.

The principal reason for the popularity of the motor coach which lies behind this growth is the fact that its service approximates more closely than any other the service rendered by the private automoblie. Whereas a journey by common carrier formerly consisted of three distinct movements, namely from origin to station, from station to station, and from station to destination, it is now made by coach in one unbroken movement. Furthermore the coach is able to pick up and discharge passengers not only at centres of population but at almost any point on the route it traverses. This flexibility enables it to provide economical transportation for a scattered population and to render a service to the travelling public not provided by any other common carrier. Further factors are the frequency of service and the convenience of schedules previously mentioned. These are such that even the owner of a private car feels that he obtains satisfactory results from motor coach travel without the expense, trouble and responsibility involved in operating his car on crowded highways.

It should not be overlooked, moreover, that the coach furnishes the only common carrier passenger service available to many areas not reached by rail service. There are thousands of communities on this continent which fall into this category. Many are small villages and sparsely settled rural sections, but others are of quite a different character. In Ontario, for instance, consider the thickly settled southern shore of Lake Simcoe, which while primarily a summer colony, supports a considerable number of permanent residents. In the past this area was served by the steam railroad, and later by an electric interurban line. Due to the inroads made on fixed right-of-way passenger traffic by the private motor vehicles, both have now disappeared. Were it not for the motor coach, the district north of Newmarket, extending along the lake to Jackson's Point and Sutton, would be without any public passenger service. In this and similar communities the discontinuance of motor coach service would be a public catastrophe, as indeed would the loss of the school bus or the small bus operated in many a rural settlement.

In all well organized areas motor coach services are subject to legislatory regulation. In Ontario—and conditions in other provinces are similar—the necess'ty and public convenience of any proposed service must be approved at a public hearing before a service can be commenced or a certificate granted. Routes must be definitely specified; all schedules must be approved by the government as meeting the public's requirements. Tariffs must be filed and approved so as to ensure fair and uniform rates. All coach drivers must undergo examinations for physical fitness and other qualifications. Hours of driving are limited to ten in twenty-four. The weight, length, width, height, of all coaches are subject to specific limitation. Headlights, brakes, emergency exit doors, floors, fire extinguishers are all subject to specific requirements. In practically all cases, these governmental regulations are supplemented by further company regulations which ensure a disciplinary control of operating personnel similar to that in effect on the steam railways.

These regulations, both governmental and company, ensure coach users safe and dependable service while at the same time protecting other users of the highways.

The growth of a business which in a little more than a decade has developed from nothing to its present size, bespeaks a popular demand and the satisfaction of a public need. Such progress indicates the existence of fair rates and convenient schedules, and a service possessing the requisite elements of efficiency, safety, and comfort. In short, brief though its history has been, the motor coach has definitely established itself as a necessary utility in the field of passenger transportation.

Highway Costs and Taxation of Motor Vehicles

It has been stated by critics of highway transportation that motor vehicles in general, and the motor coach in particular, are not paying their way; that, in effect, motor vehicle transport has been subsidized by providing it with a right of way at the expense of the taxpayers at large.

This charge the author would emphatically deny. What are the facts of the matter?

The question depends on the relation between highway costs and the aggregate taxation paid by the motor vehicle. It does not seem reasonable to ask the motor vehicle user to shoulder the entire cost of highway construction and maintenance. The highway user is not the only beneficiary of highway expenditure. Construction of any given highway benefits not only the user, but the province as a whole, the communities situated on that highway, and the owners of property abutting thereon. Various ratios for the apportionment of costs among these beneficiaries have been proposed. The finding of the Royal Commission on Transport in Great Britain, a finding subsequently endorsed by the Royal Commission on Railways and Transportation in Canada, 1932, placed the fair proportion of total highway costs which should be borne by the motor vehicle user at approximately 66 per cent. While the exact ratio may be debatable, the necessity of some such apportionment as this should be borne in mind in any comparison of highways costs and revenue from motor vehicle taxation.

In making a specific comparison in this paper the figures for the province of Ontario will be taken, since Ontario, with a population less than a third that of the Dominion, has 47,000 miles, or more than half, of the Dominion's total mileage of surfaced roadways, and therefore maintains a system relatively more costly than those of the other provinces. The total provincial highway debt in this province in 1934 was $203,785,482. Interest charges were $10,189,274 and maintenance and plant costs $4,576,394, the two items constituting a total current cost for the year of $14,766,668. These figures do not include county and municipal expenditures on secondary roads, but they do include all expenditures on all hard surface roads which in this province carry 80 per cent of all motor vehicle traffic.

In the same year, 1934, the province's revenue from motor vehicle registration fees and gasoline taxes aggregated $22,188,175, or an amount $7,431,507 in excess of carrying and maintenance requirements. It may be observed that this surplus was more than sufficient to carry depreciation charges at the customary annual rate of 3 per cent. Surely in the light of those figures and in view of the fact that no equitable assessment would charge the entire highway cost against the road users, it cannot be said that the motor vehicle is not paying its way.

Where does the motor coach come into this picture? On an average, coach operators in Ontario pay approximately 10 per cent of their gross revenue in direct highway taxes. This figure, of course, excludes non-highway taxes which are paid by coach operators as by other businesses.

The specific highway levies imposed on the coach are three in number. (1) License or registration fee. This fee is based on the weight of the vehicle ready for the road plus the number of seats multiplied by 135, representing the estimated weight of the average passenger. For the 29-passenger coach with a combined vehicle and passenger weight of 10 tons—the size generally operated throughout the province—the registration fee is $165 for one year. (2) Seat or mileage tax. This is a tax of 1/20 of a cent per seat mile on coach operations over provincial highways and 1/30 of a cent per seat mile on coaches operating over county highways. Since practically all coach routes traverse provincial highways, this tax approximates 1½ cents per mile operated by the 29-passenger coach. In the province of Quebec, the corresponding levy is 1/10 cent per seat mile and similar charges are assessed in other provinces. (3) Gasoline tax. This tax of 6 cents per gallon is paid on all fuel consumed. Since the average 29-passenger coach runs approximately 6 miles to the gallon, it is equivalent to a levy of at least 1 cent per coach mile.

Combining all three levies and calculating on the conservative basis of 40,000 miles per year (the average mileage for coaches on inter-urban operation), the total tax on a 29-passenger coach in Ontario is approximately $1,145 a year.

One need only compare this figure with the average highway tax paid by all types of motor vehicles, to realize how disproportionate is the share of highway costs assessed against coach services. In 1934, motor vehicle registrations of all types in Ontario numbered 542,245. As already indicated, the total motor vehicle taxes were $22,188,175 which means that the average motor vehicle pays a tax of less than $40 a year. Comparing this amount with the $1,145 paid by the coach, we find that the latter pays highway taxes 28½ times greater than the average paid by all types of motor vehicles. Further, according to official government figures, motor coach traffic at the maximum constitutes only 1.65 per cent of the total motor vehicle traffic on provincial highways. Is it not evident that the motor coach is more than carrying its fair share of the highway tax load?

The comparison might be extended to include relative taxes paid per passenger, by weight, by space occupied on the highways, or by miles travelled per year, as between the coach and other motor vehicles. Since the result in each case is similar to that already indicated, the point may be left with the observation that when it comes to paying taxes, the motor coach operator has few rivals.

Relation Between Railway and Highway Passenger Traffic

There is one other topic which cannot be ignored, namely, the astonishing misconceptions one encounters concerning the relation between rail and highway passenger traffic. Everyone knows that the railroads have suffered serious losses of passenger traffic. Those who have looked into the question know that motor coach operations have had a negligible effect on railway passenger traffic, yet authoritative opinions are still heard to the effect that if only the motor coach could be eliminated, rail passenger traffic would be restored to its former satisfactory dimensions.

Nothing could be further from the fact. The real cause of the decline in railway passenger earnings, as the railways themselves admit, is the private motor car, which levies toll on the railway and motor coach alike. Furthermore, any unprejudiced examination of the matter will reveal the fact that rail and motor coach passenger services are almost entirely supplementary rather than antagonistic.

As to the statistical background of these statements, one striking set of figures may be quoted. During the ten-year period commencing 1923, the Canadian railways suffered a loss in passenger revenue of $53,120,000, passenger revenue in 1923 having been $85,000,000 and in 1933, $31,880,000. In 1933, the aggregate earnings of motor coach services in the Dominion did not exceed $4,500,000. Even were the sources of motor coach traffic not further examined, these figures are sufficient to show that the motor coach had nothing whatever to do with more than nine-tenths of the railway losses. And when one realizes that by far the greater part of inter-urban coach traffic is of a type that is not, and never has been, serviced by the steam roads, and therefore could not have been taken from the steam roads, the negligible extent of the competition between coach and rail services becomes so obvious as to leave no room for argument.

The matter has been very well put by the Motor Bus Association of Virginia in a submission to the United States Commerce Commission, as follows:—

"The motor bus, except in very limited instances has developed its own business. It renders a character of service that the railroads are unable to render, both as to frequency of schedules and the receiving and discharging of passengers at convenient places along the highway, in many instances, far removed from railway stations.

"Demonstrated facts will show that the elimination of the motor bus entirely would be of very little benefit to the railroad as most of the traffic would go to private cars."

This view is concurred in by those railway authorities who have made a specific study of the problem. J. F. Deasy, Vice-President of the Pennsylvania Railroad, states in a public paper upon the co-ordination of rail and highway transportation:—

"Our studies show that the decline in passenger revenue has been brought about primarily by the use of the private automobile. The motor bus has not deprived our railroad of substantially any more business than the interurban electric lines would have done if they had survived and expanded."

The matter was very thoroughly explored by a joint committee of the two Canadian railroads which submitted its findings to the Duff Commission in 1932. This committee estimated that only 1.7 per cent of all the passenger travel in Canada is handled by interurban buses.

"It will thus be seen," the Committee's findings declare, "that the bus is almost negligible in the transportation field in Canada, and that the increased use of private automobiles must be the major factor influencing declining rail passenger revenues . . . A close study of bus travel reveals that but a small proportion of bus revenue actually is derived from lost railway passengers."

Thus it is clearly indicated that any measure designed to assist the railways by imposing restrictions on the operations of motor coach services would in practice prove abortive. This, in fact, was precisely the view taken by the Duff Commission after the most thorough examination of the transportation problem in our history. Declaration to this effect is incorporated in the Commission's official report in these words:—

"In the case of the motor coach there is little prospect that either by further taxation or increased regulation will the railroads benefit.

"There does not seem, therefore, to be any necessity to recommend additional taxation and regulation of motor coach operations in the interests of the steam railways of Canada."

Before leaving this phase of the subject the author desires to go on record as emphatically condemning punitive restriction by legislation of any form of transportation. Efficient transportation of all types is of vital importance not only to the economic life, but also to the social life, of any country. Any attempt to throttle the development of any transportation agency, be it highway or rail, which provides the most efficient and economical service in a specific field, can have only one result, namely, injury to the well-being of the country as a whole. This view agrees with the opinion of Mr. Leo J. Flynn, Examiner of the United States Interstate Commerce Commission, who says:—

"It is the duty of governments to see that adequate and efficient transportation service for the public is supplied and maintained. The problem, 'How can the commerce of the country be moved more efficiently and economically with assurance of dependable service?' should be approached as one of national transportation and not primarily as one of transportation agencies. Legislation and regulations should not be designed with a view to preserving and protecting long existing forms of transportation by stifling or restricting new forms of transportation which may be better equipped for performing certain transportation functions. The public is entitled to the best transportation service. No carrier by rail, water, motor vehicle, or air, has a vested right in the transportation of a single passenger or a single pound of freight."

In other words, national interest and not the interest of any specific agency must be the basic principle of all regulatory legislation. Such legislation should always have as its object the securing of a maximum of transportation efficiency at a minimum of cost to the country as a whole.

It may be suggested that railroad passenger services have always faced a serious limitation. They must serve two classes of people, those who wish to travel a long distance and those who wish to travel a short distance. The success of long distance railway passenger travel depends upon advantageous connections at terminals, and high speed operation. Local transportation requires convenient schedules and frequent stops at intermediate stations. The railroads have found it increasingly difficult to serve both these classes of transportation at a profit to themselves.

Is not, then, the answer to the railway passenger problem to be found in a more efficient co-ordination of rail and highway passenger services? Wherever short-haul rail passenger service is unprofitable and wherever it interferes with the speedy and efficient handling of long-haul business, should not there be a definite integration of coach and train operations?

Probably such integration would materially benefit the railways, both by enabling them to reduce costs and at the same time utilize the motor coach as a feeder for their long-haul operations.

It is a pleasure to report that one of the Canadian steam roads and the coach company with which the author is connected have been experimenting with this type of co-ordination on a route which meets the conditions described. So far as the coach company is concerned, the arrangement has been satisfactory, and it is believed that the railroad has also found it advantageous.

Whether the railways themselves should enter the field of highway transport is a question on which it does not seem proper for an outsider to express an opinion. It may be pointed out, however, that the railways, when asked by governmental authority to service highway passenger traffic, denied any responsibility in this regard and refused to undertake motor vehicle operations. In the early days of highway development both the major steam roads were offered motor coach permits on highways paralleling their rail lines by at least three provincial governments. It is a matter of official record, incorporated in the report of the Duff Commission, that both roads declined these permits, despite repeated urging by the governments concerned.

Having thus refused to service highway passenger traffic it is obvious that the steam roads cannot plead a priority claim to that traffic. Should they now desire to enter the field they can do so only with due regard to the established rights and investments of those operators who have pioneered motorized passenger service and brought it to its present advanced stage of development.

This principle has been generally recognized both in Great Britain and the United States, where a number of steam roads have associated themselves with motor coach operations. They have done so, not by initiating coach services in unserved areas or by usurping the rights of existing operators, but by the acquisition of, or purchase of stock in, companies which had established priority claims in the highway field.

It may be admitted that non-recognition of this principle would work gross injustice to established highway agencies.

Perhaps specific reference to the company with which the author is associated may be permitted, inasmuch as the reference has general application. The question is sometimes asked, how Gray Coach Lines—a subsidiary of the municipally owned Toronto Transportation Commission—came to enter the interurban motor coach field. The answer is to be found in the history of highway passenger services to which reference has just been made.

During the period 1923 to 1927 the Ontario government, realizing that the growth of highway common carrier services was inevitable, and recognizing that the public interest demanded their operation by the largest and most responsible transportation interests available, on two or three occasions approached the two large railways with the request that they apply for the necessary operating permits. Neither road could be induced to accept the proposal. It was then the duty of the provincial government to facilitate the acquiring of highway passenger transport permits by the most responsible transportation people in the several areas of the province. Gray Coach Lines, of course, was included, since it was the largest operator in the district contiguous to Toronto. If the railways had been engaged in this newer form of passenger transport in the Toronto area, Gray Coach Lines would have confined its services to Toronto and its suburban areas.

It was as a result of this opportunity that Gray Coach Lines' operations were extended to include a number of interurban routes radiating from Toronto. This does not mean that the necessary permits were secured without recognition of the rights of operators already in the field. Acquisition of the relevant franchises cost the company upwards of three quarters of a million dollars and in two instances it had to purchase the rights of operators conducting parallel services on one route, since the government insisted there should be no duplication of services between two centres.

The company's acceptance of the government's proposal was actuated largely by a belief that co-ordination of interurban services with city and suburban services existing at the time the proposal was made would result in operating economies of direct benefit to all three services. That this belief was well founded has been demonstrated by subsequent operating experience which has revealed operating economies of substantial proportions.

It would seem that the position of the motor coach service in the general transportation picture can be summarized as follows:—

1. Motor coaches render efficient and reliable service of definite social and economic value in a field not occupied by any other common carrier transportation agency.

2. Motor coach services are now adequately regulated by specific legislative enactment. So far as safety, reliability, fair rates and public convenience are concerned, there is no justification for further governmental regulations. Practically all the recommendations for the regulation of highway passenger carriers made at the recent Provincial-Dominion conference at Ottawa are already in effect under provincial authority, and inasmuch as practically all motor coach operations are purely provincial in character, there is no justification for federal regulation.

3. The motor vehicle is now adequately taxed in relation to highway costs, and motor coach services are already bearing a disproportionate share of that taxation. Further taxation of motor coach services would result only in increasing the cost to the public of this type of service through increased rates of fare which the economic facts of the case do not justify.

4. Restriction of motor coach operations by further regulation or further taxation would make no appreciable contribution to the solving of our railways' transportation problem.

To sum up: the solution of our transportation difficulties is to be found in co-operation and co-ordination, not in punitive restriction. To all measures which will increase intelligent co-ordination of passenger transportation the motor coach industry proffers its wholehearted support.

Competing Forms of Transportation

Sir Edward Beatty, G.B.E., K.C.,

President, Canadian Pacific Railway Company, Montreal, Que.

Address given at the Annual Dinner of The Engineering Institute of Canada, at Hamilton, Ontario, on February 6th, 1936.

The honour of being invited to address the annual meeting of The Engineering Institute of Canada is one which I value very highly. I am by profession, as many of you know, a lawyer, but there can be but few lawyers in Canada who have spent more of their life in contact with engineers and with their work and problems. I am specially interested in the subject which I am discussing tonight for many reasons. Not the least of these is that your immediate past-president is a friend of mine, well-known in your profession, who has recently been associated with the Canadian Pacific Railway in intensive investigation on the very subject on which I propose to speak—the problems of the acute competition between railways and other forms of transportation.

It is not remarkable that this subject should be of interest to engineers. The engineer must play a vital part in the design and construction of all great works of human ingenuity. Locomotives, permanent ways and bridges, motor vehicles and the roads on which they ride, great waterways and the ships which use them, airplanes and the facilities for guiding them and their landing places—these are all the work of engineers. To their construction and operation there have been given the wisdom of statesmen, the learning of lawyers, the technique of financial experts, and indeed, the efforts of practically every known profession. Yet transportation enterprises still remain primarily the creation of engineers, and if, as at present is the case, the nation faces serious problems in the field of transportation, it is both natural and proper that engineers should be keenly interested in their solution.

The engineer is, by definition, an ingenious man. The words have the same root, and all that we mean by ingenuity is engineering skill. Perhaps the time is coming, in this and other countries, when the engineering profession will have to increase its ingenuity in order to deal with problems more complex than those of constructing ingenious mechanical devices to overcome the forces of gravity and friction. It is not enough for us to know how to make and use machines. We must know how to insure that their making and use will be truly profitable. Profit, as you know, is a word which cannot be interpreted too simply. A machine may be made which will produce goods or services which can be sold by the user of the machine at a price which more than covers the cost of purchasing the machine and operating it, and still be unprofitable.

There are recorded cases where great engineers, engaged in construction of works in countries where labour is very cheap, have noted that the labour which would be displaced by the introduction of mechanical devices was so cheap that it did not pay to use a machine which would pay in other countries. Obviously, in such a case the ingenious man would not direct his ingenuity to the making or use of certain forms of labour saving devices. In the more complex life of advanced industrial nations the same condition may arise without being so apparent. In Egypt a steam shovel may not be able to compete with a native labourer carrying earth in a basket and this truth may be obvious. In our western civilization the application of machine power to replace labour may be apparently successful, but can only be really successful provided we have something for the displaced labour to do, or some method of providing for them without the need of toil. Thus, in certain circumstances, the fact that a corporation or individual can purchase a machine, and pay for its cost and the cost of operating it from the labour thus saved, may be deceptive. If that labour is to become a permanent burden on the community and to live perpetually in penury on charity, we may have an apparent success which is really a failure.

I am anxious that you should not misunderstand me on this point. I believe that the human race is, in the end, ingenious enough to carry the application of mechanical power much farther than we have yet done without any reason to feel that we have carried it too far. It is vital, however, that we do not carry it too fast. That will occur if we develop the ingenuity required to make these labour saving devices more rapidly than we develop the ingenuity to see that their use is fundamentally wise.

It is for this reason that I am coming to the conclusion that the economic ingenuity of engineers may have to be developed in the years to come more rapidly than their already highly developed mechanical ingenuity.

I am confident of two things. One is that as engineers begin to turn their minds more and more to economic questions they will find themselves falling into the pitfalls which lie in the way in that field of human thought. Like everyone else, they will be only too ready to make rash statements concerning the cause of our social and economic problems, and only too ready to offer what seem to be extremely appealing plans for solving them—only to find that their data are insufficient, and that the problem is much more complex than they thought. The other thing of which I am certain is that no body of men in the world will be ultimately able to go as far in the correct solution of our economic troubles as will the engineers. Some of them will, perhaps, make rash excursions in the direction of "technocracy." That is not very important. The important thing is that the engineers should become real "technocrats." A "technocrat" is, by derivation of the word, a technical ruler. It cannot be other than beneficial to this country that the ingenious men in it should become increasingly powerful in directing it.

So much for what I think of engineers. I am sure that you will be more interested in what I have to tell you about transportation and its problems.

You all know what I have had to say about railway questions as such. On the whole, railway men have contributed very little to the public discussion in this country of the competition between rail and other forms of transportation. In one of the few references which I have myself made to this subject—in this city a month ago tonight—I dealt very sketchily with the question of freight rates on highways and inland waterways. I took a line which some people seemed to find surprising. During the past few years the theory appears to have been fairly firmly established in this country that the railways have been either unfortunate or unwise in their dealings with new types of transportation. When, therefore, I ventured to suggest that possibly everything was not rosy in the situation of competing forms of transportation, it seemed to cause some surprise.

Yet, I do not think that anyone who is at all familiar with the highway transportation problem, to take only one case, will doubt that the highway transportation agencies are not entirely satisfied with present conditions —to put it mildly. Mr. J. B. Eastman, Federal Coordinator of Transportation in the United States, on January 13th pointed out that motor carriers in that country were actively supporting his efforts to introduce regulation of their rates and services. Starting with bitter hostility to the whole idea of governmental regulation, they had come to welcome it.

One of the reasons for this great change in sentiment is that in addition to acute internal competition among common carriers on the highways, there is an increasing tendency for highway common carriers to lose their business to highway contract carriers, and especially to casual invaders of the field who are ready to accept loads at very low rates and to fit their transportation of these into other operations in connection with their own business.

One point which I think I might safely raise is that there has been considerable confusion as to the extent of the damage done to railways by highway competition. In November, 1935, the total physical volume of business in this country was 110.0 per cent of the volume of business in 1926. Most items of industrial production, mineral production and forestry production were above the 1926 level. The conspicuous failures of recovery were those resulting from the failure of construction to recover, and from the small yields and slow movement to market of our grain crops. As a result, while distribution in November, 1935, was 100.2 per cent of the 1926 figure, and trade employment was 124.1 per cent of the 1926 figure, carloadings were only 66.8 per cent of the 1926 figure.

This connection between the failure of carloadings to recover and the diminished volume of construction, and the slow marketing of our chief agricultural export commodities was wholly natural. With those activities ranging between 30 per cent and 50 per cent of the 1926 figure, there is no reason to be surprised at a carloading figure of only 66.8 per cent of the 1926 figure.

In plain words, while it is impossible to determine precisely how much motor-trucks have deprived the railways of traffic, it is certain that motor truck competition has not been the only, or even the chief, factor in delaying the recovery of freight movement by rail in this country.

Do not misunderstand me. No one recognizes more clearly than I the serious damage to railway interests from highway competition. Operating chiefly in summer, and carrying almost entirely the higher priced commodities, it takes from the railways the cream of their business in the best season of the year. There can be no doubt of the loss to railway interests from this type of competition. The effect of this competition is, however, much less serious than the troubles produced by a general depression of business, still continuing in the field of construction and other heavy industries.

Another point which I may make is that a rather general public opinion that the railways were "asleep at the switch," and let highway transportation develop to its present position without meeting it intelligently, is wholly baseless. What were the railways to do when the motor car came into general use? Do you realize that during the great boom, and during the depression, motor-cars, motor-trucks and refined petroleum and its products have been among the most important items in our railway freight business? In 1929, for example, out of a total steam railway freight in Canada of 115,187,028 tons, and out of a total freight haulage of 32,471,409 tons of manufactured and miscellaneous commodities, motor-cars and petroleum products contributed no less than 5,687,792 tons of freight—and that of the highest classes. Wheat, coal, gravel, sand and stone, and lumber—all low grade commodities—were in that year the only specialized commodities listed as giving more business to the railways than we obtained from motor products and refined petroleum. Even in the bad year of 1933, out of 57,364,025 tons of freight on Canadian steam railways, and out of 14,239,120 tons of manufactures and miscellaneous, motor-cars, motor-trucks and petroleum contributed 2,748,716 tons of freight. In that year only wheat and coal, of all the specified groups of commodities, gave more business to the railways. Railway men are not given to trying to block the development of new industries. The internal combustion engine has added tremendously to human wealth in this and other countries. It was inevitable that it would take business from railways as well as give it to them, but railway men have tried to look on this subject intelligently, and to remember that the internal combustion engine has brought them gains as well as losses.

Critics of the railways, however, may admit all this and still argue that the railways failed to meet the challenge of this new form of competition. I should not have to explain that, in the matter of transportation in private passenger motor vehicles, the economics of competition are rather complex. There may be cases where, by faster trains, by more comfortable trains, or by cheaper fares, the railways could have kept, and may in the future keep, men and women from using their own cars for their own transportation and that of their friends, but they are not able to do this in many cases—especially in short distance hauls. I say without hesitation that any ordinary man will realize, if he thinks of this question at all, that the railways could not have hoped to meet the major part of the competition of private motor-cars at a profit. All that we could do in this field was to try to adjust ourselves and our operations to a condition which faced us.

It was equally inevitable that the internal combustion engine would be developed as motive power for freight. The great expansion of the use of private motor-cars, and the increasing importance of our tourist business, led to effective demand for improvement of existing highways and the construction of a great mileage of new roads. Do you believe that it would have been good policy for the railways to have set themselves up in opposition to this natural development of our social and economic life?

After a while, freight vehicles moving on the highways began to take from the railways business which the railways dislike to lose. From the time when this tendency first showed itself the railways gave constant and unceasing attention to the problem. They urged on public authorities the regulation of this form of traffic. They used all the resources of modern salesmanship to persuade their customers to remain faithful to rail transportation. They attempted reductions of rates and improvement of service to meet the competition.

The critics of railways admit all this, but they argue that the railways should themselves have entered this new form of transportation on a large scale. I cannot answer this criticism better than by asking you whether you believe that it has been unwise for the railways to refuse to enter a business which has, on the whole, and in the absence of reasonable and intelligent regulations, proved unprofitable. Vast amounts of capital have been lost in highway transportation enterprises. On the whole the business finds itself unable to give the workers in it fair wages and reasonable conditions of employment.

I shall risk a broad general statement. I assert that common carrier highway transportation of freight cannot continue on its present scale unless it is given certain rights and duties which it does not have at present. It must have franchises similar to those under which railways operate. It must have regulation of rates to protect it from cut-throat internal competition which is as dangerous to the business interests of the country at large as to the actual operators of highway transportation. It must have the duty of maintaining services on fixed schedules, ready to accept at least certain commodities when offered for transportation.

Given such a condition, it is possible that common carrier highway freight transportation may become an economic enterprise. When that is the case the railways will either be able to meet its competition, co-ordinate the operations of competing forms of transportation, or withdraw in part from that portion of the transportation field which the highways can better serve.

The problem, in short, is not as yet one of establishing a division of the field between two competing forms of transportation. In the case of one of them—the railways—we know that, with a simple rationalization of the railway situation in the country, we can correct the internal troubles of the industry and put it on a sound economic basis. In the other—the highway freight business—I say that its internal stability is not yet established, and until that is the case the established form of transportation cannot deal with it intelligently. I make these three points. Public opinion today tends to judge incorrectly the causes of the damage done to railway transportation by freight movement on highways. Public opinion misunderstands the attitude of railway men to this form of competition. Public opinion fails to realize that, in its present form, highway transportation of freight is not a proved economic enterprise.

Let me go a little further. What I have said so far I have said from the standpoint of a railway man defending the skill with which railways have met a serious challenge. Nothing can be more certain than that the people of this country are making a grave error in assuming that the problem is one for railway men alone.

In some cases, indeed, others have attempted to aid in its solution. Unfortunately, however, in almost every case their aid has been proffered in the form of advice to railway men as to how to run their railways better. With no doubt in the world that railway practice in this country can be improved, and can benefit from the advice of others who are not professional railway men, I still assert, for the reasons which I have given, that the solution of the problem lies only in part along this line. What I regret is the apparent indifference of too many of our citizens to aspects of the highway transportation situation which should concern them as citizens and taxpayers, rather than as friends of the railways.

It is not my intention to argue at length concerning the vexed question of the contribution which commercial highway transportation makes to the upkeep of our highway system. In fact I am fairly confident that there is no precise economic formula as yet developed which can be applied to fix, with definite accuracy, the taxation which should be paid by highway transportation interests in Canada.

To me the problem is a far more important one. In 1934—the last year of record—the Dominion, the provinces and the municipalities of this country spent on highway maintenance $20,881,965. In the same year the annual interest and sinking fund on provincial government funded highway debts amounted to $22,854,691. Total annual highway cost was thus $43,736,656. In the same year the total revenue from taxation on motor vehicles and the use of gasoline was $50,622,683. On the face of it it would be easy to assume that the public authorities were obtaining a revenue from highway sources in excess of their expenditures for highway purposes. I do not believe that this is the case.

The figures given were taken from the published documents of the Dominion government. It is not my intention to criticize the accuracy of provincial public accounts, but I may be permitted to point out that the figure showing interest and sinking fund on provincial government funded highway debts of $22,854,691 as I have given it cannot be one fully reflecting facts. The same public documents show total capital expenditures to the end of 1934 of $484,000,000. Proper provision for sinking fund and interest service on this amount would require at least $40,000,000 per annum. Add that to the admitted maintenance cost of over $20,000,000, and a total true annual highway cost to the provinces is obtained of over $60,000,000, as compared with the provincial revenues from highway sources of $50,622,683.

There are other reasons to doubt the accuracy of the published figures of highway costs and revenues.

In the first place, in recent years the rapidity of the process of improving the standards of highway construction has tended to interfere with correct accounting. In many cases the capital expenditures on highways by provincial governments include charges which, in my opinion, should have been maintenance charges. Where, as often has been the case, a gravel road has been constructed, and then replaced by a tar macadam road, and this in turn by a concrete road, is it good accounting to treat the three phases of construction as all capital expenditures? The first two should be charged to maintenance if their construction was really maintenance.

In the second place, the figures collected by the Dominion Bureau of Statistics, and given above, cover only capital and maintenance expenditure on provincial highways and provincially subsidized highways. The side roads of rural municipalities and small towns, and the enormously costly street systems of our great cities are all integral parts of the highway system which highway transportation interests use. The actual costs of constructing and maintaining our highway systems are far in excess of the figures which I have quoted.

In the third place the custom of accounting in connection with highway expenditures is neither well defined nor uniform in this country. The cost of maintaining the engineering and supervisory services of provincial highway departments; the cost of highway police; the cost of snow removal in cities as a result of the employment of motor-cars; the cost of traffic lights and other protective methods —these should all be included in the total cost of highway transportation if we are to obtain an intelligible figure.

I well realize the complex question which arises when we consider, for example, the streets of a city such as Hamilton. It has always been a function of a modern city to maintain streets for its citizens to use, and to maintain them out of the general taxes of the city. It is a nice question, which I recommend to your consideration, whether this principle can be considered as covering all those great costs placed on our city administrations by the coming of the motor-car. Certainly there is something economically unsound in the assumption that a motor-truck driving from the centre of Montreal to the centre of Toronto should be taxed only for the maintenance of the provincial highways between these cities, and should pay little or nothing for the use of the terminal facilities at each end. It would be very much easier for the Canadian Pacific Railway to make profits than is the case today had it free terminals furnished by the cities.

It is easy to understand why it is impossible to obtain a full and proper accounting of highway costs and highway revenue when these complexities are considered. I think, however, that it is not unfair to assert that the small surplus of revenue over expenditure which the figures that I gave you show is not an economic fact. I have no hesitation in saying that the highway revenue of our public authorities as a whole is not enough to meet their highway expenditures.

That, however, is not the most important question. The vital point is that the public authorities of this country today—Federal, provincial and municipal alike—find themselves dangerously close to a point of financial embarrassment. It does not matter, from this point of view, whether they have diverted highway revenue to the support of schools and hospitals, or whether they have taken money from the general tax fund to cover highway expenditures. The important fact is that they are all feeling financial strain.

I should like to record the opinion that, with a few regrettable exceptions, the public authorities of this country will, by strict economy and by the willingness of the taxpayers to bear added burdens, be able to meet their obligations. It must be clear, however, that the time has come when we must consider most seriously the necessity of limiting or even reducing those obligations. We face the end of the period during which increase in public debt could be recorded with indifference.

One of the major functions of provincial and municipal authorities today is to maintain our modern highway system. The value of this to our people is enormous. Its construction—as those old enough to remember a previous time well know—has revolutionized the life of the country. It is impossible and unthinkable that the people of this country should be willing to revert to the era of mud roads, and to a condition in which highway travel in this country was uncomfortable for part of the year and impossible for the rest.

We have in this country made great investments, based on the assumption that our modern highway system can be maintained. The great motor factories; a tremendous investment in facilities for the service of highway travel; indeed the livelihood of a great number of our citizens all rest on the foundation of our modern highway system.

It is thus with the deepest alarm that I see a time approaching during which the ability of our public authorities to maintain this system may be imperilled.

There have been mistakes made in planning it. Too much of its mileage has been constructed to parallel older and entirely adequate systems of transportation. Too much of its mileage has been built in districts where the density of traffic will not support the cost of the highways. Too much money has been expended in converting roads built for pleasure travel into right-of-way for heavy commercial vehicles.

It is not unusual when I discuss the subject for me to receive the answer that in no circumstances will the people of this country accept a reversion to the use of poorer highways. I am afraid that we have built too much of our economic system in this country on the assumption that people will not accept certain things. The people of this country will accept what they can get and pay for. The ability of public authorities to raise and spend money is not without its limits.

For these reasons I regret to see too little of the thought and discussion of the people of this country given to a problem of great magnitude which should concern them deeply. Desirable as it is that this country should maintain its present system of modern highways, it is by no means certain that we shall be able to do so. Those charged with their maintenance, will, I fear, during the next few years be faced with serious problems in the direction of lowering their expenditures and increasing their revenues. I offer that thought to every owner of a motor-car and to every taxpayer in this country.

It is more than probable that you will suspect that you are listening to a railway man attempting to frighten you. I shall not be surprised if I hear it said that this is all railway propaganda. I can only assure you in all honesty that it is nothing of the kind. It is the considered opinion of one who is trying to look at a great subject on broad lines.

Remember how I have put my case. I have said that the coming of the internal combustion engine and the motor-car has been a major boon to the development and wealth of Canada. I have admitted that the railways are not fully able under present conditions to meet the unregulated competition of highway freight carriers. I have told you that I believe this competition to be unsound and unprofitable. I have, finally, told you that I believe that our public authorities, all feeling the pinch of financial embarrassment, will find it increasingly difficult to maintain the highway system which they have built.

Had I the time, I might go at length into the difficult question of inland water transportation. No greater asset has been conferred on this country by nature than the great inland seas which are linked by the St. Lawrence with the Atlantic. It would be incredible that this country should not use this great channel of transportation.

I should like to remind you that, from the very first, the transcontinental railways of this country accepted the fact that, for all but the highest classes of commodities, the inland waterways would share in the traffic.

Unfortunately, however, while we readily produced the engineering skill to create such works as the Welland Ship canal, we do not seem to have had the economic wisdom to consider fully their effects. I do not believe for one moment that the people of this country would ever have approved a system by which the ships of foreign nations, using a great public work free of toll, could deprive the publicly and privately owned railways of Canada of business which they have held for generations.

I am not impressed by the contribution made to our own inland shipping industry by the latest developments of our inland waterway system. As far as I can ascertain, the owners of our shipping lines are not any more contented with their lot than are the railways and the operators of highway transportation. They have experienced the destructive internal competition which results from lack of regulation.

I believe fully that it is in the best national interest that the Government of Canada should take immediate steps to control and regulate the steamships plying on our inland waterways.

The case of the waterways presents an important difference from that of the highways. I have said that I doubt whether the collection of tolls for the use of highways is sufficient to meet the burden which their construction and maintenance imposes on our public authorities. In the case of the inland waterways, many years ago we adopted the unsound principle of throwing their use open entirely free of toll. I believe that it is in the interest of the nation that we should correct this error, and establish the principle that the traffic on our inland waterways should bear the cost of the public works provided for its use.

My intention has not been to do more than indicate the truths of this situation as I see it. What I should like to impress upon you is that these are questions too important to be regarded as merely a struggle for business between railways, highways and waterways. In view of the present financial situation of all the public authorities in this country, I believe that we must regard the entire transportation situation as a problem pressing for solution. The owners of private motor-cars whose value depends entirely on our ability to maintain a highway system for them; those engaged in the manufacture of motor vehicles and in their supply and maintenance; the owners of inland shipping, dependent for its very existence on the maintenance of great public works; the owners of shipping and highway transportation units—both suffering acutely from unregulated internal competition; the taxpayers of the Dominion, the provinces and of the municipalities who see their representatives struggling with great financial problems—all of these should remember that a time is approaching when, whether we like it or not, we shall have to face the consequences of past carelessness in the planning of our national transportation system.

I said earlier in my address that I believe that in the future the engineer would need to apply more of his thought to economic subjects and less to mechanical invention than has been the case in the past. I believe that the subject which I have discussed tonight offers an outstanding opportunity for this alteration in the direction of the efforts of the engineer.

Address of the Retiring President

Dr. F. A. Gaby, M.E.I.C.

Delivered before the Fiftieth Annual General Meeting of The Engineering Institute of Canada, Hamilton, Ontario, February 6th, 1936.

First, I wish to take this opportunity of thanking the officers and members of Council for their co-operation and assistance, and if I may, include The Institute staff. The duty of presiding over our organization during the past year has been a most enjoyable one, and the association, goodfellowship and friendliness of the officers and members have afforded very great satisfaction, and are sincerely appreciated.

Several issues of momentous importance are before the members of The Institute and its Council, and their settlement will have a far-reaching effect in the future success and in the affairs of The Institute. I refer to the establishment of a National Council for all branches of the engineering profession. It is indeed gratifying that by unanimous vote of the General Meeting yesterday the work of the Committee on Consolidation should be continued, with authority to co-operate with the representatives of the Provincial Associations. In this matter, I commend the earnest and open-minded attention of your Committee in an effort to attain a satisfactory solution of the problems confronting you.

The marked improvement in the membership during the last year is sufficient evidence as to the standing of The Institute in the profession.

In approaching the main subject of my remarks, I have made no further attempt than to indicate generally certain factors that may be of value in giving direction to your thought on several important matters. The great progress that has been made within the last four decades in the utilization of power in the broader sense in our economic world, and the part that the engineer has played in such a development, is well known to all of you. The engineer has been responsible to a considerable extent for the development of our present economic structure, and his training is highly appropriate and may be helpful in the solution of the many difficult problems which are today confronting this country, and which are more or less common to all countries. It is with this in mind that I suggest the following for the consideration of our educationalists in the preparation of the engineering student for his career.

It is indeed paradoxical that, in an age of power, there should be the occasion of disturbance and distress, apparently due to the very triumphs and achievements of the period. With the tremendous advance and increasing perfection of our technical equipment, along with the greater knowledge of our engineers, it would be expected that our civilization might expand and be free from the drudgery which has absorbed so much of man's time and energy in the past.

There is, however, an obstacle somewhere which has deprecated our efforts and still more effectively prevents the fullest development of the potentialities of our technical skill and knowledge. It might be suggested that this is the manner in which our powers have been exploited and the advent of the operation of the manifold devices for the reduction of human labour involved in production. Such a thought would lead you to concentrate upon the problems of the technical situation, and upon the actual difficulties to be overcome in relation to the utilization of power consumption, actual and potential. The solution of such problems and the adoption of new methods would add to the store of human knowledge and the world would be benefited by the achievements made possible, bringing nearer the goal of eliminating waste in both energy and time. There would still remain obstacles of a formidable nature, which might easily nullify the new knowledge that has been attained.

It must be apparent that another factor is equally important in the development of our immense power processes and the utilization of its potentialities. It is not enough that engineers should apply themselves to technical problems. They must give leadership in the adjustment of our economic structure to the new era which the technician has produced. Otherwise it may be said with some reason that the engineer has carried his work to a point where the progress made appears to threaten the stability of society. It must, however, not be thought that the technical advance should not be continued, by allowing what is really a temporary obstacle to prevent progress which has had and has still such potential capacity for lasting benefit. Rather should we give leadership in adapting our economic system, the essential function of which is to facilitate co-operation in production and distribution of commodities to the new condition.

The technical worker and engineer are constantly breaking new ground and evolving new methods, perfecting new processes and constantly revolutionizing production, which calls for modification in our economic order. The universal knowledge of matter and things, which is conveyed almost instantly throughout the world, has added to our perplexity and we can no longer deal with our national economic problems without consideration of their international implications. New concepts of economic thought; innovations in organization; rationalism; planning in control and restriction, are constantly being introduced which have a profound effect upon the character of our economic order.

Would it not be appropriate for the engineer to venture beyond his technical situation and endeavour to co-ordinate his interest with that of the economic interest by conference, discussion and the fullest interchange of knowledge to achieve the maximum possible advance in the solution of our problems?

Our professional society is a medium that is ideal for that very purpose and has in the past been available for discussions of such problems—with benefit.

This brings me to another thought and that is the broadening of the technical education of our young engineers to include other subjects that will fit him to take his place in the affairs of industry and public service as an administrator. The necessity of suitable training at an early stage is of material importance, with the object of encouraging him to equip himself for the duties and responsibilities of an executive. It must not be taken for granted that the engineer can achieve success as an executive by education, training and experience only. Other personal qualifications are of equal importance, such as tact, sincerity, initiative, temperament and leadership. These qualifications can only be evident by development and encouragement, along with the knowledge that is given by appropriate technical study. Such education will embrace scientific thought, with the ability to analyze complex data rationally and come to an intelligent, constructive conclusion and to think in terms of the general principles of physical science, with well-ordered knowledge and a thorough understanding of the significance of the fundamental economic laws. An engineer should be able to organize his thoughts for a clear logical expression, and for this purpose a course in the cultural arts is of value.

The general manager in a technical industry may require experience, seventy-five per cent administrative and twenty-five per cent technological, in order to control and co-ordinate the specialized activities; his knowledge must also extend to other external activities, such as finance, commerce, law, etc., which are correlated with industry and public service.

No doubt this complex problem is receiving the most earnest consideration and thought of our educationalists. It is, however, difficult, one will appreciate, in view of the present system of mass education, to give that personal attention necessary to observe the characteristics and qualifications, as well as the adaptability of the student. His development needs such attention to bring out the best in the individual in the interest of society. Thus should we prepare for the future with new concepts of our responsibility.

May I again thank the members, and members of Council for their excellent co-operation in dealing with the problems involved in the administration of The Institute during the past year.

THE
ENGINEERING JOURNAL
THE JOURNAL OF
THE ENGINEERING INSTITUTE
OF CANADA

VOLUME XIX MARCH 1936 No. 3

His Majesty the King

Members will note with respectful interest that The Institute for the first time counts a reigning Sovereign among its members. It will be recalled that His Majesty King Edward VIII honoured The Institute in 1919 by graciously accepting Honorary Membership when Prince of Wales on the occasion of his visit to Canada in that year.

The London Passenger Transport Board

The problems of passenger transportation arising in the great cities of the world are formidable, for within a single area the daily needs of from five to ten million people must be met, and these needs are continually changing. In its development such a city passes through a series of stages, in each of which its possible extent is limited by the means of transport available at the time. In the days of the stage-coach, for example, the size of London depended almost entirely upon the capabilities of the horse as a transport agency. After 1840, when the first suburban railways had been built and were supplemented by horse-drawn buses, a second stage was reached. In the sixties its continuous built-up area had become some eight miles in diameter. Fifty years later, by the time the steam-worked underground and suburban railways had been adapted to electric traction, and the construction of the tubes had begun, the solid core of the city was some twenty-five miles across. In the first years of this century the internal combustion engine brought about another change, with the result that motor bus and coach services now operate over an area of fifty to sixty miles in diameter. Arterial roads are being built, opening up entirely new districts, and the older avenues of traffic are being widened at great cost, with the unfortunate result that much of the added space is generally occupied by parked motor cars.

While these changes have been occurring, the distribution of population in the newer areas has not been directed to any predetermined end. Housing programmes have a tendency to centre in unexpected areas; thus, large housing developments have been carried out at points where adequate transport facilities are difficult to provide. Competition has arisen between one form of transport and another, not only for existing traffic, but also for the new traffic which the city's growth produces. It was not until 1933, when the London Passenger Transport Board was created, that a body existed whose special function it was to plan passenger transport as a single service, constituting as it were a framework upon which London can be built up.

The necessity for the establishment of this Board arose from the many difficulties due to the extreme traffic congestion in the metropolitan area, and the failure to find a solution for them under a system of uncontrolled competition. The Board functions as a controlled monopoly whose responsibility to its shareholders is limited to the maintenance of a dividend within narrowly fixed limits.

Its constitution is somewhat unusual. The stockholders have no voice on the Board, whose seven members are independent and are chosen by a selecting panel which includes the chairman of the London County Council, the chairman of the Committee of London Clearing Bankers, the President of the Law Society, the President of the Institute of Chartered Accountants, and other incumbents of responsible offices likely to change from year to year. Members of the Board thus selected can only be removed by the Minister of Transport, a feature likely to ensure freedom and integrity of action. The Board reports to Parliament through that Minister. The area served covers nearly two thousand square miles, with an estimated population of nine and a half million people.

Its capital (£110,000,000) represents the pooled resources of the various transport undertakings concerned, principally the tube railways, the tramways, and the bus and coach companies. It controls services which were previously in the hands of one hundred and sixty-five separate organizations, covering all types of passenger traffic, with the exception of the suburban services of the four main line railways which now account for only about thirteen per cent of the total passenger movement. While the Board works in consultation with these railways in all matters of mutual concern, their interests are not yet united.

The extent of its operations may be judged by the figures for 1934-35. During that fiscal year 3,600,000,000 passengers were carried by the Board's means of transportation, and 550,000,000 more by the associated suburban railways. In the London area this indicates travel at the rate of over 400 journeys per head of population per year.

The Board has 76,000 employees, operates over 3,000 railway passenger cars, nearly 6,000 buses, 2,500 tramcars, 500 motor coaches, 63 trolley buses, and a large number of miscellaneous and service vehicles. Thus it is now probably the world's largest transit system.

Provision has been made for the Board to have government assistance in raising a sum of £40,000,000, which is to be expended in five years for the improvement of London's traffic facilities, largely by developing means for the physical co-ordination of existing services. Further projects now in hand include 12 miles of new tube railway, the electrification of 44 miles, and the doubling and electrification of 12½ miles of suburban railway, and the substitution of trolley buses for tramcars on 148 route miles.

The establishment of the Board has resulted in many advantages to the public. For the first time it has been possible to make progress in utilizing the various types of vehicles for the particular services to which they are most suited. After only three years of activity, including a difficult period of preliminary adjustment, the Board has already justified the expectations of those who advocated its establishment.

In a recent address* the vice-chairman of the Board points out that the present complex systems of transport must be balanced to secure the best results. The railways must be so handled that their expensive facilities are fully occupied with the kinds of traffic for which they are particularly adapted. Since the facilities themselves create traffic, provision must be made for this circumstance. The programme should be such that the measure of the added facilities may be related to that of the anticipated traffic. Mr. Pick goes farther, and expresses the hope that the success attending the Board's operations will encourage the application of similar co-ordinative methods in the case of other utilities now administered in the London area by some three hundred autonomous bodies. He hopes that the Board will serve as a model for the control of other commercial or quasi-commercial services.

The work of such a board must be based on something more than a mass of statistics, plans and graphs. A wider vision is needed. In Mr. Pick's address he speaks of a "metropolitan state which can organize the activities of its millions of citizens to a common end and purpose, more worth while than that which could come from anything smaller. The breaking of statistical records for population, traffic movement, congestion, speed, safety, are all isolated and insignificant endeavours unless they are incidental to the conception of a life and civilization on a greater and more splendid scale." These ideas seem worth thinking over.

*The Organization of Transport, Frank Pick, Jour. Royal Soc. Arts, January, 1936.

Meeting of Council

A meeting of the Council of The Institute was held at the Royal Connaught Hotel, Hamilton, on Thursday, February 6th, 1936, at five o'clock p.m., with President E. A. Cleveland, M.E.I.C., in the chair, and twenty-two other members of Council present.

R. J. Durley, M.E.I.C., was re-appointed Secretary of The Institute, and J. B. Challies, M.E.I.C., was re-appointed Treasurer.

The resignation of Mr. J. R. Cockburn, M.E.I.C., as councillor of the Toronto Branch, was regretfully accepted, and Council's thanks were conveyed to Mr. Cockburn for his services during his term as councillor. In accordance with Section 13 of the by-laws, Colonel R. E. Smythe, M.E.I.C., was unanimously appointed, on the nomination of the Toronto Branch, to fill the vacancy caused by the resignation of Mr. Cockburn.

The Finance Committee was re-appointed for the year 1936 under the chairmanship of P. L. Pratley, M.E.I.C., the membership being as follows:—

P. L. Pratley, M.E.I.C., *Chairman.*
J. L. Busfield, M.E.I.C.
J. B. Challies, M.E.I.C.
A. Duperron, M.E.I.C.
F. Newell, M.E.I.C.

The chairmen of the other standing committees were appointed as follows, and asked to submit the names of the other members of their committees to the next meeting of Council:—

Library and House Committee............E. A. Ryan, M.E.I.C.
Papers Committee.........................R. L. Dobbin, M.E.I.C.
Publication Committee...................H. Cimon, M.E.I.C.
Legislation Committee...................R. E. Smythe, M.E.I.C.

A letter was presented from the Secretary of the Committee on Consolidation requesting Council's approval of the appointment of Dr. F. A. Gaby, M.E.I.C., as a member of that committee, this action being taken as a result of the resolution passed at the Annual Meeting on February 5th, 1936. This was unanimously approved.

A special committee was appointed under the chairmanship of J. L. Busfield, M.E.I.C., to prepare tentative plans for the celebration of The Institute's Semicentennial in 1937.

Council expressed its appreciation of the activities and useful services to The Institute of retiring councillors J. L. Busfield, M.E.I.C., and C. M. Pitts, A.M.E.I.C., during their term of membership.

It was resolved that the Council meetings of May and October 1936 should be held in Toronto.

The Council rose at six thirty-five p.m.

OBITUARIES

William Laird Ketchen, M.E.I.C.

Regret is expressed in placing on record the death on November 16th, 1935, of William Laird Ketchen, M.E.I.C., of Vancouver, B.C.

Mr. Ketchen was born at Middlesborough, Yorkshire, England, on July 14th, 1875, and served a six years' apprenticeship with James Bertram and Sons Company, Edinburgh. He attended the Heriot Watt Engineering College from 1893 until 1899. In 1899-1901 Mr. Ketchen was a draughtsman in the experimental engineering department of Poyser-Haywood-Acland, Nottingham, England, and in 1901-1902 became draughtsman and assistant engineer with John Dickinson and Company, paper makers, Hemel Hempstead, England. Coming to Canada in 1902, Mr. Ketchen joined the staff of the Canadian Pneumatic Tool Company Ltd., as draughtsman and assistant to the manager. In 1904 he was with the Dominion Pneumatic Tool Company, and in 1905 with Mr. J. A. Jamieson, M.E.I.C., consulting engineer. From 1906 until 1913 Mr. Ketchen was chief draughtsman with the Dodge Manufacturing Company Limited, in Toronto, and in 1914 he became connected with the Riordon Pulp and Paper Company Ltd., being in charge of outside construction, under the direction of the chief engineer, at Hawkesbury, Ont. In 1916 he was chief engineer of construction for the same company at Merritton, Ontario, and in 1917 occupied the same position at Hawkesbury. In 1918 Mr. Ketchen was with the Kipawa Company Ltd., at Temiskaming as chief engineer of construction. In 1922 he returned to the Riordon Company for a time, and in 1923 went to British Columbia, where he was on the staff of the Whalen Pulp and Paper Mills Ltd., at Port Alice. In 1927 he was with the British Columbia Pulp and Paper Company Ltd., also at Port Alice, and in 1934 he was transferred to Vancouver, B.C., where he remained until his death.

Mr. Ketchen joined The Institute as a Member on October 28th, 1919.

J. Albert Edouard Larrivée, Jr.E.I.C.

It is with deep regret that we place on record the untimely death on February 15th, 1936, at Victoriaville, Que., of J. Albert Edouard Larrivée, Jr.E.I.C.

Mr. Larrivée was born at Mont Joli, Que., on August 7th, 1902, and graduated from the University of New Brunswick in 1926 with the degree of B.Sc.

Following graduation Mr. Larrivée joined the staff of the Canadian National Railways, and was for a time assistant division engineer on railway construction. Later he was engaged on quantities for concrete bridges, and in 1927-1928 laid out curves and bridges in the field. In 1928 Mr. Larrivée was transferred to the maintenance of way department also as assistant division engineer. In the autumn of 1930 he entered the service of the Department of Agriculture of the province of Quebec, and was located at Victoriaville, Que.

Mr. Larrivée became a Junior of The Institute on December 19th, 1930.

George Douglas MacKinnon, M.E.I.C.

It is with regret that we place on record the death at Sherbrooke, Que., on January 24th, 1936, of George Douglas MacKinnon, M.E.I.C.

Mr. MacKinnon was born at Charlottetown, P.E.I., on June 8th, 1874, and graduated from McGill University in 1897 with the degree of B.A.Sc.

In 1898-1899 Mr. MacKinnon was engaged on engineering and contracting and sewage construction in Charlottetown, and from 1899 until 1904 he was with the Ball and Wood Engine Company, Elizabethtown, N.J., C. Carrier and Sons, Newark, N.J., and the Midvale Steel Company, Philadelphia. From 1904 until 1909 he was in charge of the plate department of Jenckes Machine Company Limited, Sherbrooke. In 1909 Mr. MacKinnon formed MacKinnon Holmes and Company Limited, which was reincorporated in 1917 as the MacKinnon Steel Company Ltd. with Mr. MacKinnon as vice-president and managing director. In 1929 he became president of the Rutherford Lumber Company Limited. Mr. MacKinnon was a member of the Canadian Manufacturers' Association and also of the Corporation of Professional Engineers of the Province of Quebec.

He joined The Institute (then the Canadian Society of Civil Engineers) as an Associate Member on January 11th, 1906, and became a full Member on May 22nd, 1922.

Frank Clinton White, A.M.E.I.C.

Regret is expressed in placing on record the death at Montreal on February 15th, 1936, of Frank Clinton White, A.M.E.I.C.

Mr. White was born at Raleigh Township, county of Kent, Ontario, on December 28th, 1885, and graduated from the University of Toronto in 1911 with the degree of B.A.Sc. Following graduation, Mr. White was until 1913 engaged on structural steel detailing with the Dominion Bridge Company and the Canadian Bridge Company, and in 1914-1915 he designed and installed electrical equipment for lift bridges for the Canadian Bridge Company. In 1915-1918 Mr. White was designing and checking for the Dominion Bridge and the Eastern Canada Steel and Iron Works, and in 1918 became engineer in charge of designing and detailing for the Canadian Desmoines Steel Company. In 1924 Mr. White was senior designer of plate and tank work and assistant to the engineer of the plate and tank department of the Dominion Bridge Company, and later was appointed assistant engineer in the company's plate and boiler department, which position he held to the time of his death.

Mr. White joined The Institute as an Associate Member on May 7th, 1929.

PERSONALS

A. Plamondon, A.M.E.I.C., consulting engineer, Montreal, has been appointed a member of the Electrical Commission of the City of Montreal.

A. H. Perry, A.M.E.I.C., formerly assistant engineer with the Department of Pensions and National Health at St. Catharines, Ont., is now district engineer for the Department at Vancouver, B.C. Mr. Perry graduated from the University of Toronto in 1930 with the degree of B.A.Sc.

Humphrey C. Beck, A.M.E.I.C., has joined the staff of the English Electric Company at Stafford, England, as manager of the substation department. Mr. Beck graduated from the Federal University of Technical Sciences at Zurich, Switzerland, in 1928, subsequently joining the engineering staff of Brown, Boveri and Company at Baden. From 1932 until 1934 he was resident engineer for that company in Canada, and since 1934 he has been engaged on electrical engineering work at the Baden works of the company.

Dr. F. A. Gaby, M.E.I.C., past-president of The Institute, has been elected to the board of the British American Oil Company and becomes executive vice-president of that company.

Dr. Gaby graduated from the School of Practical Science, University of Toronto, receiving the degree of B.A.Sc. in 1903, and those of M.E. and E.E. in 1904. Following graduation he became erecting engineer with the Canadian General Electric Company on the Nova Scotia Steel and Coal Company work at Sydney Mines. The

Dr. F. A. Gaby, M.E.I.C.

next two years found him employed in a similar capacity with the Toronto-Niagara Company, and in 1906 he became chief assistant electrical engineer at the Pointe du Bois power plant on the Winnipeg river. Dr. Gaby joined the service of the Hydro-Electric Power Commission of Ontario in 1907, and acted in the capacity of assistant chief engineer until 1912, when he became chief engineer of the Commission, later acting also as chief executive officer. Early in 1934, owing to a change in government in the province of Ontario, Dr. Gaby severed his connection with the Hydro-Electric Power Commission and became consulting engineer with Noranda Mines Limited. Later in the year he was appointed assistant to the president of the Canadian Pacific Railway Company with headquarters in Montreal, which position he now resigns.

H. Alton Wilson, A.M.E.I.C., who has for the past twelve years been with the Canadian Fairbanks Morse Company Limited, Montreal, as engineer in charge of recommendations and installations of pumps, engines and electrical apparatus, has severed his connection with that company, and accepted the position of direct factory representative and technical sales representative of several pump and engine manufacturers whose plants are located in the United States and Canada. Mr. Wilson will make his headquarters at Toronto.

Annual Fees

Members are reminded that a reduction of One Dollar is allowed on their annual fees if paid on or before March 31st of the current year. The date of mailing, as shown by the postmark on the envelope, is taken as the date of payment. This gives equal opportunity to members residing in all parts of the country.

Ernest Albert Cleveland, M.E.I.C.

One of the most valuable contributions which the Eastern provinces have made to the welfare of the West of Canada has been the stream of young and enterprising men, natives of the East, who have journeyed westward, quickly absorbed Western traditions of energy and activity, have become leaders in many fields of work in their new homeland, and have taken a notable part in its development.

The newly-elected President of The Engineering Institute of Canada for 1936, E. A. Cleveland, M.E.I.C., was one of these newcomers from the East. Born in New Brunswick in 1874, on the shores of Chignecto Bay, he arrived in Vancouver some forty-five years ago, reaching the city at a time when the Canadian Pacific Railway had just provided the link which joined British Columbia to the rest of Canada. The city, devastated by the fire of 1886, was then just beginning the phenomenal development which has given Vancouver its commanding position on the Pacific coast.

Naturally interested in engineering work, Mr. Cleveland, under the system of training then customary, became an articled pupil with Williams Brothers and Dawson, engineers and surveyors in Vancouver, and was engaged on surveys and general work in various parts of the province during his pupilage. His experience with this firm was largely in connection with road and reclamation work and the early activities of the British Columbia Electric Railway Company. On completing his articles he worked for a time under the late T. A. Noble, M.Am.Soc.C.E., on hydroelectric surveys and in 1894-1895 became an assistant on the International Boundary Surveys in Alaska. In the following year he received his commissions as British Columbia Land Surveyor and Dominion Land Surveyor.

ERNEST ALBERT CLEVELAND, M.E.I.C.

After a period spent in triangulation surveys for the provincial government, he was able to devote some time to engineering study in Seattle, and at the University of Washington, but before the completion of his partial studies there he joined the British Columbia Exploring Syndicate for work on mining exploration and operation on the coast and in the interior of the province. During the four years which followed he was also making surveys and investigations for hydro-electric power developments and railways.

In 1904 Mr. Cleveland commenced private practice, largely in connection with mining properties, and in 1910 became a partner in the firm of Cleveland and Cameron, Vancouver, which soon developed a large general practice as engineers and surveyors. His partner in the firm was Donald Cameron, who when city surveyor of Exeter, England, developed the septic tank. During 1912-1914 the firm was associated with Sir John Wolfe Barry and Partners in connection with a project for a bridge over the Second Narrows in Vancouver harbour. This bridge, however, was not constructed.

From 1919 until 1926 Mr. Cleveland was Comptroller of Water Rights for the Province of British Columbia, Chairman of a Board of Investigation under the Water Act, and consulting engineer to the Department of Lands. Under the Minister of Lands he conducted a reconstitution and refinancing of the larger irrigation projects in the province, and a general supervision over their reconstruction, and was also responsible for the design and construction of the Southern Okanagan irrigation project. Mr. Cleveland was in charge of the design for the general layout of the University of British Columbia Endowment Lands at Point Grey and the development for occupation of the first units of that area. In 1926 he was appointed Chief Commissioner of the Greater Vancouver Water District and Chairman of the Vancouver and Districts Joint Sewerage and Drainage Board, which offices he still holds.

Mr. Cleveland became a Member of The Institute (then the Canadian Society of Civil Engineers) on March 10th, 1914, and was a member of Council in 1927.

He is a Member of the American Society of Civil Engineers and of the American Water Works Association. Since 1926 he has been an active member of the Vancouver Town Planning Commission.

Mr. Cleveland, as chairman of the local advisory committee, was largely responsible for the great success of The Institute's Western Professional Meeting held in Vancouver in 1934 in conjunction with the American Society of Civil Engineers. His election to the Presidency of The Institute at this time is especially appropriate having regard to the present active movement towards professional consolidation in Canada, for in British Columbia the provincial association of Professional Engineers has been able to make progress in the organization of the profession which has not been excelled in any other province. Familiarity with the registration problem in the West cannot fail to be of value to the new President in the period of active development upon which we now hope to enter.

Those who have worked with Mr. Cleveland will not need any description of his genial personality and capacity for leadership. But to those who have not served with or under him it may be said that his outstanding position in the public life of Vancouver is due also to his technical competence as an engineer, his knowledge of affairs, his skill in dealing with contentious problems, his ability in directing discussion and his achievements as a public servant.

Members of The Institute may be congratulated upon electing as their President so sterling a member of the engineering profession in the West.

The Fiftieth Annual General and General Professional Meeting

Convened at Headquarters, Montreal, January 23rd, 1936, and adjourned to the Royal Connaught Hotel, Hamilton, on February 5th, 1936.

The Fiftieth Annual General Meeting of The Engineering Institute of Canada commenced at Headquarters on Thursday, January twenty-third, nineteen hundred and thirty-six, at eight fifteen o'clock p.m., with Vice-President P. L. Pratley, M.E.I.C., in the chair.

In response to the chairman's suggestion, all present stood in silence as a mark of respect to His Late Majesty King George V.

The Secretary having read the notice convening the meeting, the minutes of the Forty-Ninth Annual General Meeting were submitted, and on the motion of J. L. Busfield, M.E.I.C., seconded by K. G. Cameron, A.M.E.I.C., were taken as read and confirmed.

Appointment of Scrutineers

On the motion of G. Kearney, M.E.I.C., seconded by J. B. D'Aeth, M.E.I.C., Messrs. G. W. F. Johnston, A.M.E.I.C., and H. Massue, A.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 C. K. McLeod, A.M.E.I.C., seconded by R. H. Findlay, 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 fifth day of February, nineteen hundred and thirty-six.

Adjourned General and General Professional Meeting at the Royal Connaught Hotel, Hamilton, Ontario

The adjourned meeting convened at ten o'clock a.m. on Wednesday, February 5th, 1936, President Gaby in the chair, the meeting having been called a day earlier than had been originally intended in order to allow ample time for the consideration of the report of the Committee on Consolidation, which had been appointed by the Annual Meeting on February 7th, 1935.

Committee on Consolidation

President Gaby having expressed gratification at the interest shown in this question, as evidenced by the large attendance of members, R. F. Legget, A.M.E.I.C., (Montreal), presented a motion:

"That the chairman of the Committee on Consolidation read the report of his committee, or such portions thereof as he may consider necessary to provide a proper background for the discussion of the report; this presentation of the report to be followed by a period not exceeding thirty minutes, during which questions relative to the report may be asked of the chairman of the committee. Following this question period, the Secretary shall read such resolutions relative to the report as have been received from branches of The Institute. Finally, the meeting shall be thrown open to a full discussion of the report by the members present, each member being given an opportunity of speaking twice and the discussion to be terminated by members of the Committee on Consolidation."

The motion, having been seconded by Professor R. E. Jamieson, M.E.I.C., (Montreal), was *carried.*

The report of the Committee on Consolidation, having been previously submitted to the Council of The Institute at a special meeting called for that purpose on January 15th, 1936, was submitted to the meeting and introduced by Gordon McL. Pitts, A.M.E.I.C., (Montreal), who referred to the personnel of the committee, expressed appreciation of their work, and pointed out that the committee was not a committee appointed by Council, but had been established by the direct action of the Annual General Meeting of 1935. Mr. Pitts then gave a brief historical summary of the events leading up to the establishment of his committee, and after requesting all present to note on their copies of the report, as the reading proceeded, such points as might seem to require query or discussion, read the second portion of the report as published in The Engineering Journal for February 1936 (pp. 84 to 90), after which he moved the adoption of the report, his motion being seconded by Mr. Legget.

Dr. L. F. Goodwin, M.E.I.C., (Kingston), suggested that the report should be received rather than adopted, as its adoption would be a question arising after its discussion.

C. C. Kirby, M.E.I.C., (Saint John), drew attention to a reference in the report as to the Committee of Eight, and pointed out that this body had now given rise to the Dominion Council of the Professional Associations. While the Committee of Eight last met in 1933, the Dominion Council had been active since its formation in 1934, and he regretted that the report of Mr. Pitts' committee had not recognized this fact. He desired it to be understood that the Dominion Council of the Professional Associations was in existence and was prepared to receive and take action on any recommendations that The Engineering Institute of Canada desired to make.

Mr. Pitts explained that his committee had had no official notice of the existence of the Dominion Council and would be greatly pleased to hear of its existence and functioning.

At the request of the President, the Secretary read a number of communications received from Institute branches and members expressing appreciation of the committee's work and commenting on the report, as follows:

(1) Resolution of the executive committee of the Quebec Branch, January 31st, 1936, agreeing generally with the recommendations of the report, and particularly with the principle involved in recommendation No. 2.

(2) A report from the Kingston Branch regretting that the report of the Committee on Consolidation contains no constructive suggestion as to what can be done to obtain the co-operation of the provincial professional associations, although the committee has made useful suggestions as to matters of detail. The branch was of the opinion that further action should be in the hands of the Council and should be directed towards obtaining the co-operation of the Committee of Eight.

(3) Letter from the Secretary-Treasurer of the Lakehead Branch endorsing the recommendations of the Committee on Consolidation, and suggesting that action be deferred until a majority of the provincial professional associations are agreeable to consolidation; also that engineers in training with a provincial professional association be not eligible for admission to the national body until they have obtained registration.

(4) Letter from F. S. B. Heward, A.M.E.I.C., (Montreal), urging that before any further action is taken a definite plan for consolidation should be submitted to the membership, this plan being the result of conversations of duly authorized representatives of the Council of The Institute with officers of the professional associations. Mr. Heward was also of opinion that The Institute should not lower its requirements for corporate membership by admitting to membership in The Institute members of those provincial professional associations whose requirements are less onerous than those of The Institute. Such associations

should improve their standards. Mr. Heward also felt that consideration should be given to the many engineers who are not able to endorse any scheme which would render it necessary for them to apply for a provincial licence in order to participate in the activities of The Institute.

(5) Resolution passed by the executive committee of the Toronto Branch on February 4th, 1936, expressing approval of the report of the Committee on Consolidation.

(6) Telegram from the executive committee of the Victoria Branch dissenting from the report of the Committee on Consolidation on the ground that if made effective three separate groups of engineers would exist, and urging that national organization must be based primarily on an independent amalgamation of the provincial professional associations themselves, which would subsequently merge with The Institute and adopt its traditions, aims and objects. The branch was of the opinion that the associations should be willing to register all corporate members of The Institute.

(7) Telegram from the Calgary Branch executive committee approving the recommendations of the Committee on Consolidation, provided the efforts of the Dominion Council will be continued towards uniformity of requirements for admission and practice throughout the provinces and the right of interprovincial practice by members.

(8) Telegram from the Secretary of the Edmonton Branch expressing the opinion that partial consolidation would be dearly purchased if at the expense of jeopardizing the continued usefulness of The Institute or any provincial professional association. Good relations with groups of engineers not presently interested in The Institute should be carefully preserved.

(9) Telegram from Winnipeg expressing the opinion of the Manitoba Joint Consolidation Committee approving the recommendations of the Committee on Consolidation as a basis for negotiations for the establishment of one comprehensive and nationally expressive organization of engineers in Canada.

(10) Telegram from the Moncton Branch stating that the executive committee of that branch endorsed all of the nine recommendations of Mr. Pitts' committee's report.

E. Viens, M.E.I.C., (Ottawa), reported that although no wire had been received from the Ottawa Branch, a meeting had been held and the Ottawa Branch managing committee agreed with the report in general.

G. H. Wood, A.M.E.I.C., (Niagara Falls, Ont.), stated that the Niagara Peninsula Branch had held a special meeting and passed a resolution approving the report and recommendations of the committee in their present form, but reserved judgment on any specific propositions.

Gordon McL. Pitts, A.M.E.I.C., in order to meet Dr. Goodwin's objection, agreed that his motion might call for the reception of the report. The President accordingly stated that the motion now before the meeting was that the report of the Committee on Consolidation be received, and said that the discussion of the report would be in order.

Mr. Kirby drew attention to the committee's recommendation No. 8, and asked why reference had been made to the formation of provincial divisions of The Institute. He felt that their establishment would merely have the effect of setting up another provincial corporate entity in each province.

Mr. Pitts explained that the proposal was made in order to make it possible to establish a working organization in every province, providing in this way for a case in which the local professional association did not feel ready to go into the re-organization scheme.

Mr. Kirby further inquired with reference to recommendation No. 4 regarding the "acceptance of corporate membership in The Institute as qualification for admission to the professional association when permissible under the law of the province." He felt that as this action was already within the power of the several provincial professional associations there seemed no necessity for providing for it.

Mr. Pitts remarked that he was glad to learn that the power already existed and that there was no necessity for making provision for the case named. He felt the recommendation was of use because it drew the attention of the profession in the provinces to a point which would require consideration.

F. P. Shearwood, M.E.I.C., (Montreal), while in favour of co-operation between The Institute and the provincial professional associations, deprecated hasty action. He asked consideration of the following points:—

(1) While recommendation No. 2 calls for rigid limitation of the future membership of The Institute to licensed engineers, the report does not state what kinds of work should be limited to licensed engineers. For licensing to be effective it must be consistently applied and certain work must be restricted to licensees.

(2) Is it intended to exclude from the ultimate organization the many men who assist in the design of structures and machines in modern industrial work, who may not in the future satisfy the licensing requirements, or may not wish to take out licences?

(3) A clear definition is needed as to who is required to be licensed. The report makes no provision for specialists doing engineering work of a limited character in industry.

(4) The report would have been more illuminating if it had contained some of the recommendations and arguments of the eighty-eight different members who have submitted opinions to the committee. No reference or comment is made to alternative schemes such as those presented by P. L. Pratley, M.E.I.C., (Montreal), or by the authors of the papers presented for the Past-Presidents' Prize.

(5) Any final scheme should be prepared by a committee fully representative of the different branches of engineering. It should contain a full statement of worthwhile criticisms, and the committee should have upon it representatives thoroughly familiar with the work of the engineering staffs in the large industrial, transportation, and contracting companies, who are not represented on the present committee.

Mr. Shearwood felt that these points should receive consideration, and that any continuing committee should be instructed to examine and report on the Winnipeg scheme for co-operation as a possible desirable way of temporarily trying out co-operation. He felt that such an experiment might well lead to a permanent and satisfactory consolidation scheme.

D. R. Thomas, M.E.I.C., (Toronto), believed that some of the objections raised by Mr. Shearwood would be met by the classification of members which had been proposed by the committee, since Class B would comprise all those not legally required to obtain licences to practise. He believed that Class B would eventually outnumber Class A, and that the number of engineers designated as Class C by the committee, namely, those belonging to the provincial professional associations but not to the national body, would ultimately disappear. He expressed agreement with the recommendations of the committee.

Dr. R. W. Boyle, M.E.I.C., (Ottawa), after congratulating the committee on its work, did not agree with the Kingston Branch in their statement that nothing constructive had been suggested by the Committee on Consolidation. He felt that from the letters and telegrams read, none of the criticisms or cautions expressed were new, and he believed they were nothing to be afraid of. He drew attention to the figures given in the report comparing the corporate membership of The Engineering Institute of Canada and the membership of the provincial professional associations, and to the answers to question No. 3, which, in his view, indicated that some thirteen hundred engineers, members of the provincial professional associations who were not corporate members of The Institute, were anxious that consolidation should be carried out. He thought that if the assent of the majority of the provincial professional associations could be obtained, the council of The Institute should ultimately be the Dominion Council. He also offered the suggestion that The Institute might lower its membership fee in the case of those members who are also members of provincial professional associations. He believed that if this were done the Class B and Class C members shown on Mr. Pitts' diagram, would rapidly disappear.

Mr. Kirby inquired as to the exact nature of the motion before the meeting, and the President having pointed out that the motion was, that the report of the Committee on Consolidation be received and be open for discussion, Dr. Goodwin expressed the opinion that the motion should be put. The motion, having accordingly been put by the President, was *carried.*

In view of the advanced hour, J. A. McCrory, M.E.I.C., (Montreal), suggested the desirability of adjournment, the meeting to convene again at 2.00 p.m. Mr. McCrory's motion was seconded by Mr. Viens. Mr. Kirby moved as an amendment that the meeting continue to 1.00 p.m., and reconvene at 2.15 p.m., and this amendment was seconded by Dr. Goodwin. The amendment, on being put to the meeting, was *carried* unanimously.

Mr. Kirby thought that it would be proper at this time to move the adoption of the report and have the rest of the discussion on its adoption, and Mr. Pitts having accordingly moved the adoption, Dr. Goodwin pointed out that the adoption of the report would involve the inclusion of such amendments as might be made.

W. J. Smither, M.E.I.C., (Toronto), suggested that the meeting should go into committee of the whole and discuss the report clause by clause, so that afterwards a motion for the adoption of the report as amended would be in order. He made a motion accordingly, which was seconded by Dr. Boyle.

E. A. Wheatley, M.E.I.C., (Vancouver), desired to move an amendment to Mr. Smither's motion, to the effect that the present method of dealing with the problem continue, and that the original resolution that the report be received be approved. The secretary having pointed out that that motion had already been carried, Mr. Wheatley submitted that the general discussion should continue prior to lunch, and that afterwards the resolution for the adoption should be moved and the report be discussed clause by clause. D. C. Tennant, M.E.I.C., (Montreal), having seconded Mr. Wheatley's amendment, the President put the amendment that the general discussion be continued and it was unanimously *carried.*

Major L. F. Grant, M.E.I.C., (Kingston), remarked that in the view of the Kingston Branch the whole question of consolidation depended upon the attitude of the provincial professional associations, which at present was not known. He inquired as to the constitution and functioning of the Council which had succeeded the Committee of Eight, and would like to know whether that body would welcome discussion with, or the co-operation of, The Institute. Unless this point was cleared up he felt that time was being wasted.

Mr. Legget pointed out that if Major Grant would refer to the report he would see that the discussions and communications of the Committee on Consolidation had been sent not only to The Institute branches, but in all cases had also gone to the provincial professional associations, and to the Secretary of the Committee of Eight.

Mr. Kirby again pointed out that the Committee of Eight had been replaced by the Dominion Council, and Mr. Pitts explained that in the absence of official authority from the various associations his committee had been in communication with the Secretary of the Committee of Eight. He understood that the Dominion Council was to meet on February 8th, following The Engineering Institute meeting, but had had no official communication from them as to this. His committee had done everything possible to get in touch, individually or collectively, with members of the provincial professional associations. Mr. Kirby having stated that the Dominion Council had been duly constituted, Mr. Pitts said that his committee hoped to work with that body, but could not do so until informed that they were willing to enter into discussion.

Mr. Kirby pointed out an essential difference between the Committee of Eight, which could not extend its membership, and the Dominion Council, which could add to its members representatives of other associations. For the information of the meeting he stated that the present membership of the Dominion Council consisted of the following representatives of the various provincial professional associations:

British Columbia	H. F. G. Letson, Vancouver, B.C.
Alberta	P. M. Sauder, M.E.I.C., Lethbridge, Alta.
Saskatchewan	D. A. R. McCannel, M.E.I.C., Regina, Sask.
Manitoba	J. W. Sanger, A.M.E.I.C., Winnipeg, Man.
Ontario	A. B. Crealock, M.E.I.C., Toronto, Ont.
Quebec	J. M. Robertson, M.E.I.C., Montreal, Que.
New Brunswick	C. C. Kirby, M.E.I.C., Saint John, N.B.
Nova Scotia	F. R. Faulkner, M.E.I.C., Halifax, N.S.

Continuing his remarks, and speaking as the representative from New Brunswick, Mr. Kirby stated that all the engineers in that province were anxious to have a national committee set up at an early stage, on which the associations and The Institute should be represented, to study the question and agree on what should be done. Personally, Mr. Kirby felt that the report of the Committee on Consolidation was disappointing, for he felt that the report did not offer any marked inducement to the non-E.I.C. member to join The Institute. He urged that the corporate entity of all the provincial associations must be maintained. In the event of the formation of a national body provision must be made for those engineers who were not willing to join such an organization, as there should be no compulsion in the matter. Such men must still be able to practise and have a say in provincial matters. Mr. Kirby would, therefore, suggest that in order to get all Canadian engineers into a national body, when formed, it would be desirable to restrict the privilege of interprovincial practice to the members of that body. This would require the consent of all the provincial professional associations. He felt that a national body which could give the privilege of interprovincial practice would have something to offer to the large number of men who are not now members of The Institute. Mr. Kirby advocated the idea of building up a national body through optional membership with the advantage of interprovincial privileges of practice. As an alternative he might suggest the creation of a Dominion Council of the provincial professional associations on a more extensive basis than exists to-day. He thought, however, that it would be a great pity to have such a body in active competition with The Engineering Institute of Canada. He also drew attention to the question of those present members of The Institute who are not registered. He said that this point was a difficult one, and should be thoroughly considered and discussed by the national committee. Many of those men occupied leading positions and he thought could be induced to register as a measure of support to the profession as a whole. On the whole he believed that the most feasible scheme was the development of The Engineering Institute of Canada into a national body with a fundamental basis of Dominion-wide power.

At this point the meeting adjourned for lunch.

Afternoon Session

The afternoon meeting convened at two twenty p.m.

Mr. Kirby, in continuing his remarks, said that as a result of the views expressed by the engineers in New Brunswick he believed that the non-Institute members in that province would support any reasonable scheme of co-operation with The Engineering Institute. He hoped that The Institute would offer something quite definite and constructive. He would suggest that The Institute should so organize that its Council should be the Dominion Council of the professional associations in Canada. He had expressed his views in an amendment to the report which he hoped to have the opportunity of moving at a later stage of the meeting, and which read as follows:—

"That this meeting expresses its thanks to the members of the Committee on Consolidation for their exhaustive examination into the matter and that the report be received and filed,

That a committee, nominated by Council, be appointed for the year 1936, and they be requested to examine the possibility and desirability of a scheme of consolidation with the Associations of Professional Engineers of the various provinces by which—

(*a*) The corporate membership of The Institute shall consist of those Registered Professional Engineers in the provinces who apply for the privilege of interprovincial practice and pay a corresponding fee therefor, plus those present members of The Institute who now reside outside of the Dominion of Canada or in the province of Prince Edward Island.

(*b*) The Engineering Institute of Canada shall become the National Body of Engineers in the Dominion, accepted as such by the Provincial Associations of Professional Engineers with or without a change in name of The Institute.

Be it further resolved: That the Committee on Consolidation be empowered to negotiate with the Dominion Council of Professional Engineers of Canada to the end that the Provincial Associations or Corporations of the various provinces will agree:—

(*a*) That they accept The Engineering Institute of Canada as the National Body of Engineers of Canada.

(*b*) That they will grant interprovincial licences to practise to only those men who are corporate members of the national body, and who have registered with the same for such interprovincial practice.

(*c*) That the personnel of the executive and administrative bodies of the associations and the national body shall be the same, and meetings shall be joint, as far as possible.

(*d*) That present corporate members of The Institute who are not registered professional engineers and are not acceptable for admission as registered engineers, shall remain as members of the national body with or without segregation into separate classes.

Be it further resolved: That the committee be authorized to confer with the Dominion Council of Professional Engineers in respect to any other scheme of consolidation that may be proposed, and report upon the same to the next annual meeting."*

E. A. Wheatley, M.E.I.C., believed that no good result would follow attempts to minimize the great difficulties which surround the problem. The philosophy of the association in British Columbia was different from that of all the others, and in criticising the work of The Institute Committee on Consolidation, as he found it necessary to do, he felt that there should be no hesitation for fear of saying unpleasant things. First, Mr. Wheatley agreed entirely with Mr. Kirby that the creation of provincial divisions would be a retrograde step. Mr. Wheatley considered that the inferences drawn by Mr. Pitts from the figures resulting from the questionnaire were erroneous. The question was drawn up in terms of partial advocacy and the questions were so framed that nearly everyone would vote for them. Under these conditions, the final figures given by Mr. Pitts were misleading, and it did not at all follow that changes proposed in The Institute's by-laws to give effect to the Committee's recommendations would receive the two-thirds vote necessary for their approval.

Mr. Wheatley did not agree with the relative proportions assigned by Mr. Pitts to the various classes A, B, and C, in his diagram. According to the information collected by Mr. Wheatley approximate figures would be: Class A, 1,100; Class B, 1,600; and Class C, 2,300.

Mr. Pitts' diagram would give the impression that Class C, those engineers who are licensed but who are not members of The Institute, was a comparatively small one, whereas in fact it outnumbered either of the other classes, A or B. Mr. Wheatley was of opinion that the total number of engineers eligible for a licence to practise in Canada would be at least 7,000. He then outlined the situation in British Columbia where there are 824 registered engineers and 530 students, practically ninety-five per cent of the engineers in the province.

Mr. Wheatley stated that Mr. Pitts' questionnaire had not been sent out by the Council of the British Columbia Association. His Council had declined to send out the questionnaire since, of the 824 members of the association, only 157 belonged to The Institute, and an adverse vote would probably have been the result. This decision indicated the Association's Council's sympathy with The Institute.

Mr. Wheatley drew attention to the fact that the principles actuating the eight associations are at variance and are also at variance with those actuating The Institute. These differences were, however, growing less as a result of long negotiations, and Mr. Wheatley anticipated the happiest results from the move for the gradual development of common membership which was now in progress in British Columbia. If The Institute's Council would approach the Dominion Council of the Associations and work with that body for common ideals and common objectives, the two bodies would eventually go together.

J. H. Hunter, M.E.I.C., (Montreal), remarked that at the annual meeting last year it had been his doubtful privilege to move that speeches during the discussion be limited to five minutes; he now desired to make a similar motion in the present case. D. C. Tennant, M.E.I.C., having seconded this motion, Mr. Gordon Pitts definitely opposed the suggestion, and on being put to the meeting the motion was *lost.*

F. W. Paulin, M.E.I.C., (Hamilton), desired to ask Mr. Wheatley how the British Columbia Association had managed to get ninety-five per cent of all the engineers in British Columbia into its organization. Mr. Wheatley replied that this had not been done by force, but by philosophy. All the work had been based on education. The association had appealed to all the industrial organizations for this reason. There had been no thought of compulsion, but the movement had been a slow one, having taken fifteen years to reach its present stage of completion.

Colonel H. F. G. Letson, (Vancouver), as President of the British Columbia Association of Professional Engineers, desired to congratulate The Institute's committee on the work they had accomplished. In British Columbia

*This amendment was not subsequently moved.

all engineers were in accord with the idea of striving for co-ordination or co-operation, but possibly their ideas were different from those held in other parts of the country as to the best means of approach. In British Columbia they believed that the professional associations should be co-ordinated through their Dominion Council and should deal with such matters as legislation and uniform standards of admission. It was thought that the Dominion Council might well form a more intimate group with The Engineering Institute of Canada and the Canadian Institute of Mining and Metallurgy. In the view of his Council co-ordination should go forward, and with this in view these voluntary bodies might eventually appoint representatives to the Dominion Council and work hand in hand towards a further advance of our common ideals.

Brian R. Perry, M.E.I.C., (Montreal), believed it unnecessary that all engineers should be licensed to practise. The Engineering Institute of Canada was vitally interested in the consolidation question because it is an existing national body. It seemed to him that while in most provinces it was felt that progress should be made through The Institute, in British Columbia a different view was taken. He hoped that an arrangement could be effected, and that the necessary sacrifices would be made on both sides, by both The Institute and the provincial professional associations.

At this point Colonel H. J. Lamb, M.E.I.C., (Toronto), drew attention to the presence of H. W. D. Armstrong, M.E.I.C., a Life Member of The Institute, and one of those who had helped to form The Canadian Society of Civil Engineers at its foundation in 1887. Mr. Armstrong received a warm welcome from the meeting, which he gracefully acknowledged, noting the progress since 1887 when the movement for the organization of engineers in Canada began. Mr. Armstrong hoped that the members of The Institute would be able to further advance the prosperity of the Dominion and the engineering profession, and would take an increasing part in the public life of the Dominion.

T. C. Main, A.M.E.I.C., (Winnipeg), speaking as a representative of the Winnipeg Branch of The Institute and, in some measure, the Association of Professional Engineers of Manitoba, pointed out that the telegram from Winnipeg, which had been read to the meeting, was from a joint committee of those two bodies which were already in close relationship. In Manitoba the young men were unable to see the necessity of two organizations, and accordingly in Winnipeg a plan had been suggested whereby the two bodies would have the same officers. There was in Winnipeg a strong demand for this amalgamation. It was hoped in this way to iron out local difficulties. In Winnipeg it was felt difficult to conceive of the associations getting along without having a Dominion body, and they believed that that Dominion body should be The Engineering Institute of Canada. Amalgamation in some form was certainly coming in Winnipeg and Manitoba in general.

P. M. Sauder, M.E.I.C., (Lethbridge), after complimenting the committee on their report, said that the answers to the questionnaire showed that The Institute membership as a whole wished for some kind of co-ordination between The Engineering Institute and the Provincial Professional Associations. With this in mind he desired to outline a plan due to J. B. deHart, M.E.I.C., (Lethbridge), and set forth in the paper which Mr. deHart had submitted for the Past-Presidents' Prize. Briefly, this plan was to make the Dominion Council of Engineering representative of all engineering organizations in Canada, beginning with The Engineering Institute and providing for the representation of other bodies later. In this way participation would be voluntary and the separate corporate existences of the professional associations would be preserved. The Dominion Council thus enlarged would have functions similar to those of the Dominion Medical Association. He would urge that The Engineering Institute of Canada should co-operate to put the Dominion Council of Engineering on a working basis in this manner.

In Alberta the present situation was that a considerable number of mining, mechanical and electrical engineers objected to any scheme of amalgamation which would mean their membership in The Engineering Institute of Canada, a body in which they felt no interest. This was another reason why the deHart plan merited consideration. At the present time there was close co-operation between the Edmonton, Calgary and Lethbridge branches of The Institute and the provincial Association of Professional Engineers.

Mr. Gordon Pitts desired to correct an impression that might have been conveyed by Major Grant's statement to the effect that the Kingston Branch had not been supplied with information by the Committee on Consolidation. That branch had received full information from his committee, coupled with a request for help and suggestions, and had acknowledged receiving this message, which they had considered at the annual meeting of the Branch in September last.

Professor F. R. Faulkner, M.E.I.C., (Halifax), in describing the present situation in Nova Scotia, said that the Association of Professional Engineers of Nova Scotia, now about fifteen years old, had a membership of 200, and worked in harmony with the two branches of The Institute in the province, at Halifax and Cape Breton. He outlined the course of events during which the Committee of Four was succeeded by the Committee of Eight, and then by the Dominion Council, and reminded the meeting that the Committee of Four had been formed in 1931 after some of the Associations had turned down the invitation of The Institute to meet jointly. Thus the Council of The Institute was unable to join the associations in any official discussions, until the representatives of the associations extended an invitation to do this. This, however, had not prevented The Institute Committee on Consolidation from being in close unofficial contact with the members of the Dominion Council.

In view of the fact that the Dominion Council did not meet in 1934, the professional association in Nova Scotia and the Halifax and Cape Breton branches of The Institute had jointly appointed a committee to explore the possibilities of local consolidation. Their report, of which Mr. Pitts' committee had received a copy, contained certain recommendations of which he would like to give the gist. The suggestion was that the following organization should be an ideal which engineers in the province should exert every effort to attain:—

> "Scope: (*a*) To include all members of the engineering profession in Nova Scotia in one organization.
>
> (*b*) To divide the types of membership in such a way as to recognize the differences in age, experience, academic training and professional responsibility among engineers and of sufficient range to admit of membership of engineers engaged in many phases of modern society, calling for an engineer's training.
>
> (*c*) To provide similar privileges, services and responsibilities as at present provided by the Professional Association of Engineers of Nova Scotia and The Engineering Institute of Canada.
>
> (*d*) To provide for affiliation with a Dominion-wide organization which would make possible those things covered by subsection (*c*).
>
> (*e*) To encourage the formation of other similar organizations in the other provinces which would have similar aims and standards."

This report was circulated among the association members for voting on because there were certain points that required their approval. Among these he might mention a suggested amendment to the Provincial Act. Professor Faulkner felt justified in reading this proposed amendment, although association business. It was an amendment or new section which read as follows:—

> "The association shall have the power to co-operate, affiliate or combine with other associations similarly constituted in one or more of the provinces of Canada and/or with existing engineering organizations in the Dominion of Canada or that may be created in the Dominion of Canada, to form a central organization for the purpose of facilitating the acquirement and interchange of professional knowledge, for the discipline of its members, or the advancement of the engineering profession generally, and for the better protection of the public."

When the membership of the association and that of the two Institute branches was canvassed by ballot some ninety-eight per cent of those voting were in favour of the general idea. The proposed amendment to the Act, however, had not yet been applied for. Thus a strong desire for consolidation existed in Nova Scotia, and probably a local scheme would be put into effect unless there was soon unmistakable evidence of progress towards a consolidation in the Dominion as a whole.

Professor Faulkner desired to congratulate Mr. Pitts' Committee but felt that the adoption of the report as it stands would commit The Institute to a particular line of action. This he did not think advisable at the moment, and believed that it would be better that this meeting should vote favourably on the general principle involved, but should not commit itself to details. Professor Faulkner thought it probable that the Dominion Council would shortly suggest to The Institute a conference, and the way should be left open for The Institute to be able to send representatives in such an event.

Professor R. W. Angus, M.E.I.C., (Toronto), had been requested to attend as President of the Association of Professional Engineers of Ontario, but had received no further instructions. He was impressed with the difficulty of bringing a society whose express purpose was the dissemination of technical information and making it a body which will co-ordinate the provincial professional associations. He desired to draw attention to the situation in Ontario, where there existed a multiplicity of technical societies, many of which were strong branches of American organizations. The purpose of all of these was the dissemination of professional knowledge, but attempts to secure co-operation between them had so far not been very successful. Professor Angus hoped that The Institute as a national organization would take the lead in bringing about real co-operation between these bodies. Such co-operation would not mean amalgamation, and he might say that the executive committees of both the Ontario Section of the American Society of Mechanical Engineers and the Toronto Section of the American Institute of Electrical Engineers had definitely asked him to state that they would not agree to the plan proposed by Mr. Pitts' committee, as they are not willing to be forced to pay a fee to The Engineering Institute of Canada in order to belong to the Association of Professional Engineers of Ontario. Professor Angus thought this was also the case with the mining engineers, although he was not able to speak for them. The members of these technical societies and branches were desirous to co-operate, but did not think that Mr. Pitts' scheme was the right way to do it.

Mr. Paulin announced that having just been elected President of the American Concrete Pipe Association, he thought that information as to that Association's method of dealing with similar problems might be helpful. That body had difficulty in respect of the work of its local associations, which difficulty had only been removed by the effort of a special representative appointed to deal with the matter. Mr. Paulin would suggest that The Institute should follow a course which would be taken by an industrial firm under similar circumstances. He would like to give a suggestion made to him by Colonel R. E. Smythe, M.E.I.C., (Toronto), that a special counsel should be engaged to study all the suggestions made and formulate a working plan for the Council of The Institute.

E. P. Muntz, M.E.I.C., (Hamilton), believed that it would be advisable to make a start experimentally with some scheme of local consolidation such as that proposed in Manitoba. He thought that the Winnipeg proposals might well be studied by the counsel suggested by Mr. Paulin. While the membership in Manitoba is only about eight per cent of the total combined membership of The Engineering Institute and the provincial professional associations, he thought the scale of the experiment would be sufficient to show in a comparatively short time how further progress could be made.

D. A. R. McCannel, M.E.I.C., (Regina), speaking as a representative of the Saskatchewan Branch and the Association of Professional Engineers of Saskatchewan, outlined the situation in that province, where The Institute branch and the professional association have been seeking a way to consolidate for over a year. While congratulating Mr. Pitts' committee he felt that their report would not satisfy the Saskatchewan desire for consolidation at an early date. In Saskatchewan they felt that in any case the procedure should be through The Engineering Institute as the existing national body. He could not help regretting that so little had been accomplished by the Dominion Council, of which he was a member.

Major H. A. Lumsden, M.E.I.C., (Hamilton), drew attention to the position of The Institute as having been the national engineering body of the Dominion for fifty years. This gave it a special claim on the loyalty and allegiance of the engineers of the country. It seemed to him that Manitoba in many ways was pointing out the procedure desirable at this time. This was confirmed by the course of events in Saskatchewan and in Nova Scotia. He would support the recommendation of Mr. Pitts' committee to allow them to proceed, and approved of provincial consolidation wherever such a course appears satisfactory to all parties.

H. S. Johnston, M.E.I.C., (Halifax), desired to speak for the Halifax Branch of The Engineering Institute, Professor Faulkner having spoken for the Association. It was felt in Halifax that the Pitts' report was only a progress report. It could not be anything more until contact with the associations had taken place. In their opinion consolidation does not mean co-ordination, a point which had been clearly brought out by the reservation of Mr. Challies. He thought the report was a report upon co-ordination. The engineers of Nova Scotia were not concerned about the name of the national body. They desired a central body to represent the engineering profession throughout Canada, having regard to the autonomy which must exist in the various provinces. The feeling in Nova Scotia was such that local action would undoubtedly be taken there unless within, say, a year, definite progress is evident towards a Dominion-wide scheme for consolidation.

J. L. Busfield, M.E.I.C., (Montreal), pointed out that the Council of The Institute had given most sympathetic consideration to the proposals for local action coming from Manitoba and elsewhere, but had felt that while an Institute Committee on Consolidation was investigating and reviewing the whole problem throughout Canada it would be inadvisable to carry out any local arrangement in one particular province. Mr. Busfield believed, however, that the Council of The Institute would undoubtedly be willing to put in effect any workable arrangement in individual provinces without the necessity of waiting for a nation-wide programme, provided this were agreed upon as a sound policy. He hoped personally that the report would not be definitely adopted by this meeting. In that case the result would be a stalemate, since if The Institute accepted the standard of admission of every professional association, The Institute's requirements would have to be those of the professional association having the lowest standard. This would indeed be a lowering of the bars, and in Mr. Busfield's opinion would not be accepted on ballot by The Institute membership at large.

Mr. Busfield considered it necessary that one body in Canada, The Engineering Institute, should keep in its own hands the privilege of determining the qualifications for membership in the national body. The result of provincial action was seen by the changes which the various provincial legislatures had made in the original model act proposed fifteen years ago. He felt that if this meeting were to give a mandate to the Council of The Institute to call a plenary meeting of the Council and implement the proposals for local consolidation which have already been submitted, without waiting for The Institute's by-laws to be changed, some real progress could be made in this matter. He suggested that this meeting would be justified in carrying a resolution that the recommendations of the Committee on Consolidation and the discussion at this meeting should be considered by the Council of The Institute as a mandate to take action within the immediate future.

Mr. Gordon Pitts asked the meeting to note particularly the proposal just made by Mr. Busfield to place the activities of his committee in the hands of Council. As a result of his experience, and on good advice, Mr. Pitts strongly urged the meeting to take no such action.

Dr. Goodwin disagreed with Mr. Pitts on this point, and agreed with Mr. Busfield. Mr. Pitts' committee had not yet made any constructive suggestion, and from this point he thought that The Institute Council should carry on. He believed that progress would best be made by adopting the suggestion of Colonel Smythe, transmitted by Mr. Paulin, regarding employing an outstanding counsel to get these things in shape. If there were a motion appropriating $1,000 or $1,500 to pay the travelling expenses of Mr. Pitts or Mr. Busfield, or both of them, so that they could advance their point of view with the professional associations, some definite progress might be made. At present, while "Barkis is willin'," the professional associations did not seem to be so.

G. H. Wood, A.M.E.I.C., (Niagara Falls), stated that at a special meeting of the Niagara Peninsula Branch held on February 2nd, the Pitts' report had been discussed, and in their opinion could only be regarded as a progress report. The report might be accepted in its present form and no harm would be done, the committee not having presented anything specific. The branch felt that the report was largely the result of compromise and believed that until the basis was known on which the various provincial professional associations were willing to consolidate, no specific proposals could be produced. He thought, however, that in any scheme of consolidation the professional associations' standards of admission must be accepted, in spite of Mr. Busfield's view that this might lower the standards of admission of The Institute.

Colonel R. E. Smythe, M.E.I.C., (Toronto), desired to explain that Mr. Paulin had perhaps misunderstood his suggestion as to the engagement of counsel. His thought was that a man of high ability, not necessarily a lawyer, possibly an engineer familiar with the details of the question, might be appointed by the committee or the Dominion Council to represent them. The progress made in British Columbia during fifteen years had been described by Mr. Wheatley. We might visualize a new structure composed of the eight provincial associations working through a Dominion Council using the brains of the engineers provided in The Engineering Institute and in other bodies such as the Canadian Institute of Chemistry and the Canadian Institute of Mining and Metallurgy. Speaking as a professional engineer of Ontario, possibly The Engineering Institute might participate in the choice of such a man, who would take the matter in hand and follow it to its conclusion.

Hector Cimon, M.E.I.C., (Quebec), would like to express the opinion of the engineers of Quebec City, in line with the resolution from the Quebec Branch which had already been read and which endorsed the report of Mr. Pitts. We should keep in mind the idea that preceded the formation of the Canadian Society of Civil Engineers fifty years ago, the idea of definite standards for the profession of engineering in Canada. The problem confronting us to-day was not a new one; it existed in 1892, and had not yet been solved. Mr. Cimon thought, however, that the real solution was to be found in recommendation No. 2 of Mr. Pitts' report, this recommendation being the key to the problem.

C. E. Sisson, M.E.I.C., (Toronto), desired to add to what had already been said by Professor Angus in regard to the situation in Toronto. In that city there existed a multiplicity of technical organizations. At a recent meeting, intended to bring their representatives together to arrange some kind of co-operation so as to avoid conflicting dates of meeting and so on, there were representatives of no less than fifteen of these bodies. The young engineer in industry did not find it much to his advantage to become a member of the provincial professional association and usually preferred to join one of the various specialized American and other engineering societies of which there are so many active branches in Ontario. In practice the young engineer found it extremely difficult to pay membership fees, say, to the American Institute of Electrical Engineers, The Engineering Institute of Canada, and the Association of Professional Engineers of Ontario. Mr. Sisson felt strongly that in any scheme of consolidation these young engineers must be provided for, and it must not be made too difficult for them to identify themselves with a consolidated organization.

D. S. Laidlaw, A.M.E.I.C., (Toronto), ventured to speak as one of the younger engineers, and expressed the hope that he would be able to be present at the 100th anniversary of the founding of The Institute. It seemed to him that an assembly of this kind, at which only about one hundred members were present, should act with caution and refrain from any action overriding the manifest sentiment of the profession as a whole. He felt that if the provincial professional associations' requirements were adopted by The Institute, this would mean a lowering of the standard of admission, but did not think that this would be a bad thing, and therefore strongly favoured the acceptance of those requirements as the basis of The Engineering Institute membership. The difficulty outlined by Mr. Sisson would have to be dealt with. How could the younger members of the professional associations and of the technical societies like the American Institute of Electrical Engineers and the American Society of Mechanical Engineers enter into amalgamation without overcoming the obstacle of increased fees?

Clarence M. Pitts, A.M.E.I.C., (Ottawa), as the proposer of the original motion of 1935, which resulted in the formation of the Committee on Consolidation, had been glad to hear the compliments paid to Mr. Gordon Pitts and his committee. The work of that committee had confirmed his original view that Council could not possibly have done the work which the committee had accomplished. It was now evident that the general feeling is for a gathering together of the profession in Canada. The younger engineers want to belong to a Canadian society which will give them all the benefits of a multitude of societies. With regard to Mr. Busfield's suggestion Mr. Pitts did not consider that Council had the power to grant such a request as that of Manitoba without changing the by-laws. Nothing definite had been heard as to the attitude of the provincial corporation in Quebec, nor had Ontario definitely set its hand to the matter. Mr. Pitts would submit that under the terms of the 1935 resolution the committee had evolved, after a year of strenuous endeavour, a report under which British Columbia has the opportunity of coming in along with the other provinces. He thought a gesture should be made to those members of the provincial professional associations who are not now members of The Institute to give them the opportunities of broad national membership in Class A for a nominal consideration.

At this point Dr. Goodwin rose to suggest that the report be now considered clause by clause.

Mr. Gordon Pitts desired to offer some further explanations. The only object of his committee had been to find out what individual members wanted. In reporting on the 4,600 replies to the questionnaire there had been no thought of swelling the vote by taking advantage of the fact that some of the votes were from men having double membership. He felt that the answers in themselves indicated what the wishes of the whole profession were.

It was evident from the discussion at this meeting that there were two theories behind the consolidation idea. That held by the British Columbia Association and by Mr. Kirby, was that consolidation should be brought about by establishing and developing a Dominion Council, in this way bringing in all the other organizations in Canada, but in considering this proposal the committee had been faced by the fact that in Nova Scotia and elsewhere there was a desire to combine locally. In Saskatchewan they were getting busy, and in Manitoba they said "we are combined." What was to be done about this? For this reason the committee had not supported the idea of placing consolidation in the hands of a Dominion Council, another reason being that the Dominion Council had not met since 1933, and it was generally felt that delay had lasted long enough.

The committee had realized that The Institute was a solid, well established, well directed organization, that was active and could take action, and it had seemed foolish to propose to set up another organization. That was the committee's attitude. Mr. Shearwood had said that the committee should have taken into account his own representations and those of Mr. Pratley. They had done so, and had listed all the suggestions received.

At this point Mr. Shearwood explained that his thought had been that the committee had not stated any of its reasons or arguments against those various proposals. Some of the authors would have liked to have known why their suggestions had not been accepted.

Mr. Pitts, continuing his remarks, said that the interpretation of the opinions received by the committee had necessarily to be left to the committee's discretion, all of whose members were men in whom The Institute should have absolute confidence. He did not attach any importance to the presumed lowering of the standards of The Institute if qualifications for admission into the provincial professional associations were accepted by The Institute Council. Actually about ninety per cent of those entering the provincial professional associations to-day had university degrees, and in practice the objection would soon disappear.

As regards the cry of coercion, Mr. Pitts thought that this difficulty would also disappear if it were arranged to admit those members of the associations who belong to technical societies other than The Institute, for a nominal sum of, say, twenty-five cents. A professional engineer who would not come into a national organization for this sum would be a piker.

R. F. Legget, A.M.E.I.C., (Montreal), asked permission to deal with certain comments and inquiries that had been made, so that the way might be cleared for the discussion of the committee's actual recommendations. The committee had carefully considered all comments they had heard or seen in print. Possibly their report was too brief and did not explain certain details clearly enough. Mr. Legget felt that this meeting was far more significant than the usual general meeting of The Institute, since it included representatives from right across the Dominion. He wished therefore to review briefly the remarks of previous speakers.

He greatly regretted the suggestion of the Kingston Branch that the committee had not paid attention to their representations. Mr. Legget had exchanged views with Major Grant, with whom he had had helpful discussion, receiving the assurance that there was not anything lacking in the committee's action.

Major Grant remarked that this statement was correct.

Continuing, Mr. Legget observed that the Lakehead Branch reservations had both been mentioned in the report.

Mr. Heward, as an individual member of The Institute, had asked for a plan. Mr. Legget desired to point out that the nine recommendations of the committee formed as definite a plan as could be put forward at this time.

Other branch recommendations that had been read, generally confirmed the report.

Mr. Gordon Pitts had already dealt with Mr. Shearwood's remarks, but Mr. Legget might add that the position of engineers who are superficially not required by law to take out a licence had been very fully discussed at meetings of the committee. There seemed to be an idea in some quarters that some stigma attached to a provincial licence. Surely there was nothing wrong in a member of The Institute having a licence if, by doing so, he were assisting the profession to take its rightful place in the public life of the Dominion. Many senior lawyers do not practise as lawyers, but they have licences. There should be no question as to the desirability of engineers belonging to both bodies. With regard to the representation on the committee of large transport, power and contracting organizations, suggested by Mr. Shearwood, Mr. Legget would point to the presence on that committee of Dr. Gaby and Mr. Challies. He himself, while not engaged in contracting, had work which kept him in daily contact with that industry.

Mr. Main had answered Mr. Shearwood's suggestion for the adoption of the Winnipeg scheme as a result of this meeting.

Mr. Kirby had made an interesting proposal with regard to interprovincial practice. In Mr. Legget's view this must be one of the three main objects to be kept in view after the various bodies had got together, the objects being uniformity of admission, uniformity of legislation, and provision for interprovincial practice.

Expressing appreciation of Mr. Wheatley's account of conditions in British Columbia, Mr. Legget suggested that if Mr. Wheatley would give consideration to the problems of the rest of Canada in the light of his experience in British Columbia, he might yet see eye to eye with the committee. Mr. Wheatley had stated that the committee's questionnaire was based on the brochure which had been sent out. This was not correct, the brochure having been prepared on a general basis for the good of the profession and with no particular scheme in mind. Mr. Wheatley had further criticized the figures given in the report. Mr. Legget submitted that the arrangement of the figures did not affect the final result, which was that the majority of the profession who had expressed their views had answered yes to the committee's questionnaire.

The figures given by Mr. Wheatley as to the numerical strength of the profession were interesting. If, as he stated, there were 824 engineers in a population of 700,000, or one in 850 of the population, British Columbia would have about twice as many engineers in proportion to population as would the Dominion as a whole, in which there are apparently 7,000 engineers in a population of 10,000,000. Mr. Legget thought that the climate of British Columbia might have some bearing on this point, but such figures gave a clue to the strength of the profession in British Columbia, and its standing in the community.

Mr. Wheatley had spoken of the chaos now existing and had expressed fear of a snap vote, which other speakers had also mentioned. No more insidious suggestion could be made in regard to the motives of this meeting, which was continuing work begun fifty years ago. Mr. Legget would like to refer again to the words of Sir Casimir Gzowski which he had quoted last year in Toronto, to the effect that if we wait until all the provinces thought the same, we should have to wait until Doomsday, and we are still waiting. It had been stated that the sole purpose of the Dominion Council is to get unanimity between the provinces. If that were true, what better instrument could there be for this purpose than The Engineering Institute of Canada. As to the statement that the opinions actuating the eight provincial associations are all different, Mr. Legget could not admit its truth. They all sprang from The Institute and were all created to give legal status to engineers.

Colonel Letson had referred to the legally constituted professional associations on the one hand, and had placed on the other side The Engineering Institute of Canada and the Canadian Institute of Mining and Metallurgy. Mr. Legget did not think Colonel Letson was right in putting the two last named bodies together. In his opinion The Engineering Institute of Canada and the Canadian Institute of Mining and Metallurgy were poles apart. The Institute represents a profession, while the Mining Institute represents, very adequately and forcibly, an industry from top to bottom.

Mr. Sauder had mentioned the de Hart plan, and had stated that mechanical, electrical and mining men would not join The Institute, but would want to join the Dominion Council. If they wanted to join the one, what objection could they have to joining the other, with the greater position and increased service it will be able to give.

Mr. Legget had been glad that Mr. Paulin's suggestion as to an eminent counsel had been restated later by Colonel Smythe. The younger engineers particularly would be surprised if the engineering profession had to hand its problems for solution to a member of the legal profession.

At this point Mr. Paulin explained that while he had said an eminent counsel he meant some individual who could put all the facts together and present them, a thing which no committee could do. He had in mind Mr. Wheatley's name, whose work in Vancouver could very well be done in the Dominion.

Continuing his remarks Mr. Legget referred to the condition in Manitoba as mentioned by Mr. Muntz. It seemed to Mr. Legget that the framework suggested in the Manitoba joint committee's report would meet those conditions.

Mr. Legget was glad to note that Mr. Busfield felt that the report was going to be adopted. In that case he hoped that Mr. Busfield's fear of seeing the resulting changes in by-laws defeated on ballot would be unfounded, as would be the case if all active members of the profession did their part in helping to pass the by-laws when they do come up for vote. Speaking as one of the younger men, Mr. Legget disagreed with Mr. Busfield in suggesting that the matter be referred back to Council, since Council, a body fully occupied with administrative affairs of The Institute, could not deal with the amount of work which the committee will still have to do before definite and final action can be planned.

Dr. Goodwin had suggested that an expenditure of $1,500 would help the work of the committee. This constructive suggestion had been raised last year at the same time and not implemented. Mr. Legget felt that its adoption would raise difficulty. Dr. Goodwin had also asked about the Quebec Corporation and the action that they have taken or are willing to take. It was probable that the meeting would hear from Dr. Lefebvre as to this matter, and his remarks would be of particular interest since the Corporation in Quebec has the strongest Act in Canada.

Mr. Legget wished to mention one important omission from the report, which had been a deliberate one, since the report was too long already. The report had not dealt fully with the position of The Institute in relation to the engineering profession in the Dominion. Mr. Legget had been amazed at hearing The Institute described as a merely technical organization, and he would ask to be allowed to read the objects of The Institute as set forth in the by-laws as follows: (*a*) to develop and maintain high standards in the engineering profession, (*b*) to facilitate the acquirement and the interchange of professional knowledge among its members, (*c*) to advance the professional, the social and the economic welfare of its members, (*d*) to enhance the usefulness of the profession to the public, (*e*) to collaborate with universities and other educational institutions in the advancement of engineering education, (*f*) to promote intercourse between engineers and members of allied professions, (*g*) to co-operate with other technical societies for the advancement of mutual interests, (*h*) to encourage original research, and the study, development and conservation of the resources of the Dominion.

An organization with such objects as these could not be regarded as a mere technical body. The whole professional movement started with The Institute, and the professional associations were established to implement The Institute's organization. This had necessarily to be done by provincial action, as a result of which the associations started and grew.

The step now contemplated only meant a return to the original condition and a re-affirmation of the original objects of The Institute itself, its main purpose being not merely to exist as an Institute, but to advance the engineering profession in its place in the public life of the Dominion. Mr. Legget urged that this thought should be uppermost in members' minds when considering in detail the nine recommendations of the committee.

Thus consolidation had much to do with the final question—the status of the profession. The Institute took care of technical matters and the associations of legal questions, but there existed many problems affecting the profession and its relation to the public which lay between these two divisions. Unless this gap could be bridged by consolidation, the engineering profession in Canada would continue in a state typified by its present general standing in the community, and by the fact that while at the time of Confederation there was one member of the engineering profession in the Dominion Parliament, even in 1935 there was still only one member.

As a tribute to Mr. Armstrong, Mr. Legget desired to conclude by restating the admirable sentiment which he had expressed, that the deliberations of the meeting should have in mind the welfare of the profession and its place in the public life of the Dominion.

Mr. Kirby believed that it would be necessary to have an evening session, and moved the adjournment of the meeting. His motion was seconded by Professor Faulkner, but in accordance with an amendment moved by Mr. Wheatley, seconded by Mr. Main, which carried, the meeting adjourned at 5.30 to reconvene at eight o'clock p.m.

Evening Session

The meeting reconvened at eight thirty p.m.

Mr. Kirby strongly disapproved of the suggestion of Mr. Gordon Pitts that a certain class of members should be admitted to The Institute at a nominal fee. In his opinion such action would detract from the dignity of The Institute. Would such members be in a separate class, and, if so, what class?

Mr. Geoffrey Stead, M.E.I.C., (Saint John), wondered whether the value of an association to the member depends on the amount which he pays. In New Brunswick the Association of Professional Engineers' fee is small, $2.50. In New Brunswick opposition to Consolidation with The Institute came largely from men who are poor, and who cannot afford the fee for corporate membership in The Institute. Most of them, therefore, simply remain members of the professional association. Under consolidation there would be difficulty with these men, and he felt that some provision should be made for them to enable them to join as provincial members for a nominal fee.

Dr. O. O. Lefebvre, M.E.I.C., (Montreal), remarked that the committee's conclusions had resulted from a really serious consideration of all angles of the problem by members representing practically all shades of opinion. In fact, until quite recently it had been very uncertain whether a unanimous report could be agreed upon. The report should be viewed as a progress report, and judged with respect to its effect on the good of the profession as a whole, rather than what is good for The Institute, or what is good for the provincial professional associations. From this point of view he believed that unity of action throughout the different provinces was the most desirable aim for the good of the profession.

Dr. Lefebvre considered that The Institute was properly organized to carry out the functions of a Dominion body. Provincial professional associations were in existence to-day solely for the purpose of the legal control of the practice of the profession, and so long as these provincial associations limit their activities to that function, well and good. They would only do so, however, provided that The Institute provides ways and means to interest the large majority, if not all, of the members of the associations, and Dr. Lefebvre believed that The Institute should set its policy to this end so that unity and common membership would be brought about. He asked how this common membership could ever result if The Institute kept on admitting members without paying any attention to the provincial professional associations. He thought, therefore, that the proposal set up by the committee in recommendation No. 2 was the only sound one which could be made.

Arising from the committee's report, he thought that there would be difficulty in taking care of those members who had been placed in Class C, namely, those who did not belong to The Institute, but did belong to the provincial professional associations. He agreed that this could be taken care of by a relatively small increase in their fee. He felt also that by relieving The Institute Headquarters of the work involved in dealing with applications for membership, a considerable saving would be possible.

With regard to the attitude of the Corporation of Professional Engineers of Quebec to the matter of consolidation, about which Dr. Goodwin had spoken, this was clearly stated in the committee's report on page 13, where a resolution passed by the Corporation at its annual meeting on March 27th, 1935, stated that that Corporation was "ready and willing to co-operate immediately with the other provincial engineering organizations in an attempt to develop with The Engineering Institute of Canada a suitable and adequate basis of co-ordination of the engineering profession in the Dominion"; that "the lines along which such co-ordination should proceed be generally similar to those which have generally governed the organization of sister professions," and that "The Engineering Institute of Canada should rightfully be the national co-ordinating body, its corporate membership to consist solely of members of the provincial professional associations." There were other clauses covering minor details, but these dealt with the main points at issue.

Dr. Lefebvre remarked that the conclusions of the committee's report did not represent his own views one hundred per cent. In accepting the conclusions of the report, personally he had had to pour water in his wine, but believed that the report indicated the best thing that could be done under the circumstances. It represented progress, and gave a basis for negotiations with the provincial professional associations without which further development was impossible.

J. B. Challies, M.E.I.C., (Montreal), remarked that as a member of the committee he had also had to pour water in his wine. There had been compromise as to procedure and as to detail, but none as to essential principles. Common membership with the professional associations would be greatly facilitated if the present membership classes were replaced by a single class of corporate member. The membership classes now in effect in The Institute were based on the traditions of The Institution of Civil Engineers and of the founder societies of the United States. In Mr. Challies' opinion, in the interests of the engineering profession, The Institute should first provide for only one class of corporate membership, secondly, provide for the admission to The Institute of anyone who is a member of a provincial professional association, and finally—and it had taken Mr. Challies a long time to be convinced on this point—that in future The Institute should accept no corporate members who are not already members of a provincial professional association.

Mr. Challies had objected to the word consolidation, as had Dr. Decary, because he knew that in each province there must be a professional corporation, while, on the other hand, there must be a Dominion-wide professional body, which he hoped would be The Engineering Institute of Canada, and would some day contain the same common membership which the provincial associations had.

The Committee on Consolidation had not taken into consideration the problem presented by the members of the various branches of the engineering societies from the United States and the members of the Canadian Institute of Mining and Metallurgy. The committee had had no mandate to do so.

Mr. Challies expressed his great personal pleasure in meeting the President and Registrar of the Association of Professional Engineers of British Columbia. In that province, and in Ontario, it would probably be difficult to achieve a common membership, largely owing to the presence in these provinces of active branches of American societies. Mr. Challies could also see that there would be difficulties in Quebec for other reasons, but if the professional associations were not negotiated with, what was the alternative?

Mr. Challies was sure that neither Mr. Pitts nor Mr. Legget desired to leave the impression that they were critical of the Council of The Institute. That was certainly not their intention, but they had felt that after three or four years of apparent inaction, something must be done. Mr. Challies would point out that Council consists of representatives of every branch of The Institute from coast to coast, and he would ask whether it would be wise to leave the responsibility for carrying on the further steps of this work to a small group such as the committee; would it not be wiser to leave that responsibility with Council in association with such a group?

Mr. Main remarked that he had three thoughts in mind, which would form the basis of a resolution he desired to move. These were, first, the maintenance of the provincial professional associations from the legal point of view; second, the retention of the traditions of the fifty years of activity of The Institute, and, third, the importance of getting together before conditions become more difficult than they now are. He begged to move:—

> That the report of the Committee on Consolidation be adopted in principle, as a progress report: also that the Committee on Consolidation be continued and that Council be hereby given authority to take the necessary steps to make it possible for any provincial organization to work out individual consolidation or co-ordination or confederation within such province.

H. S. Johnston, m.e.i.c., (Halifax), seconded the motion.

Professor Jamieson, in the light of Mr. Challies' remarks, desired to make it clear that the committee had asked for its continuance as a committee, and definitely considered it inadvisable that from this point the work should be referred to Council. Naturally, no final action could be taken except through Council, but the continuance of the present committee was important in order to prepare the ground along the lines already indicated.

Major Grant desired to propose an amendment to Mr. Main's motion, and moved that Council be instructed to re-appoint the same committee. He did this with the idea of meeting the objection of those members who said that this should be a matter for Council, and his proposal, while retaining the same committee that had worked so ably during the past year, would make them a committee of Council, without restricting their activity. He believed that this would strengthen the committee's hands in meeting the provincial professional associations.

Mr. Gordon Pitts urged that the committee should be maintained in the same character as last year.

The amendment was seconded by W. J. Bishop, a.m.e.i.c., (Ottawa).

Mr. Main stated that, with the permission of his seconder, he was quite willing to have the clause proposed by Major Grant inserted in his motion.

Past-President J. M. R. Fairbairn, m.e.i.c., (Montreal), stated that he had already prepared a resolution covering much the same ground as that of Mr. Main and Major Grant's amendment thereto; he would like to read it and possibly Mr. Main would accept it instead of his own motion as being in the same spirit. Mr. Fairbairn then read the following motion:

> Resolved that this Annual Meeting accept the report of the Committee on Consolidation with appreciation and gratitude and hereby resolves that Council be instructed to re-appoint the Committee and add to its numbers, in order to create a nucleus for a National Committee; and that Council be also instructed to invite forthwith the Dominion Council and the Provincial Associations to appoint representatives to this National Committee, with the object of achieving the co-ordination of The Institute and the Provincial Associations.

Mr. Gordon Pitts declared that he had done a good deal of the work for the last year and if the meeting wanted him to work some more he should be given a break. The committee would do the work and do it honestly enough.

Mr. Main was afraid that Mr. Fairbairn's suggestion was not quite the same as his own, and further there was as yet no assurance from the associations that they would accept the responsibility of appointing delegates as suggested by Mr. Fairbairn. Therefore, he still thought that a private committee, not the Council, should be authorized to carry on these negotiations; further, a very essential part of his resolution was the last part which would permit such provinces as Manitoba, Nova Scotia and Saskatchewan to carry on their co-ordination independently.

Mr. Johnston said that in seconding Mr. Main's resolution he had in mind one definite thing, namely, that it was not desirable to change the status of the present committee at this point, when its report was being accepted only as a progress report. Further, he considered it important, in the case of those provinces which are ready now to consolidate, co-ordinate or confederate, that they should have that privilege, and that Council should be authorized to give them the opportunity to do so. He would very much prefer to see the resolution stand in its original form.

Mr. Legget desired to ask Past-President Fairbairn a question. Recalling that when the Committee on Consolidation was established by resolution from the annual meeting of 1935, one reason for this course was that The Institute Council was still bound by its understanding with the professional associations to take no part in the deliberations of their Committee of Eight. Mr. Fairbairn's proposal would seem to involve a change in the Council's attitude on this point. He would like to ask what had happened in the meantime to change the feeling of the Council.

Mr. Fairbairn replied that so far as he knew the feeling of the Council had not changed, but as he was not a member of Council he could not reply to this point in detail. He wished to point out, however, that the four thousand members of The Institute elected by a very well regulated system a Council, and he did not think it right that an annual meeting should appoint a committee and give it power independent of Council. He had drafted his resolution so as to give Council the right to re-appoint this committee, instruct them to add to their number, and to bring representatives from the Dominion Council, making the whole a national committee to achieve the thing we all desire.

Mr. Challies supported Past-President Fairbairn in this matter. Mr. Pitts and his committee had drawn up a report which, if accepted, could be the basis of further action by the elected representatives of The Institute membership, the Council of The Institute.

Major Grant stated that, with the permission of his seconder, he withdrew his amendment in favour of Mr. Fairbairn's motion.

Mr. Main pointed out that his original resolution was divided into two parts, the first dealing with the work of negotiation, which he thought a committee could do better than Council, and the second covering something that Council could definitely take action on, and asking Council to do so.

Dr. Goodwin supported Past-President Fairbairn's resolution, and believed that The Institute Council could not and should not be deprived of its responsibility. By having the Committee on Consolidation appointed as a committee of Council a desirable result would follow, namely, that Mr.

Pitts' committee could at any moment go to Council, ask for action, and Council could take action at once.

Mr. Gordon Pitts wanted to get down to facts. Mr. Fairbairn had suggested that Council be given authority to add to the number of the committee. His committee did not want to be diluted by any additions from Council. Had the members no confidence in his committee, which already contained three past-presidents? His committee could not change a by-law, as such changes must be placed by Council before the whole membership for discussion and ballot.

W. L. McFaul, M.E.I.C., (Hamilton), desired to support Mr. Fairbairn's motion, because, having listened to the discussion, he was of the opinion that the work of the Committee on Consolidation had now reached a stage at which the elected representatives of The Institute membership should take hold and guide the action to be taken by The Institute. He was of opinion that a committee appointed by the annual meeting, at which only a limited number of members were present, should not take precedence over the Council elected by the membership at large.

Major H. B. Stuart, M.E.I.C., (Hamilton), desired to ask Mr. Pitts' reason for objecting to be under Council or to the appointment of additional members by Council.

Mr. Pitts replied that from his experience he found that the committee as now constituted could perform its functions in the interests of the members of The Institute without usurping any of the powers of Council, or taking precedence of them in any way. His advice was to leave the committee exactly as it was, so that at the proper time the committee's recommendations and representations could be made to Council as to what changes should be made.

Mr. Wheatley pointed out that there was no seconder to Mr. Fairbairn's motion.

The President inquired whether Mr. Bishop would agree to the withdrawal of Major Grant's amendment, and Mr. Bishop agreed.

The President then ruled that Major Grant and Mr. Bishop having withdrawn their amendment, Mr. Fairbairn's resolution was now in order if regarded as an amendment to Mr. Main's motion.

Mr. Main desired to ask, in case Mr. Fairbairn's amendment carried, that the last part of his own motion be included, as he was very anxious that it should be made possible for provincial organizations to make their desired arrangements.

P. L. Pratley, M.E.I.C., (Montreal), would like to have the privilege of seconding the amendment proposed by Mr. Fairbairn. He felt that this amendment met many of the points that had been raised. He thought that the meeting would agree that the present committee should continue its work of investigation, but that it needed to be made broader before it could be truly representative of the whole Dominion. He also thought that the committee could achieve more if it had direct approach to Council, rather than having to wait for an annual meeting. It was gratifying to note from the morning discussion that the members of the Dominion Council here present and the officials of the provincial professional associations are willing to accept the implied invitation of our own Committee on Consolidation to discuss matters with them. This amendment would prepare the way by instructing The Institute Council to do its part in appointing the representatives to a proposed national committee. Therefore, he had much pleasure in seconding Mr. Fairbairn's amendment.

Mr. Legget felt that a very serious moment had arrived, and that if a vote were now taken on the amendment the position of the committee would be liable to grave misrepresentation. The tone of the discussion had indicated that for some reason or other the members of the Committee on Consolidation were thought to be antagonistic to Council. Nothing was further from the truth than this idea.

He had always been led to believe that The Institute had a principle and would stick to it. Before the Committee on Consolidation was formed members of The Institute had been told that the only reason for inaction on The Institute's part had been that the Council had tied its hands by passing the question over to the consideration of the associations alone.

Mr. Busfield said that this view was not correct, the associations having taken the matter away from The Engineering Institute of Canada.

Mr. Wheatley said that as far as at least one association was concerned there had been no breach of faith on the part of The Institute. The Council of The Institute had not asked the associations, and particularly the Dominion Council, to work together with them for the co-ordination of the engineering profession in Canada. That had been the one invitation they had been waiting for.

The President pointed out that if Mr. Fairbairn's resolution were to be put as an amendment it would have to be worded somewhat differently.

Mr. Fairbairn then read his resolution with an addition, which he hoped would make it acceptable to Mr. Main, the revised wording being:—

> That this annual meeting accept the report of the Committee on Consolidation with appreciation and gratitude and it is hereby resolved that Council be instructed to reappoint the committee and add to its numbers in order to create a nucleus for a national committee of The Institute.
>
> That Council be also instructed to invite forthwith the Dominion Council and the Provincial Associations to appoint representatives to this national committee, with the object of achieving the co-ordination of The Institute and the Provincial Associations.
>
> That Council be hereby given authority to take the necessary steps to make it possible for any provincial organization to work out individual consolidation or co-ordination or confederation within such province.

Mr. Main indicated that he could not accept this change, although he thought Mr. Fairbairn's resolution had been greatly improved by the addition of a new clause.

Mr. Fairbairn then pointed out that his motion must be regarded as an amendment to Mr. Main's resolution.

Mr. Bishop, in seconding Major Grant's amendment, had understood that the Committee on Consolidation would continue until such time as they went to the Council for their authority.

Mr. Gordon Pitts asked if Mr. Fairbairn's amendment implied that the committee should go to Council and ask for more members, or would Council appoint additional members.

Mr. Challies desired to answer Mr. Pitts' pertinent question whether Council would overload his committee with additional members. He could not conceive of Council adding to Mr. Pitts' committee any members who would be liable to obstruct the committee's work.

Mr. Clarence Pitts said that, assuming that the meeting was sincere in its appreciation of the committee's work, Mr. Main's motion would afford an opportunity to receive the report, adopting it in principle as a progress report, and letting the committee go on with its work. It further gave the authority to Council to override the by-laws so as to permit what Manitoba, Nova Scotia and Saskatchewan wanted, namely, an early consummation of provincial consolidation. Mr. Fairbairn's amendment, however, was something quite different. Mr. Clarence Pitts had been on Council for two years. In trying to promote the idea of consolidation he had been up against a stone wall. It had been necessary, therefore, to obtain action in another way, through the annual meeting. If members present were satisfied with the honesty and integrity of the present committee, and if expedition were desired, he earnestly asked them not to permit the dilution of the committee by appointments from Council. He believed that Mr. Main's motion gave everything that The Institute and the profession wanted to implement the general idea of consolidation. It also gave the authority to Council to do the immediate things which the provinces have asked for, and he asked the meeting to view Mr. Fairbairn's amendment as something entirely different—as sand in the gear box.

Mr. Fairbairn said that the spirit which was being shown by the committee in this discussion began to make him wonder whether the committee ought to be asked to function by itself. He really thought dilution by a few members of Council, who, after all, are The Institute's elected representatives, would be a good thing for the committee.

Dr. Lefebvre could not help feeling surprised and slightly suspicious when he found that the seconder of Mr. Fairbairn's amendment was a strong opponent of any method of consolidation. Possibly through the amendment a method of killing the procedure would be found.

Mr. Fairbairn remarked that the meeting had heard Dr. Lefebvre's suggestions. Mr. Pratley had not been asked to second his amendment, and Mr. Fairbairn had had no ulterior motive in putting that amendment forward for Mr. Main's acceptance or for the meeting.

The President pointed out that as Mr. Main had not ithdrawn his motion, Mr. Fairbairn's proposal had to be treated as an amendment.

Mr. Fairbairn begged to put it forward accordingly, and stated that at the suggestion of a member of the Committee on Consolidation he had made two changes, so that his amendment would now read:—

> THAT this annual meeting accept the report of the Committee on Consolidation with appreciation and gratitude and hereby resolves that Council be instructed to re-appoint the committee and in co-operation with the Committee on Consolidation that it add to its number in order to create a nucleus for a national committee of The Institute, and the Council be also instructed to invite forthwith the Dominion Council and the Provincial Associations to appoint representatives to this national committee with the object of achieving the co-ordination of The Institute and the Provincial Associations.

The whole object of this amendment was to achieve the co-ordination of The Institute with the professional associations, and Mr. Fairbairn asked why, if Mr. Pratley were opposed to any method of consolidation as stated by Dr. Lefebvre, he would be willing to second it.

Mr. Busfield desired to put forward a suggestion. Could not Mr. Fairbairn and Mr. Main withdraw from the meeting and perhaps present a joint resolution?

Mr. Pratley asserted that Dr. Lefebvre had no right to say that he was opposed to consolidation, but remarked that his interpretation of consolidation was probably different to that which first of all was in the mind of Mr. Pitts. A year ago Mr. Pitts had an opinion on consolidation, and not until the report of his committee was published, was it known that he did not still have the same meaning in his mind. There were, however, other interpretations of consolidation with which Mr. Pratley was heartily in accord, and he thought the report offered many solutions to the problem other than the total integration of the various units in the country. There was need for much co-operation, and his object in seconding the amendment was to provide a quick means of getting in touch with the provincial professional associations through their officers and their joint Dominion Council. It had been stated by Mr. Wheatley that they are ready to meet any committee The Institute provides. He resented gratuitous remarks about his opposing this, that, and the other, and challenged Dr. Lefebvre to produce any evidence that he was opposed to consolidation in his own way of interpreting the term.

Otto Holden, A.M.E.I.C., (Toronto), wished to offer an amendment to Mr. Fairbairn's amendment so that it would read:—

> THAT this annual meeting accept the report of the Committee on Consolidation with appreciation and gratitude and hereby resolves that Council be instructed to re-appoint the committee and add to its members in order to create a nucleus for a national committee of The Institute, and that Council be also instructed to invite forthwith the Dominion Council to appoint representatives to the national committee with the object of achieving the co-ordination of The Institute and the Provincial Associations on the general basis of the above report.

Mr. Holden considered that the addition of the last eight words was necessary so that the committee would know what basis to work on.

The President suggested that Mr. Fairbairn should be asked if he would accept these changes.

Mr. Paulin desired to ask, while this conference was taking place, what the committee expected to do if re-appointed. Was their report not a full report? Did they intend to be a committee who would negotiate with the provincial professional associations independently of the Council? Where would they obtain the money which would enable them to do so, and how were they to be empowered to bring about the achievement of their scheme of consolidation if, as, and when made? Mr. Paulin felt sure that if definite action were not taken by this annual meeting, action would be taken independently of The Institute in some of the provinces. He would also ask for the reasons which led the committee to ask to be continued with exactly the same status as before.

Mr. Kirby remarked that the desire of some members present seemed to be that The Institute committee was to appear before the Dominion Council with an absolutely hidebound proposition, endorsed by this comparatively small gathering. He suggested that this would be a most unfortunate course. The hands of the committee should not be tied. They should have some authority and get it from a larger and more representative gathering than this, namely, from Council.

Mr. Gordon Pitts, in reply to Mr. Paulin's inquiry, stated that if this meeting gave approval to the general scheme laid out in his committee's report, the committee would take the steps necessary to obtain information and would endeavour to obtain the co-operation of the provincial professional associations, thus making a basis for setting up such revisions as may be necessary in the by-laws of The Institute to put consolidation into effect. Such proposed revisions to The Institute by-laws would be dealt with in the same manner as that followed in regard to the proposals of the Committee on Development in 1933-34, the course prescribed in Section 75 of The Institute by-laws. According to this procedure the committee would have to be in a position by October to submit its suggestions with regard to revisions to the by-laws to Council. After consideration by Council, the revisions would be discussed at an annual meeting of The Institute, and then go out to the members for vote by ballot.

While his committee knew that there was to be a meeting of the Dominion Council on the 8th, they had not yet been invited to join in its deliberations. As Mr. Kirby had pointed out, the committee could not do anything without the co-operation of the associations. They were certainly not going to the associations with any hidebound idea as to what the arrangement must be. If it transpired that any of the associations had a better scheme, his committee would be glad to hear of it, and an opportunity would be provided to bring that scheme to the attention of the members of The Institute. His committee was not trying to force anyone to do anything. Did the meeting want the committee to carry on and finish what they were doing?

J. R. Dunbar, A.M.E.I.C., (Hamilton), thought that the committee should be appointed by Council instead of by this meeting so that its proposals for the revision of the by-laws might come in regular form.

Mr. Pitts explained that the committee in proposing any revisions of the by-laws did not need the consent of Council, as they could be presented over the signatures of any twenty corporate members of The Institute; that was one of the two legal ways in which revisions to the by-laws could be put forward.

Mr. Sauder desired to point out that in his opinion this meeting was not representative of The Institute, as it was made up largely of members from the larger cities of Hamilton, Toronto and Montreal. While not opposed to the recommendations of the Pitts' committee, he thought that the committee should be appointed by the Council so as to represent the whole membership of The Institute, which this meeting did not represent, but which the Council did. For this reason he would support Mr. Fairbairn's motion, and he also felt that the committee would be in a better position to negotiate with the Dominion Council if it were a committee of The Institute Council. He drew attention to the fact that six representatives of the Dominion Council were present at this meeting as members of The Institute. He hoped they would have a get-together meeting on the 7th, and a formal meeting later, at which he thought arrangements could be made to have representatives of The Institute present.

Mr. Busfield desired to make apology for an error which he had made in contradicting Mr. Legget and Mr. Pitts earlier in the evening by stating that the associations took the consolidation question out of the hands of The Institute. He had since been informed that this was not the case, as, at the suggestion of the associations, The Institute Council had voluntarily refrained from further action. Mr. Busfield wished also to make it clear that members of The Institute Council were of one mind in desiring consolidation, any difference of opinion having had reference only to the best method of accomplishing that object.

Mr. Kirby thought it was important that the committee should continue, particularly during the next three days, when there was an opportunity of making contact with the Dominion Council. He suggested, therefore, that the committee be empowered to continue as they are, make contact with the Dominion Council, and report to a plenary meeting of Council for further instructions. Such a meeting might be held in October with a representative from every Institute branch throughout Canada, and he could imagine no more representative gathering for the purpose of dealing with the findings of the committee.

Mr. Main had been greatly surprised at the idea expressed by Mr. Sauder that the annual meeting of The Institute had very little weight. If the annual general meeting of The Institute could not make decisions why hold it?

Dr. Lefebvre remarked with regard to this point that he had always understood that with an association of this character the annual meeting holds the supreme authority. Thus the phrase used in the motion, "instructs Council" would be quite a proper one.

Dr. Lefebvre desired to apologize to his friend Mr. Pratley for any unjustified statements he had made, and was glad to learn that Mr. Pratley had changed his opinions to some extent.

Dr. Boyle agreed with Dr. Lefebvre as to the power of the annual meeting to give instructions to Council. He felt, however, that the Committee on Consolidation should be considered as an *ad hoc* committee of Council charged with the special duty of furthering the advance of consolidation or confederation in the spirit of their report. He did not quite agree, however, with Mr. Fairbairn's proposal that the Council be charged with adding to the numbers of the committee, but thought that the committee should be permitted to exercise the power they already possessed and add to their number those men whom they undoubtedly knew to be helpful, and who would be useful rather than deadwood. Let the committee do the picking of its additional members, providing they are approved by Council.

Mr. Gordon Pitts inquired why the approval of Council was suggested.

Colonel Letson, as a non-member, asked permission to say a few words. He could not see why it would not further the best interests, not only of The Institute but of all the provincial professional associations, to allow The Institute committee to consult with such members of the associations as the Council of The Institute might select to act with them on their committee.

Mr. Fairbairn remarked that Dr. Boyle's suggestion was practically in agreement with his amendment, and if the meeting preferred Dr. Boyle's version he would be glad to withdraw his amendment.

Mr. Main stated that he had the permission of his seconder to accept Dr. Boyle's phraseology and was very glad to see that Mr. Fairbairn was willing to withdraw his amendment.

Mr. Wheatley observed that after three or four years of silence reference had at last been made to the Dominion Council of the provincial professional associations, although Mr. Main's original motion made no reference to the Dominion Council or the associations.

If he understood the amendment rightly, the committee, or continuing body, was authorized to get in touch with all the associations, those holding opposing views as well as those holding favourable views. It should take up the position of an impartial investigator. Mr. Wheatley therefore regretted to hear Mr. Fairbairn suggesting the withdrawal of his amendment. If withdrawn, he would ask Mr. Main and his seconder to make as wide and as general a reference as possible in their resolution to the Dominion Council, a body which wishes to assist, and wishes to invite The Institute. He would ask that the errors of the past be not continued by a dead silence with regard to the Dominion Council.

Professor Faulkner agreed with Mr. Wheatley, and with Dr. Lefebvre's statement that the annual meeting has precedence in power over the Council except in the matter of changes in the by-laws. If the motion could contain a provision that the committee be continued, and in addition that it be empowered to confer with the Dominion Council upon invitation from that Council, he thought the whole matter would be settled. As himself a member of the Dominion Council, he believed that it was the hope that the Dominion Council when it meets will be able to confer with representatives of The Institute. Professor Faulkner knew of no group of men better qualified at the present moment to represent The Institute than Mr. Pitts' committee.

Mr. Johnston pointed out that Mr. Main's resolution, if changed by the addition suggested by Dr. Boyle, would be entirely in accordance with the ninth recommendation of the report, which proposes that "The Institute continue the present Committee on Consolidation with the commission to represent The Institute in discussions with the provincial professional associations." In principle the resolution was thus already contained in the committee's report. Would Mr. Main agree to a rewording of his resolution giving the committee power to add to its numbers providing such additional members are approved by

Council, and providing also that Council be given authority to take the necessary steps to make it possible for any provincial organization to work out individual consolidation or co-ordination within its province.

Mr. Pitts expressed himself as being agreeable to this.

A. B. Crealock, M.E.I.C., (Toronto), speaking as the representative of the Ontario Association of Professional Engineers on the Dominion Council, was in entire agreement with Mr. Wheatley, but would like to ask whether Mr. Fairbairn's resolution, with the revision regarding the appointment of additional members as suggested by Dr. Boyle, would be agreeable to Mr. Pitts.

Mr. Pitts then suggested the addition of the phrase "and the Dominion Council."

Mr. Main said that his seconder and himself agreed to the suggestion of Mr. Wheatley and offered a revised wording of his resolution as follows:—

> THAT the report of the Committee on Consolidation be adopted in principle as a progress report; Also that the Committee on Consolidation be continued and be given power to add to its numbers, providing such additional members be approved by Council; That it be empowered to confer with the Dominion Council of the Provincial Professional Associations, upon invitation received, and that Council be hereby given authority to take the necessary steps to make it possible for any provincial organization to work out individual consolidation or co-ordination or confederation within such province.

Mr. Wheatley thought this version was a slight improvement, but he still objected to it because the wording did not ensure that Mr. Pitts' committee, when continued, would have upon it any representatives from the provincial professional associations.

Mr. Gordon Pitts said that his committee would welcome such additional members, and if the provincial professional associations were agreeable his committee would be prepared to form a national committee representing The Institute and the associations.

Mr. Wheatley asked if this would be written into the resolution, and remarked that this meeting was really dealing with the destiny of a large body of engineers who are not members of The Institute. There were 2,400 professional engineers who would be affected, and in addition 2,500 not yet licensed, but who would be licensed in the future. Surely a resolution passed by this meeting should contain a statement that The Institute's continuing committee desired to confer with the representatives of the Dominion Council. [Cries of "Put it in," "Put it in."]

Mr. Wheatley stated that a member of the Dominion Council had put forward the suggestion that the President appoint a committee to draw up a single resolution to include the various points that had been stressed.

Mr. Busfield supported this idea and urged that the wording should be very carefully considered. If such a resolution carried, a mandate was being given to the committee and also to the Council of The Institute to go ahead.

The names of Messrs. Busfield, Main, Wheatley and Pitts having been suggested from the floor, the President named them and they accordingly retired to consult.

On their return, the resolution they had prepared, moved by Mr. Main, and seconded by Mr. Johnston, was put to the meeting by the President, and *carried* unanimously as follows:—

> THAT the report of the Committee on Consolidation be adopted in principle as a progress report; also that the Committee on Consolidation be continued with instructions to add to their number two members of the Dominion Council of the associations, and be empowered to add further to their number, providing such additional members be approved by Council, and that Council and the committee shall co-operate for the speedy consummation of consolidation, co-ordination or confederation throughout the Dominion.

The President congratulated the meeting on coming to so satisfactory a conclusion, and particularly upon the unanimous character of the vote.

Mr. Smither thought a vote of thanks was due to the Committee on Consolidation for the work they had accomplished, and his suggestion was received with prolonged applause.

Mr. Pitts, in acknowledging this, said that this committee hoped to continue their work and bring it to a successful conclusion.

The President, in adjourning the meeting, remarked that the discussion had been throughout of a high order; he believed that the resolution which had been unanimously passed would be gratifying and satisfactory to the members both of The Institute and of the provincial associations of professional engineers.

Before dispersing, Mr. Pitts asked the meeting to express its appreciation to President Gaby, who had so ably guided the committee in all its work, and had been of such material assistance to them. This suggestion was received with hearty and prolonged applause, and the meeting adjourned at 11.20 p.m.

Editor's note.

Following the above resolution of the Annual General Meeting, The Institute's Committee on Consolidation met the Dominion Council of Professional Engineers and other representatives of the provincial professional associations at a round table conference on Friday, February 7th. A report of the proceedings of this conference will be published when available.

The provincial professional associations and their Dominion Council have implemented the terms of the resolution by naming C. C. Kirby, M.E.I.C., (Saint John), and A. B. Crealock, M.E.I.C., (Toronto), (who are now respectively President and Vice-President of the Dominion Council of Professional Engineers) as the Dominion Council's representatives upon The Institute's Committee on Consolidation.

That committee has further added to its number Past-President F. A. Gaby, M.E.I.C., with the approval of Council expressed at its meeting on February 6th.

The present membership of The Institute's Committee on Consolidation is therefore:—

Gordon McL. Pitts, A.M.E.I.C., (*Chairman*).
J. B. Challies, M.E.I.C.
A. B. Crealock, M.E.I.C.
A. R. Decary, M.E.I.C.
G. J. Desbarats, M.E.I.C.
F. A. Gaby, M.E.I.C.
R. E. Jamieson, M.E.I.C.
C. C. Kirby, M.E.I.C.
O. O. Lefebvre, M.E.I.C.
R. F. Legget, A.M.E.I.C., (*Secretary*).

BUSINESS SESSION

The adjourned meeting convened on Thursday, February 6th, 1936, at ten a.m., with President F. A. Gaby in the chair.

The Secretary read the cable which had been sent to His Majesty King Edward VIII on January 25th, 1936, which had already been published in The Journal for February 1936, page 106.

After announcing the receipt of a number of messages of regret and felicitation, the Secretary submitted the membership of the Nominating Committee appointed to nominate the officers of The Institute for 1937 as follows:—

NOMINATING COMMITTEE—1936

Chairman: A. J. Taunton, M.E.I.C.

Branch	*Representative*
Cape Breton Branch	F. W. Gray, M.E.I.C.
Halifax Branch	R. L. Dunsmore, A.M.E.I.C.
Saint John Branch	A. Gray, M.E.I.C.
Moncton Branch	H. B. Titus, A.M.E.I.C.
Saguenay Branch	N. F. McCaghey, A.M.E.I.C.
Quebec Branch	L.-P. Methé, A.M.E.I.C.
St. Maurice Valley Branch	Z. Lambert, M.E.I.C.
Montreal Branch	J. A. Lalonde, A.M.E.I.C.
Ottawa Branch	C. P. Edwards, A.M.E.I.C.
Peterborough Branch	A. L. Killaly, A.M.E.I.C.
Kingston Branch	L. M. Arkley, M.E.I.C.

Toronto Branch	J. W. Falkner, A.M.E.I.C.
Hamilton Branch	J. R. Dunbar, A.M.E.I.C.
London Branch	S. G. Johre, A.M.E.I.C.
Niagara Peninsula Branch	C. G. Moon, A.M.E.I.C.
Border Cities Branch	A. J. M. Bowman, A.M.E.I.C.
Sault Ste. Marie Branch	A. H. Russell, A.M.E.I.C.
Lakehead Branch	H. G. O'Leary, A.M.E.I.C.
Winnipeg Branch	F. V. Seibert, M.E.I.C.
Saskatchewan Branch	R. A. Spencer, A.M.E.I.C.
Lethbridge Branch	J. Haimes, A.M.E.I.C.
Edmonton Branch	R. S. L. Wilson, M.E.I.C.
Calgary Branch	J. J. Hanna, A.M.E.I.C.
Vancouver Branch	E. E. Carpenter, M.E.I.C.
Victoria Branch	E. C. G. Chambers, A.M.E.I.C.

Awards of Medals and Prizes

The Secretary announced the winners of the various prizes and medals of The Institute, and the President stated that the formal presentation of these distinctions would take place at the Annual Dinner in the evening.

The Sir John Kennedy Medal to A. H. Harkness, M.E.I.C., Toronto, Ont.

The Past-Presidents' Prize to J. B. deHart, M.E.I.C., Lethbridge, Alta., for his paper on "The Co-ordination of the Activities of the Various Engineering Organizations in Canada."

The Gzowski Medal to P. L. Pratley, M.E.I.C., Montreal, for his paper on "The Substructure of the Second Narrows Bridge."

The Leonard Medal to R. W. Diamond, M.C.I.M.M., Trail, B.C., for his paper on "The Trail Heavy-Chemical Plants."

Students' and Juniors' Prizes

H. N. Ruttan Prize (Western Provinces) to Z. Levinton, S.E.I.C., Ridgedale, Sask., for his paper "Determination of Temperature Stresses in an Arch Bridge Model by Means of the Photoelastic Method."

Phelps Johnson Prize (Quebec—English) to S. T. Fisher, Jr.E.I.C., Montreal, Que., for his paper on "Recent Developments in Sound Pictures."

Ernest Marceau Prize (Quebec—French) to Yvon-Roma Tassé, S.E.I.C., Montreal, Que., for his paper "Le Vent pour Electrifier nos Campagnes."

Martin Murphy Prize (Maritimes) to F. L. Black, Jr.E.I.C., Moncton, N.B., for his paper "The Low Voltage Cathode-Ray Oscillograph and Several Applications in Radio Research."

1937 Annual Meeting

The President drew attention to the fact that at the time of the Annual General Meeting of 1937 fifty years of corporate existence of The Institute would have been completed, and stated that in the opinion of Council the occasion should be marked by a Semicentennial Celebration. J. L. Busfield, M.E.I.C., as the chairman of a committee appointed by Council to outline a tentative programme and make preparations for this event, explained the main features of the plans which are receiving the consideration of the committee.

After discussion Mr. Challies moved that it is the sense of this annual meeting that the Fiftieth Anniversary of the founding of The Institute should be appropriately commemorated and celebrated; that the general ideas that we have heard be approved in principle; and that J. L. Busfield, M.E.I.C., be appointed chairman of a committee to carry out the proposals, the rest of his committee to be named by the incoming Council. The motion was seconded by Mr. Massue and *carried* unanimously.

Report of Council and Report of Finance Committee

The Secretary read the report of Council for 1935 and the Treasurer's report. P. L. Pratley, M.E.I.C., chairman of the Finance Committee, presented that committee's report, after which, on the motion of Mr. Pratley, seconded by Dr. O. O. Lefebvre, M.E.I.C., the report of Council, the Treasurer's report, the report of the Finance Committee, and the financial statement were *adopted*.

Reports of Committees

The Secretary having indicated the principal points of interest in the reports of the various committees, they were submitted for approval.

In regard to the Committee on Western Water Problems, Mr. Main reminded the meeting that the Dominion Government had appointed an Advisory Committee to carry out the provisions of the Prairie Farms Rehabilitation Act, and that a Committee on Water Development, a Committee on Soil Drifting, and several other active committees were working under that Advisory Committee. Mr. Main was a member of the Committee on Water Development, and stated that substantial progress had been made in the matter of farm water supply, and the people in the west were pleased with what had been accomplished. He had hoped that in view of the importance of the question to the country as a whole, time would have been available for discussion of this important matter at the present annual meeting. It was gratifying to note that so many western members were taking an active part in the work of The Institute's committee, particularly C. H. Attwood, A.M.E.I.C., L. C. Charlesworth, M.E.I.C., Dean C. J. Mackenzie, M.E.I.C., Past-President S. G. Porter, M.E.I.C., and G. A. Gaherty, M.E.I.C.

Speaking of the report of the Unemployment Committee, Mr. Tennant briefly outlined the work which had been accomplished during the past year, and particularly congratulated the branch unemployment committees on the helpful work done locally in their own districts.

Referring to the report of the Legislation Committee, Mr. Crealock drew attention to the work of committee members in regard to the change in the Highway Improvement Act of Ontario, which he hope would soon provide for the recognition of corporate membership in The Institute as a qualification for appointment for county highway engineers.

After further brief discussion, it was *resolved*, on the motion of Geoffrey Stead, M.E.I.C., seconded by J. A. McCrory, M.E.I.C., to adopt the following reports: Membership Committee, Papers Committee, Library and House Committee, E.I.C. Members of the Main Committee of the C.E.S.A., Committee on Relations with National Societies, Board of Examiners and Education, Committee on Western Water Problems, Legislation Committee, Communication Engineering Sections, Unemployment Committee, and the Employment Service Bureau.

Branch Reports

In presenting the branch reports, the Secretary asked members to note the very satisfactory condition of activity of the branches as a whole as shown by their reports, particularly as regards the number of meetings which have been held, the great variety of subjects treated in the papers and addresses, and the interest in Institute affairs and questions of the day which the reports evidenced. The financial statements of the various branches also indicated a satisfactory situation as regards branch finances.

On the motion of Major L. F. Grant, M.E.I.C., seconded by P. M. Sauder, M.E.I.C., it was *resolved* that the reports of the various branches be taken as read and adopted.

Entrance Fee

The President announced that in the opinion of Council it would be desirable to continue for another twelve months the reduced entrance fee of $5.00 for all classes of membership which has been in effect for the last year, and Council would ask the approval of the meeting for the continuance of this variation from the by-laws for the ensuing year. On the motion of H. Massue, A.M.E.I.C., seconded by P. L. Pratley, M.E.I.C., it was unanimously *resolved* to approve Council's action in this matter.

Address of Retiring President

The President then delivered his address which is printed in full on pages 150 to 151 of this issue of The Journal, which was received with marked interest and appreciation.

Election of Officers

On the conclusion of the retiring President's address, the Secretary read the report of the scrutineers appointed to canvass the officers' ballot for 1936, and the officers named therein were declared duly elected as follows:—

President	E. A. Cleveland
Vice-Presidents:	
Zone B	R. L. Dobbin
Zone C	A. B. Normandin
Zone D	H. W. McKiel
Councillors:	
Cape Breton Branch	Y. C. Barrington
Moncton Branch	T. H. Dickson
Quebec Branch	H. Cimon
Montreal Branch	F. S. B. Heward
	F. Newell
Ottawa Branch	A. K. Hay
Peterborough Branch	A. B. Gates
Hamilton Branch	E. P. Muntz
Niagara Peninsula Branch	E. P. Murphy
Sault Ste. Marie Branch	F. Smallwood
Winnipeg Branch	T. C. Main
Calgary Branch	H. J. McLean
Lethbridge Branch	G. S. Brown
Victoria Branch	H. L. Swan

Dr. Gaby welcomed Mr. Cleveland to the Presidency, and the newly elected President was conducted to the chair by Past-President O. O. Lefebvre, M.E.I.C., and Past-President F. P. Shearwood, M.E.I.C. President Cleveland briefly expressed his appreciation of the honour conferred upon him by this election.

Mr. Challies drew attention to the fact that two of the past-presidents of The Institute, recipients of the Sir John Kennedy Medal, Dr. R. A. Ross, M.E.I.C., and Dr. G. H. Duggan, M.E.I.C., were unable to attend the meeting, one on account of severe illness, and the other as the result of a bad accident. At his suggestion the Secretary was directed to forward telegrams of condolence to both these gentlemen.

On the motion of J. A. McCrory, M.E.I.C., seconded by Geoffrey Stead, M.E.I.C., it was unanimously *resolved* that the thanks of The Institute be conveyed to the Hamilton Branch in recognition of their hospitality and activity in connection with the holding of the Fiftieth Annual General and General Professional Meeting.

On the motion of H. A. Lumsden, M.E.I.C., seconded by D. A. R. McCannel, M.E.I.C., it was unanimously *resolved* that a very hearty vote of thanks be accorded to the retiring President and members of Council in appreciation of the work they have done for The Institute during the past year.

On the motion of J. B. Challies, M.E.I.C., seconded by Col. H. J. Lamb, M.E.I.C., it was unanimously *resolved* that a vote of thanks be tendered to the scrutineers for their services in preparing the report on the election of officers, and that the ballot papers be destroyed.

Mr. Busfield desired to remind the meeting of a remark made by J. B. Carswell, M.E.I.C., during his address at last year's annual meeting, to the effect that engineers in general, and members of The Engineering Institute in particular, did not take sufficient interest in the public affairs of the Dominion. In this connection, Mr. Busfield had noted with pleasure the series of papers to be presented that afternoon on a subject of great public interest, namely, transportation, a matter to which reference had already been made in the press, approving The Institute's attitude in taking up this subject.

Mr. Busfield believed that the time was opportune for the Council of The Institute to appoint a committee to prepare a comprehensive report on transportation, which would embody pertinent facts regarding various phases of the subject. Such a committee could be assisted by suitable sub-committees and, while not attempting to present solutions to the many vexed questions connected with the subject, should confine themselves to presenting facts in a logical manner, so that The Institute members and other interested parties could have real knowledge on which to base their opinions.

Mr. Busfield then moved that this meeting urges upon Council the desirability of appointing a comprehensive fact finding committee to report upon all phases of transport in Canada, with the suggestion that such committee be divided into sub-committees dealing respectively with railway, highway, aviation, water-borne and urban transport, each sub-division being subdivided into groups dealing with mechanical, physical and economic problems. He had already spoken to the Minister of Transport indicating his intention of bringing this matter up, and Mr. Howe had given him permission to tell the meeting that he would welcome the appointment of such a committee. Mr. Busfield's motion was seconded by Mr. Clarence Pitts, and on being put to the meeting was *carried* unanimously.

The meeting adjourned at twelve thirty p.m.

Social Functions

At the formal luncheon which followed the conclusion of the Annual General Meeting, the chairman of the Hamilton Branch, W. Hollingworth, M.E.I.C., presided. His Worship the Mayor of Hamilton, William Morrison, K.C., in welcoming the members and guests to the city, took occasion to make some timely observations on the functions of the engineer in connection with the construction industry and municipal work, particularly in an industrial centre like Hamilton. The Mayor was followed by Mr. J. E. Hammell, President of Pickle Crow Gold Mines, Limited, whose reminiscences of his adventures in mining exploration and prospecting in the north country, and his experiences with financial magnates, were greatly appreciated by the large audience present.

The newly inducted President of The Institute, E. A. Cleveland, M.E.I.C., of Vancouver, presided at the Annual Dinner of The Institute in the evening, and presented the prizes and medals of The Institute. The principal speaker was Sir Edward Beatty, whose address is published in this issue of The Journal, pages 146 to 150. Sir Edward was followed by Professor T. R. Loudon, M.E.I.C., of the University of Toronto, who gave a thoughtful address on industrial and social conditions in Germany as he had seen them in the summer of 1935. The close attention with which the audience listened to both speakers evidenced their appreciation.

The dinner was to have been followed by a dance, but as a mark of respect to His Late Majesty King George V the latter function was cancelled.

The smoking concert which closed the meeting on the evening of Friday, February 7th, was greatly appreciated, its principal features being a display of sleight of hand by an excellent conjurer, who also gave comment on the interesting travel films which were shown through the courtesy of the Pan-American Airways and the kindness of Mr. J. A. Wilson, A.M.E.I.C., Controller of Civil Aviation, Ottawa, and the films of wild life kindly released for the meeting by Mr. J. B. Harkin, Commissioner of Parks, Department of the Interior, Ottawa.

Technical Sessions

At the professional sessions held on Thursday afternoon, February 6th, a series of papers on transportation topics were presented in the Connaught Room under the chairmanship of Major H. A. Lumsden, M.E.I.C., as follows:—

"Advance Through Adversity," by L. K. Sillcox, M.E.I.C.

"Highways and Highway Transportation," by A. H. Foster.

"Motor Truck Transportation," by W. H. Male.

"An Outline of Commerce on the Great Lakes and St. Lawrence," by C. G. Moon, A.M.E.I.C.

"The World's Airway System," by J. A. Wilson, A.M.E.I.C.

This symposium of papers dealing with various aspects of our national transportation problem received well-merited attention.

The paper by Mr. Sillcox, vice-president of the New York Air Brake Company, contained a review of recent developments in the design of railroad equipment and expressed the view that traffic was to a large extent dependent on railroad facilities and that transportation in the future must be co-ordinated.

Mr. Foster, who is president of the Ontario Association of Motor Coach Operators, and Mr. Male, who is a Director of the Automotive Transport Association of Ontario, dealt with passenger and truck highway transportation and suggested that the effect of the motor vehicle on railway traffic in Canada had been negligible. They advised against further regulatory measures at present as being unnecessary.

Mr. Moon's paper presented a statistical review of traffic on the St. Lawrence river and the Great Lakes, and Mr. Wilson, who is Controller of Civil Aviation, Department of National Defence, Ottawa, gave a review of the present air services of the world with particular reference to developments in Canada.

The address of Sir Edward Beatty, President of the Canadian Pacific Railway Company, at the annual dinner of The Institute proved exceptionally interesting when taken in conjunction with the above papers. Sir Edward was not in agreement with some of the arguments put forward by their authors.

In reference to this discussion on transportation it may be noted that the Council of The Institute has been urged by a resolution of the Annual General Meeting to set up a fact-finding committee to consider the general subject of transportation in Canada, with sub-committees to deal with the several branches of transport. This undertaking is understood to have the approval of the Hon. C. D. Howe, M.E.I.C., Minister of Railways, Canals and Marine, who has stated that he would welcome the setting up of such a committee. The matter is receiving Council's attention.

In Room 1110, under the chairmanship of Jas. J. MacKay, M.E.I.C., the following papers were presented:—

"Ceramics," an address by F. W. Paulin, M.E.I.C.

"The Blast Furnace Process," by N. B. Clarke.

These papers, dealing with the technical features of important Hamilton industries, were greatly appreciated.

On the morning of Friday, February 7th, the following papers were presented:—

In Room 1110 under the chairmanship of R. K. Palmer, M.E.I.C.:

"The Superstructure of the Reconstructed Second Narrows Bridge, Vancouver," by P. L. Pratley, M.E.I.C.

This paper, following that presented in 1934 by the same author, on the substructure of the same bridge, completes the account of its design and construction.

In Dining Room A under the chairmanship of L. P. Rundle, M.E.I.C.:

"The 45,000-kv.a. Frequency Changers at Chats Falls," by H. U. Hart, M.E.I.C.

"The Manufacture of High Voltage Porcelain Insulators," by J. M. Somerville.

These papers, like those of Messrs. Paulin and Clarke, treated of characteristic engineering or technical work carried out by Hamilton establishments.

On the afternoon of Friday, opportunities for visiting engineering works in Hamilton and the vicinity were taken advantage of by large parties, the following being included in the programme:—

The Steel Company of Canada Limited—
The blast furnaces, open-hearth steel furnaces, coke ovens and by-products plant were visited.

The Canadian Westinghouse Company Limited—
Visitors saw the manufacture and assembly of electric refrigerators, metal clad switchgear, large transformers, motors up to 100 h.p. and the new A.B. type air brake.

Dominion Foundries and Steel Limited—
This company has recently put in operation a complete plant for hot and cold rolled strip and tin-plate (the only tin-plate made in Canada) and operates the only mill in Canada rolling steel plates up to 78 inches wide.

The Canadian Porcelain Company Limited—
At these works were seen the processes of manufacturing and testing high voltage porcelain insulators for a wide range of services under exacting conditions.

The Water Filtration Plant of the City of Hamilton—
This modern installation was designed by the City Engineer's Department, and illustrates recent advances in water filtration and purification.

They were welcomed at all these plants by officials of the company or department, who acted as guides and willingly furnished information on points of interest.

Arrangements for the meeting were in the charge of the following local committee:—

W. Hollingworth, M.E.I.C.,
Chairman, Annual Meeting Committee.

E. G. MacKay, A.M.E.I.C.,
Vice-Chairman, Annual Meeting Committee.

A. Love, M.E.I.C.,
Secretary, Annual Meeting Committee.

W. Hollingworth, M.E.I.C.,
Chairman, Finance Committee.

W. J. W. Reid, A.M.E.I.C.,
Chairman, Paper and Technical Events Committee.

V. S. Thompson, A.M.E.I.C.,
Chairman, Committee on Visits to Plants.

G. Moes, A.M.E.I.C.,
Chairman, Hotel Arrangements and Entertainment Committee.

A. R. Hannaford, A.M.E.I.C.,
Chairman, Committee on Information, Registration, Printing and Signs.

T. S. Glover, A.M.E.I.C.,
Chairman, Publicity Committee.

E. P. Muntz, M.E.I.C.,
Chairman, Reception Committee.

R. K. Palmer, M.E.I.C.,
Chairman, Ladies' Committee.

The Ladies Committee, of which Mrs. R. K. Palmer was convenor, did a great deal to ensure the success of the meeting. The hospitality of the Tamahaac Club, and the kindness of the individual members of the committee, made the visiting ladies feel at home, and added greatly to their enjoyment.

The large registration and attendance at all the sessions bore testimony to the effectiveness of the committee's efforts. A particularly interesting and important feature of the meeting was the prolonged and thorough discussion on the consolidation problem, to which the whole of the first day was devoted.

The Sir John Kennedy Medal Awarded to Andrew Harkness Harkness, M.E.I.C.

Andrew Harkness Harkness, M.E.I.C., is the recipient of the Sir John Kennedy Medal of The Engineering Institute of Canada for the year 1935.

This gold medal was established in commemoration of the great services rendered to the development of Canada, to engineering science and to the profession by the late Sir John Kennedy, past-president of The Institute. It is the highest honour which The Institute can bestow and is given only when the occasion warrants, as a recognition of outstanding merit in the profession or of noteworthy contribution to the science of engineering or to the benefit of The Institute. Previous recipients of this award have been the late Colonel R. W. Leonard, M.E.I.C., G. H. Duggan, M.E.I.C., A. J. Grant, M.E.I.C., and R. A. Ross, M.E.I.C.

Mr. Harkness was born at Iroquois, Ontario, on January 31st, 1873, and graduated from the School of Practical Science at Toronto in 1895, returning to the University of Toronto for the degree of B.A.Sc. in 1897.

After graduation Mr. Harkness spent some three years in an architect's office and then joined the designing staff of the Canada Foundry Company in their steel and bridge division. He remained with this company eight years, holding in the latter years the position of assistant chief engineer.

In 1910 he commenced consulting practice in the city of Toronto, and his work since that date has made an outstanding contribution to Canada's growth. The structural features of important buildings from Vancouver to Halifax pay tribute to his ability in that branch of engineering. He was responsible for the structural engineering work of the Confederation Life building, Winnipeg, the Canadian Pacific Railway building, Toronto, the New Parliament buildings, Toronto, the Canadian Bank of Commerce building, Toronto, the Canadian Bank of Commerce building, Montreal, the Sun Life building, Montreal, the General Hospital buildings, Halifax, and the Civic Hospital, Ottawa. His work on the Sun Life building and the Canadian Bank of Commerce buildings alone would constitute an achievement of rare merit. It has fallen to the lot of few engineers in the British Empire to be responsible for so much difficult structural design.

ANDREW HARKNESS HARKNESS, M.E.I.C.

Mr. Harkness' professional reputation is nation-wide. There is probably no engineer in the Dominion whose opinion on structural design is more highly regarded by other members of the profession.

In spite of busy and responsible years of technical achievement, Mr. Harkness has made time for activity in affairs affecting the welfare of engineers. He joined The Engineering Institute of Canada in 1912 as an Associate Member. In 1917 he was made a member, and for many years was a member of the Toronto Branch Executive, serving as chairman in 1919. In 1920 he was a member of Council and in 1932 was elected a vice-president of The Institute. In all these offices and as a member, he has given his time and counsel generously, and loyally assisted his fellow members.

When the Association of Professional Engineers of Ontario was formed, he was one of its charter members. In 1930 he was elected vice-president and in 1931, president. In that year he travelled widely in an endeavour to improve legislation for engineers. In 1930 the Lieutenant-Governor of Ontario appointed him to represent the government of Ontario on the Council of the Association. Mr. Harkness is a Member of the American Society of Civil Engineers.

It is difficult to enumerate the many services which Mr. Harkness has rendered to the public throughout his career. That he is serving at this time, without remuneration, as a standing member of the Building Code Committee of the city of Toronto, as chairman of a Committee on Engineering Education, and as a trustee of the Toronto Branch Loan Fund, will give some idea of the many charitable and constructive activities which he kindly supports or directs.

His sterling character and friendliness have won for him general esteem and respect. All his professional work has been carried out with the single-minded devotion to the client's interests which characterizes the ideal consulting engineer. In fact, throughout his career he has followed and illustrated those high traditions of conduct and professional eminence which the Council of The Institute had in mind when founding the Sir John Kennedy Medal.

Award of Medals and Prizes

PAST-PRESIDENTS' PRIZE

J. B. DeHart, M.E.I.C., is the recipient of the Past-Presidents' Prize for the year 1935. This has been awarded to him for his paper on "The Co-ordination of the Activities of the Various Engineering Organizations in Canada."

Mr. DeHart is a graduate of McGill University, having received a B.Sc. in civil engineering in 1910, B.Sc. in mining engineering in 1911 and M.Sc. in mining engineering in 1912. In 1914-1915 he was manager for the Twin City Coal Company, and from 1915 until 1918 held the same position with the North American Collieries Ltd. at Coalhurst. In the following year Mr. DeHart was general superintendent of the same company, and from 1919 until 1922 he was manager of the Monarch Colliery. In 1922-1923 he was engineer and manager for the Cadomin Coal Company, and in 1923 Mr. DeHart was appointed district inspector of mines for the government of the Province of Alberta, being located at Lethbridge, Alta., which position he still holds.

J. B. DeHart, M.E.I.C.
Past-Presidents' Prize

P. L. Pratley, M.E.I.C.
Gzowski Medallist

R. W. Diamond
Leonard Medallist

Z. Levinton, S.E.I.C.
H. N. Ruttan Prizeman

S. T. Fisher, Jr.E.I.C.
Phelps Johnson Prizeman

Yvon-Roma Tassé, S.E.I.C.
Ernest Marceau Prizeman

GZOWSKI MEDAL

P. L. Pratley, M.E.I.C., has been awarded the Gzowski Medal for the year 1934-1935 for his paper entitled "The Sub-Structure of the Reconstructed Second Narrows Bridge, Vancouver" which was presented at the Western Professional Meeting of The Institute held in Vancouver in July, 1934, and appeared in the August, 1934, issue of The Journal.

Mr. Pratley was born at Liverpool, England, and received his education in that country, receiving the degree of B.Eng. with first class honours from the University of Liverpool in 1905, and the Master's degree in 1908.

Coming to Canada in 1906 he worked with the Locomotive and Machine Company, Montreal, as designer and draughtsman, and from 1906 until 1909 he held the same position with the Dominion Bridge Company, Montreal. In 1909-1910 Mr. Pratley was with the Quebec Bridge Board as mathematician, designer and checker, and from April to September of the latter year he was engaged with the St. Lawrence Bridge Company as designing engineer in charge of designs for the Quebec bridge, later returning to the Quebec Bridge Board during the official investigation of submitted designs. From 1910 until 1920 Mr. Pratley was designing engineer with the Dominion Bridge Company in charge of the estimating and designing office. In 1920 he served on the G.T.R. Arbitration Board, with the Department of Railways and Canals. In 1921 he became a member of the firm of Monsarrat and Pratley, consulting engineers, Montreal.

Mr. Pratley has long taken an active interest in Institute affairs. He has served on Council for many years, and is now a vice-president of The Institute.

LEONARD MEDAL

The Leonard Medal (for which members of The Institute or of the Canadian Institute of Mining and

Metallurgy are eligible) has this year been awarded to Mr. R. W. Diamond, General Superintendent of the Concentration Department, Chemical and Fertilizer Department, Consolidated Mining and Smelting Co. of Canada Ltd., Trail, B.C., for his paper entitled "The Trail Heavy-Chemical Plants" which was presented before the Annual General Meeting of the Canadian Institute of Mining and Metallurgy in April, 1934, and published in the September, 1934, issue of the Bulletin of that society.

Mr. Diamond was born in Campbellford, Ontario, in 1891, and graduated from the University of Toronto in 1913 with the degree of B.A.Sc. in mining and metallurgical engineering. From 1913 until 1917 he was in the testing, research and concentration departments of the Anaconda Copper Mining Company, at Anaconda, Montana, and from January until June 1917 he was mill superintendent of the Ohio Copper Company of Utah, Lark, Utah. In June 1917 Mr. Diamond entered the employ of the Consolidated Mining and Smelting Company of Canada, and during the years immediately following was in charge of the research work on the concentration of Rossland and Sullivan mine ores, being largely responsible for the development of successful processes for the concentration of both. Mr. Diamond was superintendent of concentration until the spring of 1929 when he received his present appointment. During the winter of 1929-1930 he toured Europe studying nitrogen fixation and chemical fertilizer methods, following which he co-operated in the design and construction and was responsible for the operation on completion, of the group of plants built by the Consolidated Mining and Smelting Company for the production of chemicals and chemical fertilizers at Trail, B.C.

Mr. Diamond was the recipient of the 1933 McCharles award and gold medal presented by the University of Toronto, in recognition of his valuable work at Trail, especially in connection with differential flotation of Sullivan ore and in the chemical and fertilizer undertaking of the Consolidated Mining and Smelting Company.

Students' and Juniors' Prizes

Four of these prizes were awarded this year as follows:

The H. N. Ruttan Prize (Western Provinces) to Z. Levinton, S.E.I.C., of Ridgedale, Sask., for his paper on the "Determination of Temperature Stresses in an Arch Bridge Model by Means of the Photoelastic Method." (Published in The Journal for December, 1934.)

F. L. Black, Jr.E.I.C.
Martin Murphy Prizeman

The Phelps Johnson Prize (Province of Quebec, English) to S. T. Fisher, Jr.E.I.C., engineer with the Northern Electric Company Limited, Montreal, for his paper entitled "Recent Developments in Sound Pictures." (Published in The Journal for June, 1935.)

The Ernest Marceau Prize (Province of Quebec, French) to Yvon-Roma Tassé, S.E.I.C., a student with the Canadian General Electric Company Ltd., at Peterborough, Ontario, for his paper on "Le Vent pour Electrifier nos Campagnes."

The Martin Murphy Prize (Maritime Provinces) to F. L. Black, Jr.E.I.C., junior engineer with the New Brunswick Electric Power Commission, Moncton, N.B., for his paper "The Low Voltage Cathode-Ray Oscillograph and Several Applications in Radio Research."

Elections and Transfers

At the meeting of Council held on January 24th, 1936, the following elections and transfers were effected:—

Members

KELLY, William Nielson, (Liverpool Univ.), consltg. engr. and marine surveyor, 837 West Hasting St., Vancouver, B.C.

RAE, William, chief inspr., Dept. of Railways, B.C. Govt., Court House, Vancouver, B.C.

SCALES, William, (Thomason Civil Engrg. Coll., Rurkee, India), city engr., Courtenay, B.C.

Associate Members

BARCLAY, James Bow, consltg. struct'l. engr., 3937 West 37th Ave., Vancouver, B.C.

PIERCE, Arthur Leonard, B.Sc. (Univ. of Man.), office engr., Dept. Northern Development, Nipigon, Ont.

SCOTT, Lewis John, B.Sc. (McGill Univ.), asst. purchasing agent, Anglo-Newfoundland Development Co., Grand Falls, Nfld.

OAKES, Cecil Hewitt, (Liverpool Univ.), engr. surveyor, Boiler Inspection and Insurance Co. of Canada, Vancouver, B.C.

Juniors

CASSIDY, Stanley Bernard, B.Sc. (Univ. of N.B.), 48 Fleet St., Moncton, N.B.

JOHNSTON, Orval Ellsworth, B.A.Sc. (Univ. of Toronto), engrg. asst., H.E.P.C. of Ontario, Niagara Falls, Ont.

MALBY, Arthur Leslie, B.Sc. (Univ. of Man), student engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont.

PATERSON, Walter Howard, B.Sc. (Queen's Univ.), asst. to city engr., Owen Sound, Ont.

Affiliate

BEANEY, Sydney William, (Central Tech. School, Toronto), sales engr., Joseph Taylor & Son, Toronto, Ont.

Transferred from the class of Associate Member to that of Member

BALL, Alfred N., B.Sc. (Queen's Univ.), chief engr., The E. B. Eddy Co. Ltd., Hull, Que.

BELL-IRVING, Robert, B.Sc. (McGill Univ.), asst. gen. mgr., Powell River Co. Ltd., Vancouver, B.C.

HOLDCROFT, John Barber, hydraulic engr. and asst. mgr., Pacific Coast Pipe Co. Ltd., Vancouver, B.C.

JARMAN, Percy Edward, gen. mgr., City of Westmount, Westmount, Que.

MACKENZIE, John Percival, Lt.-Col., D.S.O. (2 Bars), C. de G., (Univ. of Glasgow), gen. mgr., Western Bridge Co. Ltd., Vancouver, B.C.

McKENZIE, James Edgar, B.Sc. (Queen's Univ.), 239–12th Ave. West, Calgary, Alta.

PENFOLD, Douglas Kent, (Bengal Engrg. Coll., Calcutta), district engr., Water Rights Br., B.C. Govt., Kelowna, B.C.

SANDWELL, Percy, consltg. mech'l. engr., 1049 Nanton Ave., Vancouver, B.C.

TAUNTON, Arthur John Showell, B.Sc. (Univ. of Man.), temp. senior asst. engr., Dept. Public Works, Canada, Winnipeg, Man.

TRIPP, George Mason, gen. supt., B.C. Electric Railway Co., Vancouver Is. Divn., Victoria, B.S.

Transferred from the class of Junior to that of Associate Member

BRAIN, Cecil, B.Sc. (McGill Univ.), asst. to plant engr., International Pulp and Paper Co., Corner Brook, Nfld.

BURGESS, Bert I., B.Sc. (Univ. of N.B.), switchboard engrg. dept., Can. Gen. Elec. Co. Ltd., Peterborough, Ont.

FANJOY, William Thomas, B.Sc. (Univ. of Alta.), industrial control engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont.

HAYES, St. Clair Joseph, B.Sc. (N.S. Tech. Coll.), lecturer in engrg., Memorial University College, St. John's, Nfld.

SILLS, Hubert Ryerson, B.Sc. (Queen's Univ.), asst. engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont.

VAN KOUGHNET, Edward Matthew, (Grad., R.M.C.), 157 Notre Dame St., St. Lambert, Que.

Transferred from the class of Student to that of Junior

DONNELLY, William David, B.Sc. (Queen's Univ.), Ford Motor Co. of Canada, Windsor, Ont.

McINTYRE, Douglas Vallance, B.Sc. (Univ. of Alta.), McWatters Gold Mines Ltd., Rouyn, Que.

Students admitted

ALLAIRE, Lucien, B.A.Sc., C.E. (Ecole Polytechnique, Montreal), 2182 Sherbrooke St. East, Montreal, Que.

DESORMEAUX, Dollard, (Ecole Polytechnique, Montreal), 1826 Champlain St., Montreal, Que.

DRYNAN, David Alan, B.Sc. (Univ. of Man.), 333 Reid St., Peterborough, Ont.

HUNTER, Lawrence McLean, (Queen's Univ.), 7 Willard Ave., Ottawa, Ont.

PINDER, Harold, (McGill Univ.), 3506 University St., Montreal, Que.

PLATT, Peter Leverich Waddington, (McGill Univ.), 2944 Viewmount Ave., Montreal, Que.

ROSS, Joseph Hope, Royal Military College, Kingston, Ont.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Punjab Engineering Congress: Proceedings 1935, Volume 23.

American Institute of Electrical Engineers: Transactions 1935, Volume 54.

Reports, etc.

North East Coast Institution of Engineers and Shipbuilders: List of Members, 1936.

Canada, Bureau of Statistics: Statistics of Steam Railways of Canada for the year ended December 31st, 1934

American Society for Testing Materials: Index to Standards and Tentative Standards, January 1st, 1936.

International Tin Research and Development Council: Technical Publications. Series A.
- No. 26—The Mechanical Properties of Tin-Base Alloys.
- No. 27—The Electrodeposition of Bronze Using Bronze Anodes.
- No. 28—The Electrodeposition of Bronze Using Bi-Metallic Anodes.

Board of Water Supply of the City of New York: Annual Report 1934.

Canadian Radio Broadcasting Commission: Annual Report 1935.

International Nickel Company of Canada Limited: The Nickel Industry in 1935.

Technical Books, etc., Received

Canadian Almanac 1936.

Alternating Current Machines, by A. F. Puchstein and T. C. Lloyd (*John Wiley and Sons, New York*) (*Renouf Publishing Co., Montreal.*)

Refrigeration, by J. A. Moyer and R. U. Fittz (*McGraw-Hill Book Company, New York.*)

The Financial Post Business Year Book, 1936.

Who's Who, 1936.

Mathematics of Modern Engineering, by R. E. Doherty and E. G. Keller (*John Wiley and Sons, New York.*).

BULLETINS

Disconnecting Switches.—Canadian Westinghouse Company Ltd., Hamilton, have issued two four-page leaflets, No. H5042A describing the company's Type K disconnecting switches for indoor and outdoor service, for capacities 400 up to 1,200 amperes and voltages from 23,000 to 115,000 and No. H6114, describing the type HH disconnecting switches, 3 pole gang operated light duty indoor service rear and front connected, 400 to 1,200 amperes, 5,000 to 23,000 volts.

Stokers.—The Iron Fireman Manufacturing Company, Cleveland, Ohio, have issued their catalogue No. I138, containing 20 pages and giving particulars of a number of their installations suitable for commercial heating plants.

Trucks.—A 16-page bulletin received from the Four Wheel Drive Auto Company, Kitchener, Ont., describes and illustrates their trucks, giving a number of illustrations of use in varying circumstances.

Diesel-Electric Generators.—An 8-page pamphlet received from the Caterpillar Tractor Company, Peoria, Ill., describes the company's 60-, 40- and 25-kw. Diesel-electric direct-connected generator sets

Sheet Piling.—The Canadian Sheet Piling Company Ltd., Montreal, have issued a 6-page folder describing the strengthening of a railway bridge by use of steel sheet piling.

Inert Gas Producer.—Roots-Connersville Blower Corporation, Connersville, Indiana, have issued a 4-page leaflet containing particulars of their Harrison inert gas producers. These are built in a number of sizes ranging from 7,500 to 40,000 cubit feet of inerts per hour measured at 60 degrees F. against pressure of 2 pounds.

Nickel Cast Iron.—An 8-page bulletin received from the International Nickel Company Inc., New York, describes the thermal expansion characteristics of some nickel cast iron, and presents the results of recent research.

Excavators.—R. G. LeTourneau Inc., Peoria, Ill., have issued a 12-page booklet illustrating and describing their scrapers bulldozers, buggies, cranes, etc

The above photograph has just been received from China, and shows Tibetans mounted and armed ready for the road, and A. T. Cairncross, S.E.I.C., who was at the time engaged in a highway survey at Tatseinlu, Shikang. Mr. Cairncross, who is a graduate of Queen's University of the year 1931, is the Technical Expert, Department of Engineering, on the Generalissimo's Staff of the National Government of China, with headquarters at Chengtu, Szechuen.

New Electrical Units

The International Committee on Weights and Measures has definitely set January 1st, 1940, as the date on which new values of the electrical units shall be substituted for the present international units. The purpose of the change is to bring electrical measurements into concordance with the fundamental mechanical units. The adjustment necessary is not large enough to have an appreciable effect in ordinary engineering measurements and calculations, but it will require changes in the correction factors for standards and instruments of precision.

In principle the change is a radical one, since it reverses the decisions of the International Electrical Congress of 1893 and the 1908 International Conference on Electrical Units and Standards regarding the basis for the units. These bodies decided to define the "international ampere" and the "international ohm" respectively, by means of arbitrary standards, the silver voltameter and the mercury ohm tube. The units thus defined were to be retained even if they were later found not to be consistent with mechanical units as they were intended to be. The International Committee, on the other hand, has reverted to the principle of "absolute measurements" as a basis for the units, in accordance with earlier recommendations of the British Association's committee on electrical standards

For several years determinations of the electrical units by absolute measurements have been in progress in national laboratories of various countries. The results already reported show that the international ohm is larger than the absolute ohm by about 5 parts in 10,000, while the international ampere is smaller than the absolute by one in 10,000. Consequently the international volt and watt are too large by 4 and by 3 in 10,000. By 1939 the International Committee hopes to fix the ratios between units of the two systems within a few parts in 100,000. Definite values for standards on the new basis will then be certified to the governments of the thirty-two countries which belong to the international organization dealing with weights and measures.

June Journals Required

Copies of the June, 1935, issue of The Engineering Journal are required for binding, and it would be appreciated if members having no further use for this issue would forward copies available to Headquarters at 2050 Mansfield Street, Montreal An allowance of 25 cents to cover the cost of postage, etc., will be made on each copy received.

Committee on Consolidation

Further Report following the Annual General Meeting of 1936

The Report of the Committee on Consolidation was considered by Council at a meeting specially called for the purpose, on January 15th. The complexities of the problem and the achievement of unanimity of opinion in the Committee made it impossible to place this report before Council at an earlier date.

Council directed that copies of the report be issued to the members of The Institute in pamphlet form. It has also been published in two sections in the January and February issues of the "Journal," and issued to those Provincial Professional Associations which have expressed a desire to be provided with copies.

While Council took no action in approval of the report, it considered it advisable to re-arrange the programme of the Annual Meeting in order to provide a proper opportunity for its reception and discussion, and directed that the Annual Meeting be held one day earlier than originally intended, the first day to be devoted entirely to this important matter.

The Annual Meeting was therefore convened in Hamilton on the morning of Wednesday, February 5th, at 10.30, Dr. Gaby presiding. It was a most momentous gathering of The Institute in that there were present representatives from every province of the Dominion, and the subject under discussion was one which might very materially affect both the future of The Institute and the professional well-being of some six thousand engineers throughout Canada.

After the opening remarks of the President, the meeting decided by resolution that the Chairman of the Committee on Consolidation should read such portions of the report as he might consider necessary to form a proper background for discussion, after which the members present would have an opportunity for the fullest possible expression of their views.

The Chairman therefore gave a brief historical review and read those sections of the report covering the work of the Committee, present conditions within the profession, and the conclusions and recommendations of the Committee.

The Secretary, Mr. Durley, read a resolution from the Quebec Branch, a report from the Kingston Branch, letters from the Lakehead Branch, Mr. F. S. B. Heward, Mr. O. Holden, the Vice-Chairman of the Toronto Branch, and wires from the Calgary Branch, the Winnipeg Branch, the Edmonton Branch, the Moncton Branch and the Victoria Branch. One of the Ottawa representatives advised that a communication had been sent forward by the Ottawa Branch but the Secretary reported he had not received it. Mr. G. H. Wood reported the views of the Niagara Peninsula Branch.

During the morning session the discussion was participated in by C. C. Kirby, member of the Dominion Council, Saint John, N.B.; F. P. Shearwood, Past-President, Montreal; D. R. Thomas, Toronto; Dr. R. W. Boyle, Ottawa; Major L. F. Grant, Kingston; Mr. R. F. Legget, Montreal.

The discussion included:—

(*a*) Consideration of the constitution, function and present activity of the Dominion Council of Professional Engineers;
(*b*) The question of making licensing effective and the possible restriction of licences;
(*c*) The classes of membership in the proposed National body;
(*d*) The figures of the returns on the "Questionnaire":
(*e*) Suggestion that "consolidation" or "confederation" be promoted on the basis of the privilege of inter-provincial practice by members of the national body, etc.

The morning session adjourned for lunch at one o'clock.

The afternoon session convened at 2.20 p.m., the speakers included: C. C. Kirby; E. A. Wheatley, Registrar of the Professional Association of British Columbia; Colonel Letson, President of the Professional Association of British Columbia; Brian R. Perry, Montreal; T. C. Main, Winnipeg; P. M. Sauder, Lethbridge; Professor F. R. Faulkner, Halifax; Professor R. W. Angus, President of the Professional Engineers of Ontario; F. W. Paulin, Hamilton; E. P. Muntz, Hamilton; D. A. R. McCannel, member of Dominion Council, Regina; Major H. A. Lumsden, Hamilton; H. W. D. Armstrong, Charter Member of The Institute; H. S. Johnston, Halifax; J. L. Busfield, Montreal; Dr. L. F. Goodwin, Kingston; G. H. Wood, Niagara Peninsula Branch; Colonel R. E. Smythe, Toronto; J. M. H. Cimon, Quebec; C. E. Sisson, Toronto; D. S. Laidlaw, Toronto; G. M. Pitts, Ottawa; R. F. Legget, Montreal; G. M. Pitts, Montreal.

The discussion covered:—

(*a*) The returns on the "Questionnaire" issued by the Professional Association of New Brunswick;
(*b*) A series of suggested amendments to the Report;
(*c*) The philosophy of the profession in British Columbia;
(*d*) Criticism of the figures of the returns on the "Questionnaire";
(*e*) Delineation of the difficulties confronting Consolidation;
(*f*) Analysis of conditions in the various provinces; suggestion that co-ordination should go forward through the Dominion Council, The Engineering Institute and the Canadian Institute of Mining and Metallurgy appointing representatives on the Dominion Council;
(*g*) Demand by certain provinces that they be permitted to carry out Consolidation between the Professional Association and Branches within their own provinces.
(*h*) Exposition of the plan proposed by Mr. deHart, which was awarded The Institute Past-Presidents' Prize and which proposes that co-ordination should be carried out by the Dominion Council of the Engineering Profession, that this Dominion Council be made the representative of all the engineering organizations in Canada, and to attain this end representation on this Council should be extended to include The Engineering Institute, the Canadian Institute of Mining and Metallurgy, and later the Canadian Section of the American Society of Mechanical Engineers and the Canadian Branch of the Institute of Electrical Engineering;
(*i*) Report of the Committee of Eight of the Province of Nova Scotia, which recommends one single engineering organization for that province and encourages the formation of similar organizations in other provinces;
(*j*) Suggestion that Manitoba be allowed to proceed with their scheme at once;
(*k*) Request from Saskatchewan for provincial consolidation;
(*l*) Autonomy must be in the various provinces; the entities of the Provincial Professional Associations must be maintained;
(*m*) Position of the young engineer in the profession and the significance of the decisions now being made in respect to him;
(*n*) Discussion of methods of procedure, (1) a scheme by which Consolidation is effected through the Dominion Council by the simultaneous agreement of all the Provincial Professional Associations; (2) the procedure suggested by the Report, and requested by Saskatchewan, Manitoba and Nova Scotia, whereby each province is permitted and assisted to carry out Consolidation within the province at a time best suited to its needs;
(*o*) Criticism that the report of the Committee on Consolidation went too far, and criticism that it did not go far enough; explanation that the word "consolidation" as used in connection with this movement is generic.
(*p*) It was pointed out that as it has become the practically universal procedure for men to be admitted to the profession by virtue of degrees from accredited universities, the question and difficulties related to uniform standards of admission are obviated.
(*q*) The desirability of putting into effect the broad principles of Consolidation at once, and the working out of the more intricate details together later;
(*r*) Stressing the policy that any decision must have as its basis the welfare of the whole engineering profession in Canada, without differentiation as to organization, Association or Institute.
(*s*) It was pointed out that The Institute was not a mere technical organization, but that its objects were essentially professional. Etc.

The afternoon session adjourned at 5.35 p.m.

The evening session convened at 8.30 p.m.

The following took part: C. C. Kirby; G. Stead, President of the Professional Association of New Brunswick; P. B. Motley, Montreal, Dr. O. O. Lefebvre, Past-President, Montreal; J. B. Challies, Montreal; President F. A. Gaby, Montreal; T. C. Main; Professor R. E. Jamieson, Montreal; Major L. F. Grant; Dr. J. M. R. Fairbairn, Past-President, Montreal; P. L. Pratley, Montreal; R. F. Legget, Montreal; H. S. Johnston; Dr. F. L. Goodwin; G. McL. Pitts; W. L. McFaul, Hamilton, Major H. B. Stewart, Hamilton; J. L. Busfield; E. A. Wheatley; Mr. Bishop; O. Holden, Toronto; F. W. Paulin; J. R. Dunbar; P. M. Sauder; Dr. R. W. Boyle; Colonel Letson; Professor Faulkner; Archie B. Crealock; W. J. Smither.

The evening discussion included:—

(*a*) A consideration of the standing in the National body of the non-Institute members of the Professional Associations; unity through common membership;
(*b*) Attitude of the Corporation of the Province of Quebec on Consolidation;
(*c*) Authority to representatives of The Institute to negotiate with Professional Associations;
(*d*) The necessity for this Annual Meeting to make definite progress;
(*e*) Suggestion that the Committee on Consolidation be made a Committee of Council.

The general discussion of the Report and its recommendations was brought to a close in a resolution moved by Mr. T. C. Main and seconded by Mr. H. S. Johnston:—

> That the Report of the Committee on Consolidation be adopted, in principle as a progress report; also that the Committee on Consolidation be continued and that Council be hereby given authority to take the necessary steps to make it possible for any provincial organization to work out individual consolidation or co-ordination or confederation within such province.

Mr. J. M. R. Fairbairn read another resolution which he suggested Mr. Main might accept in place of the one originally moved:—

> Resolved that this Annual Meeting accept the Report of the Committee on Consolidation with appreciation and gratitude and hereby resolves that Council be instructed to re-appoint the Committee and add to its numbers, in order to create a nucleus for a National Committee; and that Council be also instructed to invite forthwith the Dominion Council and the Provincial Associations to appoint representatives to this National Committee, with the object of achieving the co-ordination of The Institute and the Provincial Associations.

After considerable discussion, and in view of the fact that Mr. Main was not in a position to accept Mr Fairbairn's suggestion, this proposed alternative resolution was revised, made an amendment to the original motion, and moved by Mr. Fairbairn and seconded by Mr. Pratley.

After some further discussion on the details of the motion and the amendment, particularly in regard to the appointment of members to the Committee by Council, and representation of the Dominion Council on the Committee, both the motion and its amendment were withdrawn and a committee of Messrs. Main, Busfield, Wheatley and Pitts were delegated by the meeting to prepare a new resolution, and it was moved by Mr. T. C. Main and seconded by Mr. H. Johnston:—

> That the Report of the Committee on Consolidation be adopted, in principle as a progress report; also that the Committee on Consolidation be continued with instructions to add to their number two members of the Dominion Council of the Associations, and be empowered to add further to their number, providing such additional members be approved by Council, and that Council and the Committee shall co-operate for the speedy consummation of Consolidation, co-ordination or confederation, throughout the Dominion.

This resolution was carried unanimously and the meeting adjourned at 11.20 p.m.

The members of the Dominion Council of Professional Engineers, together with other representatives of the Professional Associations, met in Hamilton on Tuesday, February 6th, 1936. On this occasion Mr. C. C. Kirby of Saint John, N.B., was elected President of that Council and Mr. Archie B. Crealock of Toronto, Vice-President. These gentlemen were also appointed by the Dominion Council as its representatives on the "Committee on Consolidation."

A meeting of the Committee on Consolidation held on February 6th, nominated Dr. F. A. Gaby as a member of the Committee, and this nomination was subsequently approved by the Council of The Institute.

On Friday, February 7th, an informal conference was held of the Dominion Council, the representatives of the Provincial Professional Associations, and the representatives of The Engineering Institute.

Those present at this meeting were:—

Members of the Dominion Council of Professional Engineers:

C. C. Kirby, *(President)*.	Saint John, N.B.
Archie B Crealock, *(Vice-President)*.	Toronto, Ont.
Colonel F. H. G. Letson,	Vancouver, B.C.
P. M. Sauder,	Lethbridge, Alta.
D. A. R. McCannel,	Regina, Sask.
Professor F. R. Faulkner,	Halifax, N.S.

Other Representatives of the Provincial Professional Associations:

E. A. Wheatley,	Vancouver, B.C.
T. C. Main,	Winnipeg, Man.
J. M. H. Cimon,	Quebec, P.Q.
A. B. Normandin,	Quebec, P.Q.
G. Stead,	Saint John, N.B.

Members of the Committee on Consolidation, representing The Engineering Institute of Canada.

Dr. O. O. Lefebvre,
J. B. Challies,
Dr. F. A. Gaby,
Professor R. E. Jamieson,
Gordon McL. Pitts, *(Chairman)*.

This was a most momentous day in the history of the engineering profession in Canada, as it provided the long-sought opportunity for a round table discussion of the many details and varying points of view involved in the uniting of the engineering organizations of the Dominion into one coherent, expressive, national body. Those present appreciated the significance of the occasion and the deliberations and discussions were carried on in the spirit of the fullest co-operation and compromise.

Mr. C. C. Kirby acted as Chairman of the meeting, and E. A. Wheatley as Secretary. The conference lasted throughout the day and the results of its discussions will be available shortly.

In the meantime, the Committee on Consolidation, enlarged to include representation of the Dominion Council of the Provincial Professional Associations, is proceeding with the work of advancing the objects of its mandate as set forth in the unanimous Resolution of the Annual Meeting of The Institute.

Gordon McL. Pitts,
Chairman.

February 21st, 1936.

BRANCH NEWS

Border Cities Branch

C. F. Davison, A.M.E.I.C., Secretary-Treasurer.
F. J. Ryder, S.E.I.C., Branch News Editor.

On January 17th, 1936, the regular monthly dinner meeting was held at the Prince Edward hotel, with twenty-eight persons present. The speakers for the evening were Mr. S. Crocker and Mr. D. H. Corey, both of the Detroit Edison Company. The subject presented was "The Welding of High Pressure Piping," Mr. Crocker presenting the technical and theoretical side of the paper and Mr. Corey explaining the subject from the practical or field point of view.

The welding of high pressure piping has been a gradual development from actual practice. First it was used on ordinary pipe lines or returns, then low pressure lines, and now it is being used on pipe lines carrying steam at 800 pounds pressure at about 700 degrees. The great advantage of welded pipe is the reduction in size of cumbersome and costly castings. In welding a T joint the development of the "welding saddle" added to the strength of the joint. However, this was gradually reduced to the "welding ring" which was smaller in size.

Mr. Corey stated that his firm did not use the electric arc type of welding equipment solely because they were producers of electric power, but that the choice was made after a good deal of research between the electric arc and oxy-acetylene types. These experiments showed that there was little choice between the two methods. The main point in high pressure welding is to employ exeprienced men. The procedure in choosing these men was as follows: the foreman of a gang points out those whom he thinks best. These men are then watched and studied as to their steadiness, temperament and ability. If satisfactory, they are allowed to take the tests which consists of welding horizontal and vertical specimens under the same conditions as would exist in the field. These specimens are subjected to tensile tests, ductility tests and soundness or penetration. (Six voids per square inch is maximum allowed. All tests must be perfect before the man is classed as A 1.)

A crew consists of a welder and a cleaner. The duty of the cleaner is to clean off each layer of weld with an air-chisel as a welder cannot be expected to do this and maintain his steadiness. All welds are laid on in thin layers.

A good deal of research has been carried on to find some practical method of testing welds. The X-ray was tried but found of no use. The areronograph is an electrical device that records the voltage being used at all times. This has been found helpful as it gives a record of the steadiness of the arc and any variations would show by an increase or decrease in voltage.

All welded joints are stress relieved by an electrical field device. This procedure does not aid the joint as far as the static load is concerned, but improves the joint for any dynamic loads that occur.

Mr. Corey showed a number of slides of metallographic structures of various types of weld. After an interesting discussion it was moved by C. G. R. Armstrong, A.M.E.I.C., and seconded by C. F. Davison, A.M.E.I.C., that Mr. Crocker and Mr. Corey be given a hearty vote of appreciation.

Lakehead Branch

G. R. McLennan, A.M.E.I.C., Secretary-Treasurer.

The regular monthly meeting was held on January 22nd, 1936, in the Royal Edward hotel, with R. J. Askin, A.M.E.I.C., in the chair.

Dinner commenced at 6.30 p.m., and was attended by fifteen members and nine guests. In respect to our late King a minute of silence was observed. A toast to His Majesty King Edward VIII was drunk. After dinner the chairman asked each member and guest to introduce himself. The guest speaker, R. F. Legget, A.M.E.I.C., was introduced, and gave an interesting address on the history and use of foundation materials, with particular reference to steel sheet piling. He traced the history of building materials and stated that up until about 1920 no steel piling had been used to any great extent. The advantages of steel over timber are due to the fact that the composition and uniformity of steel can be controlled within narrow limits, whereas timber, though uniform, cannot be pre-tested adequately. The use of reinforced concrete required skill in construction and careful supervision. The choice of proper materials, however, depends on local conditions.

The speaker showed that steel is often the best material for certain classes of construction when true economy is considered. True economy can be practised only when the following items are taken into consideration:—

(1) First cost.
(2) Sinking fund allowance based on the estimated life of the structure.
(3) The annual charge due to maintenance.

It has been found that steel has a definite life, in water it is estimated at eighty years. This long life is due mainly to the development of copper bearing steel. The speaker pointed out that steel does deteriorate to a small extent, but that the decrease in strength of a pile driven in moist ground is offset by the reduction in load on the piles, as it is well known that the piles are most heavily loaded at the time of construction, and as the earth around the piles gradually compacts the stresses in the piles are decreased.

Speaking of the history of steel sheet piling, the speaker stated that Larssen, a Norwegian, constructed walls of steel piling in 1897. In Europe, in 1903 or 1904, steel piling in the shape of a U with a dovetailed joint was used. In Canada, a man named Hunter used boxes made from channel shapes. Lackawanna steel piling with a ball and socket joint was used and found satisfactory, except that it it proved weak in bending.

In 1924, after the hurricane in Florida, steel piling was used to repair damage done to the docks. Since that date the use of steel piling in America increased, and many steel manufacturers now turn out various types of steel piling.

The speaker mentioned that improved design methods are being developed in Germany, and considerable importance is attached to the new subject of "Soil Mechanics" from which it is expected new theories will be developed to supplant the much used Rankine Theory in respect to earth pressure.

The use of steel for foundations is confined practically to sheet steel piling. Steel piles for bearing in the shape of H beam sections were found economical where the soil was of a nature that wood piles were difficult to drive. Another form of steel bearing pile was used in Africa. This was known as a screw pile and was used where a great depth of mud was encountered. The pile was screwed down by means of a twisting motion. The blades were found sufficient to give the pile stability.

A vote of thanks was moved by J. Antonisen, M.E.I.C., and seconded by H. G. O'Leary, A.M.E.I.C.

Mr. Legget was then asked to discuss the matter of consolidation of the engineering profession.

The speaker gave a very clear description of the report which has just been completed by the Committee on Consolidation.

London Branch

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

The annual dinner meeting and election of officers for 1936 was held on January 29th, at the club house of the Highland Golf Club.

The speaker of the evening was Captain T. F. Williams, instructor at the London Airport, and his subject "Instruments and Their Use in Aviation."

Owing to the severe weather and the snow-covered roads coupled with the fact that several of our members were out of town, the attendance was not very good. Only twenty-six were present as against forty to fifty in previous years.

The chair was occupied by S. W. Archibald, M.E.I.C., who called upon Councillor J. A. Vance, A.M.E.I.C., to introduce the speaker.

Instruments and Their Use in Aviation

Captain Williams opened his address by giving a short history of the various instruments used in aviation, pointing out that, although great improvements had been made in recent years, a great deal still remained to be done before the instruments could be termed perfect.

There are so many dials, etc., on the dashboard that at first glance they seem very complicated, but this is in part accounted for by the fact that many dials and indicators in connection with the engines are in duplicate for each motor. Regarding the instruments in connection with the aeroplane itself, while they were accurate themselves they were liable to register inaccurately at times due to different locations and different atmospheric conditions. When flying with poor visibility and particularly through fog banks these instruments are needed the most and it is on such occasions they are liable to give inaccurate findings.

Take, for instance, the altimeter which is actuated by barometric pressure, varying at different heights above sea level. An accurate adjustment for the height above ground can be made where the elevation of that ground is known. However, in long distance flying the aviator passes over ground of which he does not know the elevation in relation to his starting point, hence with poor visibility he must be extremely cautious, and even when knowing the elevation the difference on local barometric pressure often accounts for a false reading by many hundreds of feet.

The compass, also accurate in itself, is liable to be affected by the static of the aeroplane as well as other magnetic currents set up in its steel components. Thus the pilot is often entirely dependent on the radio beam signals for direction.

It is difficult for a pilot to determine the speed at which he is flying as the speedometer is based on the increased pressure of air due to increased velocity and as air density enters so largely into the calculation it can only be accurate at one given height. It also merely registers the speed at which he is flying through the air. However, the air is seldom still and the wind must be calculated at 100 per cent of its value plus, or minus, in determining the ground speed.

What is urgently required is an instrument that will record the distance the machine is from the surface of the earth.

Following an interesting discussion, during which many questions were answered by the speaker, a vote of thanks to Captain Williams was proposed by S. W. Archibald, M.E.I.C., seconded by J. Ferguson, A.M.E.I.C., and unanimously carried.

The business of the meeting was then proceeded with, the first items of which were the secretary's and auditor's reports which were read and adopted.

The election of officers then took place.

The members then adjourned to the lounge and Colonel Dillon enlivened the meeting throughout by rendering selections on the pianoforte.

Montreal Branch

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

Annual Meeting

The annual meeting of the Montreal Branch was held on January 9th, 1936. F. S. B. Heward, A.M.E.I.C., was in the chair. The business included the report of the retiring executive committee, the report of the nominating committee and the installation of officers. J. B. D'Aeth, M.E.I.C., is the new chairman. The total membership of the Branch was shown to be 1,161, an increase of 34 over 1934. Moving pictures of an entertaining nature were shown, and refreshments were served at the conclusion of the meeting.

The General Contractor in Relation to the Architect and the Engineer

On January 16th J. L. E. Price, M.E.I.C., addressed a joint meeting of the Branch and the Province of Quebec Association of Architects, his subject being "The Function of the General Contractor in Relation to the Architect and Engineer." The speaker during his talk remarked that "it has now come to be generally acknowledged that activity in the construction industry can be stimulated naturally only through the medium of healthy demand springing from the purchasing power of the masses." Mr. R. H. MacDonald, R.A.I.C., was in the chair.

Junior Section

The Junior Section of the Montreal Branch held its annual meeting on January 20th when the report of the retiring executive committee was presented and the election of officers for the coming year took place. E. R. Smallhorn, A.M.E.I.C., was in the chair. L. A. Duchastel, Jr.E.I.C., was elected chairman for the coming year. J. B. D'Aeth, M.E.I.C., chairman of the Montreal Branch, addressed the meeting briefly, and refreshments were served.

The Soya Bean

At its meeting on January 23rd, Mr. D. L. Calkin, sales manager of Dominion Soya Industries Limited, Montreal, gave an interesting talk on "The Versatile Soya Bean—its Growth, Processing and Uses." The speaker gave general information on a relatively new raw material which is proving to be an economical source of many unexpected products. Graham Kearney, M.E.I.C., acted as chairman.

Evolution of the Modern Transmission Line

Mr. Theodore Varney of Aluminium Limited addressed the Montreal Branch on January 30th, his subject being "The Evolution of the Modern Transmission Line." The speaker discussed wind and ice loads on conductors, calculation of sags, corona, lightning, conductor vibration, protection against vibration and dancing conductors. The paper was illustrated with slides and moving pictures, and proved to be exceedingly interesting.

Niagara Peninsula Branch

P. A. Dewey, A.M.E.I.C., Secretary-Treasurer.
C. G. Moon, A.M.E.I.C., Branch News Editor.

The branch held a dinner meeting at the Leonard hotel, St. Catharines, on January 15th, 1936, with Mr. J. W. Bishop, of the Canadian General Electric, as speaker.

Air Conditioning

Air conditioning means the carrying out of five functions, namely, control of temperature, control of relative humidity, filtration of air, circulation of air, and ventilation.

The latter is sometimes omitted but by ventilation only can smoke and odours be successfully removed. As yet there have been no filters developed which will remove either smoke or odours.

During the winter months the control of temperature requires heat and the control of relative humidity necessitates the addition of moisture. If summer air condioning s attempted the reverse process must ensue.

Winter air conditioning :s now coming into general use but, owing mainly to the cost of installation and operation, summer air conditioning is at present confined to those establishments which render service to the general public such as theatres and restaurants.

A number of slides showing air conditioning and oil furnace equipment were explained by Mr. Bishop and the ensuing discussion was quite lengthy.

A special meeting was called for February 3rd, to discuss the question of Consolidation and the naming of delegates to the Annual Meeting in Hamilton. This was held in the evening at the Municipal Hall, Thorold. Councillor Walter Jackson, M.E.I.C., who is also chairman of the special committee on Consolidation, gave a resumé of what had been accomplished during the past year and there was some discussion. Paul Buss, A.M.E.I.C., was in the chair.

Ottawa Branch

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

ANNUAL MEETING

The twenty-sixth annual meeting of the Ottawa Branch of The Engineering Institute of Canada was held at the Auditorium of the National Research Laboratories, Sussex Street, on the evening of January 9th, 1936. About eighty members were present; the retiring chairman, Dr. R. W. Boyle, M.E.I.C., presiding. F. C. C. Lynch, A.M.E.I.C., secretary-treasurer, was present and carried out the duties of his office.

The chairman, in commencing his address, stated that in the year just closed the Branch had seen the sign of emergence from the conditions of the economic depression but it was hardly possible as yet to foresee how rapid would be the advance in the fortunes of the Branch in the immediate future. A good sign, he remarked, was the significant increase in the branch membership, notably in the district.

The death was recorded with deep regret of two prominent members of long standing: A. B. Lambe, A.M.E.I.C., and J. E. Noulan Cauchon, A.M.E.I.C. Both members had taken an active part in the organization and had been prominent in the affairs of The Institute.

The chairman referred to the fact that, following upon suggestions put forth at the annual meeting a year ago, a beginning had been made during 1935 to enlist a more active interest in the affairs of The Institute on the part of the younger members. He recommended that more along these lines should be done as opportunities presented themselves. Efforts should be made to induce the younger members to contribute more written papers.

Following along the lines initiated some years ago the Branch had again contributed two sets of draughting instruments to the local technical schools to be given out as prizes to students for proficiency in draughting.

During the year the chairman and the immediate past-chairman, Alan K. Hay, A.M.E.I.C., acted as a liaison sub-committee on the question of the proposed consolidation between The Institute and the Professional Engineers Associations of the provinces. The chairman also referred to the Branch's social event of the year, the annual dance held on December 5th, with which was combined a complimentary dinner in honour of a fellow member of The Institute, the Hon. C. D. Howe, M.E.I.C., upon his elevation to the Federal Cabinet. This double event was highly successful.

The chairman closed his address with expressions of appreciation for the whole-hearted co-operation on the part of the various committees and also for the generous treatment accorded to the Branch on the part of the local press.

The Secretary-Treasurer's report revealed that the finances of the Branch were in good condition with a cash balance (including bank balance, cash on hand and government bonds) of $1,686.47, and total assets of $1,853.32. The membership increased from a total of 385 for resident and non-resident members in 1934 to 407 in 1935. The greater part of this increase was in district membership.

Seven luncheon meetings were held by the Branch, six evening meetings including the annual branch meeting, and a half-day's visit to the plant of the E. B. Eddy Company at Hull was combined with one of the luncheons.

The reports of Committees presented, after the chairman's address and the secretary-treasurer's report, were:—

Proceedings Committee by T. A. McElhanney, A.M.E.I.C.

Membership Committee by J. G. Macphail, M.E.I.C., for G. R. Turner, A.M.E.I.C.

Advertising Committee by the chairman for B. F. Haanel, M.E.I.C.

Aeronautical Section by E. W. Stedman, M.E.I.C.

Dinner Dance Committee by T. H. Doherty, S.E.I.C.

The report of the Aeronautical Section stated that this section now has a membership of 87, and held five evening meetings of its own at which technical subjects of aeronautical interest were discussed. During the year the chairman was Group Captain E. W. Stedman, chief aeronautical engineer of the Department of National Defence, and the secretary was K. F. Tupper of the National Research Council.

After the reading and discussion of reports, together with business arising therefrom, the election of officers for the new year was announced.

The retiring chairman, Dr. R. W. Boyle, then called upon E. Viens, M.E.I.C., incoming chairman, to take the chair. The latter expressed his thanks for the honour which had been conferred upon him by the Ottawa Branch. R. J. Durley, M.E.I.C., general secretary of The Institute, who was present at the meeting, spoke briefly, complimenting the Branch upon its fine showing. After a vote of thanks had been moved for the retiring officers of the Branch, D. A. Nichols, M.E.I.C., of the Geological Survey, gave a lecture illustrated with coloured lantern slides and three reels of motion pictures taken by himself.

At the conclusion of the meeting refreshments were served.

THE RISING OF THE NORTH COAST OF THE CONTINENT

The speaker accompanied the Eastern Arctic Expedition, 1935 organized by the Lands, Northwest Territories and Yukon Branch of the Department of the Interior, for the purpose of making physiographic studies of the Arctic region, and to collect rocks, minerals and fossils for museum study.

The Arctic archipelago consists of a group of islands whose foundation is the rocks of the Canadian shield, one of the three old continental land masses lying around the great central depression of the North Polar seas. The islands, to a great extent, participated in the general physiographic history of the mainland of the continent, but have characteristics of their own which make it advisable to group them in one major physiographic province and include with them the peninsulas of Melville and Boothia.

This assemblage of islands and peninsulas contains about half a million square miles. Baffin island alone has an area of 201,600 square miles or about the same as that of Nova Scotia, New Brunswick and Prince Edward Island combined.

After a varied geological history, the archipelago was submerged during glacial times. When the ice cap was removed, uplift of the land ensued and part of the area lost during submergence was regained.

The total amount of submergence cannot be determined definitely, for the water probably stood against the ice when submergence was greatest, but raised beaches are found up to at least 650 feet, representing the old shore lines formed during depression. Many beaches up to 500 feet contain marine fossils. The emergence is probably still in progress.

Archaeological evidence as seen in the position of the old pre-Eskimo house ruins indicate an uplift since these were built, of at least 33 to 43 feet. In the west, the ruins are at a higher elevation and at a more distant location from the sea, than in the east. This may mean, either that the uplift was greater there than in the east or, that the culture did not reach the east until the land had risen a considerable amount, or, that the rise is faster in the west than in the east.

Over a great deal of the Arctic regions there is less snowfall than in northern Virginia, as the icebound seas give off little moisture for precipitation. At 60 degrees the longest summer day is about eighteen and a half hours, at the Arctic circle it is twenty-four hours. At 70 degrees there are seventy-three days of continuous sunshine and several thousand square miles of the Arctic have more than thirty days of continuous sun. The sun works overtime, and speeds up plant life. Plants rush through their life cycle; grow, bud, seed and decay in a short period of time. Marine life is abundant but there are not as many species as in southern waters.

THE HYDROGENATION OF COAL

Dr. T. E. Warren, of the Fuel Research Laboratories of the Department of Mines, addressed the first noon luncheon of the 1936-37 term, held at the Chateau Laurier on January 23rd. E. Viens, M.E.I.C., newly-elected chairman, presided and additional head table guests included: C. A. Magrath, M.E.I.C., L. L. Bolton, M.E.I.C., R. E. Gilmore, M.E.I.C., John McLeish, M.E.I.C., Dr. R. W. Boyle, M.E.I.C., B. F. Haanel, M.E.I.C., Dr. B. R. MacKay, F. H. Peters, M.E.I.C., J. L. Rannie, M.E.I.C., and C. McL. Pitts, A.M.E.I.C. At the commencement of the address the members present observed one minute's silence out of respect for the death of His Majesty King George V.

During the past six years Dr. Warren has carried on research work at the Fuel Research Laboratories on the investigation of the hydrogenation of fuels.

Coal and gasoline, he stated, differ in three important particulars: first, in the proportion of hydrogen; second, in the molecular weight; and third, in the matter of impurities. The hydrogen content of coal is about 5 per cent whereas that of gasoline is about 14 per cent; the molecular weights, respectively, are approximately 2,000 or more and 100; and the usual impurities of coal are nitrogen, oxygen, and sulphur, whereas with gasoline, which consists of compounds of carbon and hydrogen, the impurities should be removed. In order to convert coal to gasoline, therefore, it is necessary to add hydrogen, reduce the molecular size and remove the nitrogen, oxygen and sulphur. These changes are accomplished by heating the coal at 842 degrees F. with hydrogen at a pressure of 3,000 pounds per square inch.

The way in which this is done on a laboratory scale was first described after which commercial methods were dealt with. Operating under a preference brought about by a hydrocarbon oils production bill passed in 1934, the terms of which are to run for at most nine years, a plant of the Imperial Chemical Industries in England produces some 45,000,000 gallons of gasoline annually—between 4 and 5 per cent of the total consumption for the country—from British coal and tar oils. This plant took nearly two years to build and gives employment to some four thousand men, half of whom work in the plant itself and the other half in the coal mines. There is also a large plant in Germany and two in United States, but the British plant is the first large scale plant to operate on bituminous coal.

The speaker reminded his listeners that the gasoline used in Canada is almost entirely produced from imported crude oils and stated that the experiments at the laboratory had demonstrated that Canada has the raw materials suited to the production of gasolines from coal. However, the matter of costs when applied on a commercial scale was one that should be given further attention. Commercial costs were most difficult to estimate in advance on account of the very heavy expenditures required for plant equipment.

Peterborough Branch

W. T. Fanjoy, Jr.E.I.C., Secretary-Treasurer.
E. J. Davies, Jr.E.I.C., Branch News Editor.

Mechanized Warfare

The development of the tank and the engineering aspects of its construction for use in modern mechanized warfare was the subject of an illustrated address to the Branch by Lieut.-Colonel N. C. Sherman, M.E.I.C., of Kingston, at the regular monthly meeting on January 9th, 1936, at which there was a record attendance of members and guests, including many from the local military units.

Colonel Sherman dealt with the subject authoritatively through long service as a military mechanical engineer in England and Canada. He is at present ordnance mechanical engineer for the five military districts for maintenance and development of mechanical military equipment.

Warning against the popular visions of completely mechanized warfare in the future, he said, "I wish to make clear that, while I am an engineer concerned with mechanical warfare appliances, I do not hold the optimism that mechanical inventions will win wars by themselves. When added, however, to a proper understanding of principles and when they are used with a full understanding of their limitations they will go a long way toward ensuring victory."

The first mechanization of warfare occurred thousands of years before Christ when chariots were brought into battle. Ancient history also saw the use of the battering ram, of stone catapults and movable sheds for protection of soldiers. The first crude visions of the modern tank was used in warfare in the 18th and 19th centuries but between 1800 and the Great War, no worth-while attempts at a practical tank were made. The major development in mechanical warfare was the machine gun, brought out around the turn of the century.

Although the idea of the tank was an old one, yet the Germans were taken by surprise when they encountered the first tanks of the Great War in the Battle of the Somme in 1916. The success of the tank was indicated by the fact that, at the conclusion of the Great War, the Allies had built more than 2,800.

The post war tendency has been toward lighter and faster tanks and in the speaker's opinion the day of the large 28-ton tanks used in 1917 and 1918 is gone.

Humour has its chance even in the testing of the deadly equipment of modern mechanized warfare. Canadian military authorities were testing a new Canadian-made armoured car at Petawawa. The car was equipped with two front wheels and two sets of driving wheels spaced closely at the rear. It surmounted with ease all obstacles put in its path but met its Waterloo when it encountered a log. The log passed underneath the front wheels but lodged between the two sets of drive wheels at the rear in such a way that the wheels rotated in a reverse direction.

To the chagrin of observers, the dauntless armoured car suddenly started backwards at the same speed it had been proceeding forward when it encountered the simple obstacle. "Just one of those simple things that you can't foresee before an actual test," Colonel Sherman commented.

Saint John Branch

F. A. Patriquen, Jr.E.I.C., Secretary-Treasurer.

The annual joint dinner and meeting of the Association of Professional Engineers of the Province of New Brunswick and the Saint John Branch was held in the Admiral Beatty hotel on January 30th, 1936, at 6.15 p.m.

In the afternoon preceding the dinner, the annual meeting of the Association was held, at which the officers for the coming year were elected. Geoffrey Stead, M.E.I.C., was elected president, succeeding Professor A. F. Baird, M.E.I.C.

After a very enjoyable dinner, at which seventy-four were present, the members of both bodies had the pleasure of hearing a talk on "Arctic Flying" by T. C. Macnabb, M.E.I.C., general superintendent of the New Brunswick Division of the Canadian Pacific Railway. The talk was based on the experiences of the speaker while conducting an aerial survey, in connection with the transportation of ore in northern Canada.

Sault Ste. Marie Branch

N. C. Cowie, Jr.E.I.C., Secretary-Treasurer.

The Sault Ste. Marie Branch held its February meeting at the Windsor hotel, Sault Ste. Marie, on Thursday, February 6th, 1936.

This meeting was an open meeting for members and guests. Thirty-six were present at the dinner which commenced at 6.45 p.m.

John L. Lang, M.E.I.C., called the meeting to order at 8.00 p.m. The first speaker, Mr. Theodore Varney, consulting engineer, Aluminum Company of Canada, was then introduced to the members by Mr. Lang. Speaking on the subject "Aluminum Cables, Steel Reinforced for Electrical Conductors," Mr. Varney, by his speech and accompanying lantern slide and motion picture illustrations, reviewed the evolution of the modern transmission line. The difficulties encountered with vibration and dancing of transmission line conductors and their causes was exhaustively explained. Mr. Varney presented a detailed mathematical study of this question and then illustrated definite methods which are being used to overcome these difficulties.

Mr. W. M. Gifford, vice-president of the Aluminum Company of Canada, was then introduced by the chairman and spoke briefly on "Some Aspects of Aluminum and its Alloys." Mr. Gifford illustrated his talk with samples of some of the products using aluminum that are now being fabricated.

Mr. Varney and Mr. Gifford were tendered a very hearty vote of thanks for their interesting talks and illustrations by those present at the meeting.

Winnipeg Branch

J. F. Cunningham, A.M.E.I.C., Secretary-Treasurer.
H. L. Briggs, A.M.E.I.C., Branch News Editor.

High Voltage Low Current D.C. Transmission

With G. E. Cole, A.M.E.I.C., as acting chairman, the Winnipeg Branch held its first meeting of the new year on January 23rd, a previous meeting having been postponed on account of sickness.

R. F. Legget, A.M.E.I.C., secretary of the Committee on Consolidation, addressed the Branch regarding the work of this committee, briefly summarizing their recommendations which are being presented at the annual meeting.

The address of John W. Dorsey, assistant professor of electrical engineering, University of Manitoba, on the subject "High Voltage Low Current D.C. Transmission," dealt with a new method which he has himself developed and tested of securing high voltage d.c. for transmission purposes.

To obtain high voltage d.c. from the high voltage output of a transformer bank, the phase to phase voltages are full wave rectified through six high voltage rectifier tubes. The novel feature used in conjunction with the tubes is a synchronous switch which consists of six commutator discs located on a shaft driven at synchronous speed, and arranged in such a way that each tube is in the circuit for only one-third of the voltage cycle, during which time the tube is conducting. For the remaining two-thirds of the wave, the synchronous switch keeps the tube plate circuit open so that the tube is not subjected to high inverse voltages far beyond the ability of the tube to withstand. Transfer from one phase to another of the current load occurs at the instant when one phase voltage wave when on the decrease is equal to the next phase voltage wave on the increase. If close adjustment of the synchronous switch could always be relied upon to switch the phases at the time of the crossing of the voltage waves, the rectifier tubes would be unnecessary, and a number of tests have been successfully run without them.

Using 7,000-volt tubes, and a bank of 20,000-volt transformers star connected, Professor Dorsey has supplied a load of 2 amperes at 50,000 volts d.c. with his experimental apparatus.

At the inverter end, where the d.c. is reconverted to a.c., the problem is more involved. Synchronous machine capacity is necessary to bring the load power factor to 100 per cent, and to maintain approximately sine wave form by supplying the harmonics to combine with the otherwise rectangular waves of the inverted direct current.

After the discussion which followed, H. L. Briggs, A.M.E.I.C., moved the vote of thanks to the speaker, which was heartily concurred in by all present. The meeting then adjourned for light refreshments.

Students' Engineering Society

The February 6th meeting was turned over to the Students' Engineering Society of the University of Manitoba, under the chairmanship of Mr. J. L. Henning. The two student papers receiving the prizes awarded by the Winnipeg Branch were presented by the authors.

Mr. F. P. Findlay's paper, "Bituminous Materials in Highway Construction," gave useful initial cost and maintenance cost data on gravel, concrete, and bituminous macadam highways as constructed in the Province of Manitoba.

"Atmospheric Phenomena During Dust Storms, and their Effect on High Tension Wires" was presented by Mr. J. Duane McKenzie. The paper set forth the experience in operating a 129-mile 33-kv. transmission line in southern Saskatchewan during dry seasons when dust storms were prevalent. Whether the line was on load or dead, the dust particles in the air would cause static charges to build up on the conductors to the extent of requiring the lightning arresters to discharge as frequently as once every two seconds, thereby quickly destroying the arresters.

Preliminary Notice

of Applications for Admission and for Transfer

February 26th, 1936

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, 1936.

R. J. Durley, Secretary.

*The professional requirements are as follows:—

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

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

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

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

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

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

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

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

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

FOR ADMISSION

ANDERSON—OSCAR VICTOR, of 68 Indian Road Crescent, Toronto, Ont., Born at St. Paul, Minn., Mar. 5th, 1886; Educ., Elec. Engr., Univ. of Minnesota, 1910; 1910-11, Penn. Tunnel and Terminal Rly. Co., New York City; 1911-12, engr., City Light and Power Dept., Winnipeg; 1912-13, engr., Toronto Hydro-Electric System, Toronto; 1913-15, supt., London Electric Co., on constrn. for Toronto Power Co., Toronto; 1915-23, supt., dist. dept., Toronto and Niagara Power Co., Toronto, Ont.; 1923-24, engr., and 1924 to date, field engr., stations constrn. section, Toronto Hydro-Electric System, Toronto, Ont.
References: H. A. Bodwell, E. T. J. Brandon, W. P. Dobson, M. P. Whelen, C. E. Sisson.

BALDRY—GEORGE EPHRIAM, of 810 Wolseley Ave., Winnipeg, Man., Born at Osgoode, Ottawa Valley, Ont., Oct. 29th, 1883; Educ., Wesley College, Winnipeg, and private tuition; 1902-03, C.P.R.; 1904-05, gen. engrg.; 1906, with L. A. Smart organized the Baldry Engineering Co., specializing in foundation work; 1907-09, designed Cornwall Apts.; 1910, consltg. engr. on foundations and reinforced concrete constrn. for A. L. McLean, J. E. Wilson, Ross & Co., Saskatoon, McFarlen & Co., Brandon, and others; 1911, surveys and constrn. work on roads and bridges on timber limits for Hiram Sykes & Co.; 1912-14, design and constrn. of Wolseley Apts. and highway constrn.; 1914-17, overseas service with Y.M.C.A.; 1919-30, foundation designs and remodelling for various large bldgs., including Princeton Apts. ($300,000); 1930 to date, design and constrn. work for large bldgs. (mostly foundation work), including Devon Court ($200,000), Lincoln Apts. ($100,000), St. Michaels Hospital, Grand Forks ($400,000), and other jobs, in some cases design for foundations only, in others the contract for the foundations, or for the complete building.
References: W. Walkden, A. Campbell, J. N. Finlayson, A. E. MacDonald, H. B. Henderson, E. S. Kent, E. W. M. James, C. H. Gunn.

FOSTER—JOHN DAVID, of Kenora, Ont., Born at Winnipeg, Man., Sept. 8th, 1907; Educ., B.A., Univ. of Man., 1928; With C.P.R. as follows: 1927, chainman, 1928, rodman, 1928-29, topog'r., 1929-30, instr'man., 1930, leveller, 1931, instr'man., 1932, dftsman.; With Dept. of Northern Development: 1933-35, instr'man., 1935 to date, res. engr.
References: J. A. McCoubrey, J. F. Lester, E. A. Kelly, C. G. J. Luck, A. E. Sharpe, T. C. Macnabb, T. F. Francis.

GIBBON—ROY, of Port Arthur, Ont., Born at Port Arthur, Ont., Nov. 24th, 1908; Educ., 1921-26, Port Arthur Collegiate, passed maths. subjects only for Junior Matric.; Studying I.C.S. course in Civil Engrg.; 1929-32, chainman and rodman, and 1932 to date, dftsman and asst. to engrs., City of Port Arthur, Ont. (1935, 4 mos., lab. work on road constrn. for Warren Bituminous Co. Ltd.)
References: J. Antonisen, F. C. Graham, P. E. Doncaster, H. G. O'Leary, G. H. Burbidge, G. Eriksen, G. P. Brophy.

JOHNSTONE—JAMES CAMERON, of 3884 West 10th Ave., Vancouver, B.C., Born at Glasgow, Scotland, July 7th, 1881; Educ., 1898-1903, Glasgow and West of Scotland Technical College; 1898-1903, ap'ticeship, Master of Works Dept., City of Glasgow; 1903-11, with City of Glasgow Water Works Dept. as follows: 1903-05, asst. engr., 1905-08, res. engr. on repairs to old aqueduct from Loch Katrine; 1908-09, design of special structures for a pipe line from reservoir to Glasgow, 1909-10, constrn. of filter beds at Barrhead Water Works, 1910-11, compiled book of maps; 1911, alterations to Ladysmith, B.C., sewerage systems, constructed according to own plans and reports; 1912, asst. district engr , North Vancouver Municipality; 1912-13, city engr., Port Alberni, B.C.; 1913-15, preparing plans and profiles for grading streets in Ladysmith and Port Alberni, locating trails on West Coast Vancouver Is. for Forestry Br., B.C.; 1915-19, overseas, Major, Chief engr., 9th C.R.T., and acting second in command; 1919, asst. district engr., Dept. Public Works, B.C.; 1920-23, res. engr. on Southern Okanagan Irrigation Project, Oliver, B.C.; 1923, wharf constrn. for Dom. Public Works; 1924-29, Alberni Pacific Logging Co., Port Alberni; With Dept. of Public Works, B.C., as follows: 1929-30, asst. district engr., 1930-34, district engr. (various districts); 1935, res. engr. on constrn. of Nanaimo Assembly Wharf, incl. dredging, sheet piling, bearing piles, water supply, road trestle and rly. trestle; At present, engr. i/c Project No. 55, Trans-Canada Highway.
References: J. Robertson, H. N. Macpherson, E. A. Cleveland, W. Anderson, C. T. Hamilton, J. P. Mackenzie, P. Sandwell, E. A. Wheatley.

LUMB—WILLIAM EWART, of Moncton, N.B., Born at Fort Stewart, Ont., Feb. 26th, 1890; Educ., B.Sc., Queen's Univ., 1913. O.L.S., D.L.S.; 1911-17, asst. engr., Topog'l. Surveys Br., Ottawa; 1917-22, private practice, Ontario land surveys; 1926-29, asst. res. engr., Ontario Provincial Highways; 1922-25, chief of party, subdivn. surveys, Tampa, Florida; 1929 to date, promotion engr., Canada Cement Company, Moncton, N.B.
References: R. M. Smith, A. Gray, H. S. Van Scoyoc, J. M. Breen, J. Pullar, G. N. Hatfield, J. B. Stirling.

MOLD—ROBERT CHARLES, of 4554 Draper Ave., Montreal, Que., Born at Walsall, England, April 24th, 1901; Educ.. Evening classes in maths. and arch'l. drawing; 1917-23, dftsman. and junior fire protection engr., Grinnell Co.; 1923-28, inspector in sprinkler risk dept., Canadian Fire Underwriters Assn.; 1929-32, district representative, contractor and supt. of outside work for H. G. Vogel Co. (Can.) Ltd., and from 1932 to date, Montreal manager for same company. (Applying for admission as an Affiliate of The Institute.)
References: A. J. B. Foy, N. C. Cameron, J. A. H. Henderson, W. J. Armstrong, H. J. Whiting.

MUIR—HARVEY JAMES, of Winnipeg, Man., Born at Wiarton, Ont., Sept. 29th, 1904; Educ., B.A.Sc., Univ. of Toronto, 1930; 1930-31, cadet engr., Bailey Meter Co., Cleveland, Ohio; 1931 to date, sales-service engr., selling and supervising installn. of flow metering and automatic control equipment; conducting combustion and boiler efficiency tests, Bailey Meter Co. Ltd., Montreal, Que.
References: N. M. Hall, R. W. Angus, T. C. Main, W. L. Thompson, L. M. Hovey, A. Ritchie.

PINCHBECK—GEORGE REGINALD, of 43 Kensington Apts., Edmonton, Alta., Born at Winterburn, Alta., Aug. 15th, 1908; Educ., B.Sc. (E.E.), Univ. of Alta., 1931; Summers 1928-29-30, chainman and rodman, Dept. Public Works, Alta ; 1931-32, student test course, Can. Gen. Elec. Co. Ltd.; 1932 (Aug.-Oct.), inspr., Northwestern Utilities, Ltd., Edmonton, Alta.; 1934 (Sept.-Dec.), instr'man., Dept. Public Works, Alta.; 1935 (Apr.-Nov.), asst. i/c of survey and constrn., main highway project No. 26 A-1; Present winter employment—asst. municipal secretary.
References: H. J. MacLeod, R. S. L. Wilson, E. Nelson, W. E. Cornish, C. A. Robb, H. R. Webb.

STEVENS GUILLE—HENRY LeMARCHANT, of Turner Valley, Alta., Born at Little Torrington, N. Devon, England, Sept. 12th, 1901; Educ., B.Sc. (Div. I) Oil Engrg. and Refining, Univ. of Birmingham, England, 1924; A.M.I.Chem.E. (London); 1925-27, process asst. in refinery of British Burma Petroleum Co., Rangoon, Burma, working as operator on stills, cracking coils and heating plants; 1927, night operator in charge of refinery for same company, and 1927-28, in charge of wax dept. for same company; 1928 to date, chem. engr. i/c laboratory, testing of plants and of obtaining

and applying technical data on all phases of the production, measurement and purification of natural gas; and extraction and stabilization of natural gasoline with the Royalite Oil Co. Ltd., Turner Valley, Alta.
References: S. G. Coultis, F. G. Bird. W. H. Broughton, F. J. Heuperman, F. M. Steel.

TELEMAQUE—LIONEL JEAN BAPTISTE MARIE, of Port-au-Prince, Haiti, Born at Aux Cayes City, Haiti, Apr. 6th, 1901; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1927. Studied also at Ecole Supérieure des Travaux Publics, Paris, and Mass. Inst. Tech., Cambridge, Mass. Town planning engr. and sanitary expert; 1922-23 (summers), with F. Pressoir, consltg. engr., Paris; 1925, civil engr., on public works, Aux Cayes; 1928, civil engr. in designing office of the General Direction of Public Works, Republic of Haiti; 1929, engr. with Henri Lossier, consltg. engr., Argenteuil, Paris; 1930, engr. with M. Pegeot, Paris, also special study in preparation for degree of Doctor of Science, Univ. of Paris; 1932, became professor in Faculty of Applied Science, Univ. of Haiti, 1932, professor of strength of materials, 1933-34, professor of strength of materials and hydraulics, and at present, professor of strength of materials and structures, mechs., theoretical and applied hydraulics, at the same university.
References: A. Frigon, T. J. Lafreniere, A. Mailhiot, A. Cousineau.

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

BISHOP—ARTHUR LEONARD, of Toronto, Ont., Born at Brantford, Ont., Oct 21st, 1895; Educ., 1912-14, R.M.C.; 1912-13, refinery supt., Coniagas Reduction Co. Ltd.; 1914, survey party, Nat. Trans. Rly ; 1914-18, overseas, Capt., Royal Engrs.; 1919-25, president, British American Ship Building Co., Welland, and 1919 to date, president, Electric Steel and Engineering Co., Welland, including its subsidiaries. Also during this period, vice-president, president and director, of numerous mining and construction companies. (*Jr. 1919, A.M. 1924.*)
References: F. S. Keith, R. E. Smythe, R. L. Peek, C. H. Mitchell, A. J. Grant, H. G. Acres.

DUNCAN—WILFRID EBEN PINKERTON, of 19 Rochester Ave., Toronto 12, Ont., Born at Glasgow, Scotland, March 2nd, 1891; Educ., B.Sc. (Engrg.), Glasgow University, 1913; 1910-11-12 (summers), chainman, rodman, topog'r., and 1913-14, dftsman., C.P.R.; 1914-15, asst. engr., Lake Erie and Northern Rly.; 1915-16, overseas, Can. Rly. Constrn. Corps.; 1916-19, Major, Royal Engrs.; 1919-21, estimating engr., Carswell Construction Co. Ltd.; 1921-23, asst. engr. of structures, and 1923 to date, engr. of structures, Toronto Transportation Commission, in full charge of design, constrn. and mtce. of all types of structures, bldgs., bridges, etc. (*St. 1911, A.M. 1919.*)
References: J. B. Carswell, D. W. Harvey, J. A. McNicol, H. W. Tate, C. R. Kinnear, C. S. L. Hertzberg.

FRANCIS—THOMAS FREDERICK, of Toronto, Ont., Born at Moncton, N.B., Mar. 29th, 1890; Educ., 1911-16, McGill Univ. (enlisted in 4th year); With C.P.R. as follows: 1908-09, chainman, rodman, topog'r.; 1910-12, instr'man.; 1913-14, res. engr.; 1915, instr'man.; 1916, instr'man. and designer, Metagami Pulp and Paper Co., Jacksonborough, Ont.; 1917-19, overseas, Lieut., 3rd C.R.T., engr. locating and constrn. of rlys. in France; With C.P.R. as follows: 1919-27, res. engr., rly. constrn. and bridges; 1928, locating engr.; 1929-32, asst. engr.; 1935 to date, engr. of constrn., Dept. of Northern Development, Prov. of Ontario. (*A.M. 1920.*)
References: T. C. Macnabb, A. B. Crealock, W. A. Mather, E. A. Kelly, J. A. McNicol.

HARRISON—RONALD, of 1859 Kingston Rd., Birch Cliff, P.O., Ont., Born at Toronto, Ont., Jan. 19th, 1897; Educ., B.A.Sc., Univ. of Toronto, 1920. R.P.E. of Ont.; 1916-18, overseas, Lieut., Can. Engrs.; 1918 (summer), Canadian Aeroplanes Ltd., Toronto; 1919 (summer) and 1920-22, hydraulic dept., H.E.P.C. of Ontario; 1922 (2 mos.), traffic study, Toronto Transportation Commission; 1922 (2 mos.), plan examiner, Toronto City Architects Dept.; 1922-23, with James, Proctor & Redfern, consltg. engrs., Toronto; 1923-25, engr. and supt waterworks, and 1925 to date, manager, hydro and waterworks depts., Scarborough Public Utilities Commn. (*St. 1919, Jr. 1921, A.M. 1925.*)
References: R. L. Dobbin, R. L. Hearn, E. M. Proctor, A. E. Berry, H. A. Babcock, J. J. Traill, W. Maclachlan.

LOVELL—WILLIAM EDWARD, of Saskatoon, Sask., Born at Toronto, Ont., June 25th, 1893; Educ., B.Sc. (E.E.), Univ. of Man., 1921; 1922-23, Manitoba Power Co.; 1923, and summers 1924-25-26, Winnipeg Electric Co.; 1923-28, asst. prof. of elect'l. engrg., and 1928 to date, professor of elect'l. engrg., Univ. of Saskatchewan, Saskatoon, Sask. (*St. 1911, A.M. 1925.*)
References: C. J. Mackenzie, A. R. Greig, E. V. Caton, E. P. Fetherstonhaugh, A. J. Taunton.

TATE—HARRY WILLIAM, of Toronto, Ont., Born at Wimbledon, England, Oct. 4th, 1884; Educ., B.A.Sc., Univ. of Toronto, 1909; 1905-06, chainman, rodman, C.P.R.; 1907-08-09, Kerr Lake Mine, i/c claim dept., underground surveyor, etc.; 1910-11, articled to N. D. Wilson, O.L.S.; 1911-13, practising surveyor, Toronto; 1913-14, field engr., Federal District Ottawa and Hull; 1915-19, C.E.F., Major, 2 years second in command of engrs. batts.; 1920 to date, with Toronto Transportation Commission, as follows: 1920-23, field engr.; 1923-24, asst. engr. of way; 1924-27, engr. of way; 1927 to date, asst. manager. (*St. 1909, A.M. 1913.*)
References: D. W. Harvey, N. D. Wilson, A. E. K. Bunnell, J. R. W. Ambrose, C. R. Young, J. G. R. Wainwright, M. A. Stewart.

WIREN—ROBERT NICHOLAS RUDOLPH CHARLES, of Toronto, Ont., Born at Juriev-Dorpat, Esthonie, May 10th, 1896; Educ., B.A.Sc., Univ of Toronto, 1926; 1913-15, electric wiring, etc.; 1916-20, Russian Army. 1916-17, instructor in motor mechanics' school; 1917-20, garage and shop mgr., Armoured Car Service; 1926-28, designing engr., Combustion Engrg. Corpn., Toronto and Montreal; 1928-31, designing engr., Ruths Steam Storage Ltd., Toronto and Montreal; 1931-34, instructor, and 1934 to date, lecturer in mech'l. engrg., University of Toronto, Toronto, Ont. (*A.M. 1929.*)
References: C. H. Mitchell, R. W. Angus, E. A. Allcut, W. S. Wilson, W. B. Dunbar.

FOR TRANSFER FROM THE CLASS OF JUNIOR

McFARLAND—WALTER IRVING, of Montreal, Que., Born at Havelock, N.B., Nov. 10th, 1902; Educ., B.Sc. (E.E.), Univ. of Alta., 1929; 1929-30, test work, switchboard wiring, sales correspondence, Canadian Westinghouse Co., Hamilton; With Beauharnois Construction Co. as follows: with elect'l. engrg. dept. on constrn. of power house and all elect'l. work in connection with constrn. project. Responsible for ordering and delivery of materials, checking drawings, and asst. to elect'l. engr. in handling of elect'l. forces on elect'l. constrn. 1933-34, in charge of elect'l. installn. and mtce. for constrn. of Coteau control dam. 1934 (Jan.-Mar.), operating above gates; 1934-35, in charge of elect'l. installn. and mtce. for constrn. of 2nd control dam at Coteau; also same work for constrn. of remedial weir at Cedars; responsible for transmission lines and substation for two dredges and elect'l. drag line in Beauharnois canal; Mar. 1935 to Jan. 1936, elect'l. engr. for constrn. dept. of Beauharnois Light, Heat and Power Co. (*Jr. 1931.*)
References: B. K. Boulton, L. H. Burpee, M. V. Sauer, P. H. Morgan, H. J. MacLeod, H. R. Webb.

McMILLAN—RALPH EDWIN, of 3410 Atwater Ave., Montreal, Que., Born at Detroit, Mich., Nov. 10th, 1902; Educ., B.Sc. (E.E.), McGill Univ., 1926; 1926-28, asst. sales engr., Northern Electric Co. Ltd., Montreal; 1928-30, electrical designer, Fraser Brace Engrg. Co. Ltd., Montreal; 1930-32, asst. elect'l. engr., Canada Cement Co. Ltd., Montreal; 1931-34, chief ship's electrn., E.M.V. "Cement Karrier," Point Anne, Ont.; 1933-34, plant electrn., Peerless Milk Co. Ltd., Montreal; 1935, asst. engr., and 1935 to date, plant engr., The British Rubber Co of Canada Ltd., St. Laurent, Que. (*St. 1922, Jr. 1930.*)
References: C. V. Christie, W. R. Bunting, J. B. D'Aeth, W. G. H. Cam, K. L. McMillan.

RUSSELL—JOHN ARTHUR, of 418 Whitney Ave., Sydney, N.S., Born at Birmingham, England, Aug. 12th, 1904; Educ., Passed E.I.C. Exams. under Schedule "B" for admission as Junior, Nov. 1930; 1919-24, ap'ticeship, 1924-29, dftsman., M. B. Wilde & Co., Birmingham; 1929-30, dftsman., and 1930 to date, chief mech'l. engr., Dominion Coal Company, Sydney, N.S. In charge of engrg. dept. and drawing office. Responsible for layout and design, comparison of tenders, etc., for colliery machy., hoists and haulages, coal screening and preparation plants, pumps, steel and wood structures. Responsibility covers suitability of layout, strength and accuracy of design, accuracy of estimates, and inspection of final installn. (*Jr. 1930.*)
References: K. H. Marsh, F. W. Gray, W. C. Risley, A. L. Hay, S. C. Mifflen.

FOR TRANSFER FROM THE CLASS OF STUDENT

DEXTER—JOSEPH DIMOCK, of Brooklyn, Queen's Co., N.S., Born at Brooklyn, Dec. 5th, 1907; Educ., B.Eng., McGill Univ., 1932; Summer work: 1928, rodman on constrn., Mersey Paper Co.; 1929, dftsman, same company; 1930, rodman, Maine Seaboard Paper Co.; 1931, office computations, Beauharnois Constrn. Co.; 1933 to date, dftsman., Mersey Paper Co. (*St. 1932.*)
References: C. V. Christie, E. Brown, R. E. Heartz, J. H. M. Jones, R. L. Seaborne.

DOHERTY—THOMAS HUGH, of Ottawa, Ont., Born at Montreal, July 31st, 1908; Educ., B.Sc. (Mech.), McGill Univ., 1929; 1925-29 (summer work), erecting, machine shops and dfting office, C.P.R.; 1929-30, junior engr., Riley Engineering and Supply Co., Toronto; 1930-32, calculating engr., Lima Locomotive Works, Inc., Lima, Ohio. Calculations pertaining to locomotive design and constrn.; 1932 to date, junior research engr., in charge of Fire Hazard Testing Lab., National Research Council, Ottawa, Ont. (*St. 1928.*)
References: R. W. Boyle, J. H. Parkin, B. G. Ballard, C. M. McKergow, R. A. Strong.

HUGHES—PHILIP BERNARD, of 4100 Cote des Neiges Rd., Montreal, Que., Born at Montreal, July 1st, 1905; Educ., B.Sc. (Mech.), McGill Univ., 1926; 1924 (summer), timber cruising, St. Maurice Paper Co.; 1926-28, International Paper Co., Bureau of Tests, Glen Falls, N.Y. Including paper mill economy and yield studies; inspection and trial of machinery as asst. or in charge. Carried out work in various mills of company in Canada and U.S.A.; 1928-29, International Power and Paper Co. of Nfld. Ltd., Corner Brook, Nfld., on dfting board during expansion of paper and sulphite mills; 1929 (3 mos.), John S. Metcalf Co. Ltd.; 1929-30, Dominion Rubber Co., planning and engrg. dept.; 1930 to date, with Plessisville Foundry, Montreal. Three years estimating and drawing in materials handling and transmission division. Last two years selling in Montreal territory. (*St. 1927.*)
References: L. Coke-Hill, R. Ford, K. O. Elderkin, R. A. Gurnham, C. U. Vessot.

McLEAN—GORDON MITCHELL, of Pascalis, Que., Born at Souris, P.E.I., Feb. 20th, 1908; Educ., B.Sc. (Mech.), N.S. Tech. Coll., 1932; 1935-36, Diesel engine operator and mechanic; At present, mechanic, Perron Gold Mines, Pascalis, Que. (*St. 1931.*)
References: H. W. McKiel, F. L. West, F. R. Faulkner, J. A. Black, S. Ball.

SCOTT—LLOYD GEORGE, of Winnipeg, Man., Born at Waskada, Man., Jan. 8th, 1912; Educ., B.Sc. (E.E.), Univ. of Man., 1932; 1931 (summers), constrn. work at Saskatoon, and 1932 (summer), student engr. at Hamilton, Otis-Fensom Elevator Co. Ltd.; 1932 to date, asst. to supt. of bldgs. and equipment, Hudson's Bay Company, Winnipeg, Man. (*St. 1930.*)
References: C. E. Joslyn, G. H. Herriot, W. E. Hobbs, J. N. Finlayson, E. P. Fetherstonhaugh, N. M. Hall.

TIMM—CHARLES RITCHIE, of 343 Lansdowne Ave., Westmount, Que., Born at Westmount, Mar. 19th, 1908; Educ., B.Sc. (E.E.), McGill Univ., 1930. 1932-33, further work in 3rd and 4th years, mech. engrg., McGill Univ.; Summer work: 1926, struct'l. dftsman., Dominion Bridge Co., Lachine; 1927, rodman and instr'man., Fraser Brace Ltd., Paugan Falls, Que.; 1928-29, dftsman., Power Engrg. Co., Montreal; 1930-31, test dept., Gen. Elec. Co., Schenectady, N.Y., and Pittsfield, Mass.; 1931-32, sales engr., E. W. Playford, Ltd., Montreal; 1933-34, instr'man., constrn. of cable testing plant, Dominion Bridge Co.; 1934-35, dftsman., paper machy. dept., and 1935-36, installn. of electric steam generators for Dominion Engrg. Works Ltd.; Jan. 1936 to date, estimator, Bepco Canada Ltd., Montreal, Que. (*St. 1928.*)
References: C. V. Christie, C. M. McKergow, J. A. McCrory, R. E. Crawford, R. A. Yapp, A. J. McLennan.

TIBBITTS—ANGUS GORDON, of Dartmouth, N.S., Born at Truro, N.S., July 15th, 1904; Educ., B.Sc. (Mech.), N.S. Tech. Coll., 1931; 1928 (summers), Geol. Survey; 1928-30, 8 mos full time, and 16 mos. part time, with N.S. Fuel Board on boiler test, also respons. for all tests on domestic heating; 1930 to date, asst. chief engr., Acadia Sugar Refining Co. Ltd., full charge of many constrn. and installn. works, supervision of mtce. repairs. (*St. 1930.*)
References: J. D. Fraser, J. S. Misener, A. G. Pedder, F. R. Faulkner. S. Scrymgeour, R. R. Murray.

Jenkins Bros. Limited, valve manufacturers of Montreal, have just issued a new catalogue containing 280 pages and describing and illustrating the complete line of Jenkins valves and mechanical rubber goods. It gives information about types, patterns, sizes, weights and list prices, and 35 pages are devoted to tables and engineering data.

Babcock-Wilcox and Goldie-McCulloch Limited have recently announced the appointment of Austen Bros., Limited, Halifax, N.S., as their agents in the province of Nova Scotia for the sale of "Babcock" centrifugal pumps, "Babcock" vertical air compressors, and "Babcock" steam turbines.

EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada

2050 Mansfield Street, Montreal

Situation Vacant

List No. 647

FILM EDITOR

24781.—A film editor (and sound technician), (Male), in the Canadian Government Motion Picture Bureau, Department of Trade and Commerce, Ottawa, initial salary of $3,000 per annum. For such appointment the initial salary of $3,000 may be increased upon recommendation by $120 per annum until a maximum of $3,480 has been reached.

Duties.—Under direction, to arrange and supervise the depicting of narrative, nature, art, or industrial processes employing silent or sound motion picture films; to prepare scenarios, work scripts, titles and narratives for sound and silent films; to arrange for and supervise cinematographic work in the field and studio; to compile, assemble and edit sound and silent films and film slides; to supervise sound recording operations, and the matching, synchronization, etc., of sound film negatives for printing; to supervise the processing of sound and silent films, including the determination of contrast and density for positive and negative sound films.

Qualifications Required.—Education equivalent to graduation in science from a university of recognized standing, or from an advanced technical school of recognized standing; preferably three years of experience in the preparation and production of sound films, film editing and sound recording, part of which shall have been in a position of responsibility; knowledge of and preferably practical experience in sound cinematography, recording and processing of sound films, supervisory ability, ability to plan and construct new apparatus.

Application forms properly filled in must be filed with the Civil Service Commission, Ottawa, **not later than March 19, 1936.** Application forms may be obtained from the offices of the Employment Service of Canada, from the Postmasters at any City Post Office, The Engineering Institute of Canada, Montreal, or the Secretary of the Civil Service Commission, Ottawa.

Situations Wanted

PURCHASING AGENT. Graduate mechanical engineer, Canadian, married, age 36, with fourteen years experience in industrial field, including design, construction and operation, eight years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on sale of surplus construction equipment. Full details on request. At present employed. Apply to Box No. 161-W.

SALES ENGINEER, S.E.I.C.; B.Sc. C.E., 1930 (Univ. N.B.). P.E.N.B. Age 28. Experience includes building inspection, structural detailing, road construction, and chemical operation. Interested in sales work on the sales staff of some manufacturing or wholesale concern. Apply to Box No. 225-W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

ENGINEER AND ACCOUNTANT, Jr.E.I.C., (Capt. Can. Engrs., reserve). Age 35, Canadian. Experienced in mechanical and civil engineering, Diploma; general office, draughting and instrument work; assistant engineer erection Royal York hotel; assistant resident engineer T. & N.O. Ry. const. Desires position in Toronto where combination of technical and business experience will be of value, as have been director and accountant last three years. Apply to Box No. 377-W.

ENGINEER, A.M.E.I.C. Age 30. Single. Employed. Civil and mining experience, capable of designing and superintending construction of timber, concrete and steel structures, rock crushing and ore plants. Would consider position with mining or engineering company designing and building mills. Apply to Box No. 431-W.

CIVIL ENGINEER, B.A.Sc. and C.E.; A.M.E.I.C., A.M. A.S.C.E., age 32, married. Experience over twelve years as assistant and resident engineer on the construction of hydro-electric, railway, and aerodrome works. Also office and teaching work on hydraulic designs and investigations, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

Situations Wanted

CIVIL ENGINEER, B.Sc. '25, A.M.E.I.C., P.E.Q., single, experienced in pulp and paper mill construction and hydro-electric developments; also experienced in highway construction and topographical surveying. Available at once, location immaterial. Apply to Box No. 473-W.

MECHANICAL ENGINEER, B.Sc. Age 31. Married. Last ten years includes:—Mechanical structural and reinforced concrete design in pulp and paper mills, industrial plants, hydro-electric, mine, sewers and sewage disposal plant construction. My experience also includes shop production, steam plant combustion, fuel analysing, inspecting, supervising and instrument work on industrial construction. Permanent position preferred. Apply to Box No. 521-W.

CONSTRUCTION ENGINEER, age 26, unmarried, graduate C.E. Experience includes hydro-electric, railroad, highway, and industrial plant construction, both field and office, including cost accounting, estimating, stores, layout, general engineering and supervision, as well as practical work in mechanical trades. Apply to Box No. 567-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aero-photographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

Employment Service Bureau

This bureau is maintained by The Engineering Institute of Canada for the benefit of members and organizations employing technically trained men.

An enquiry addressed to 2050 Mansfield Street, Montreal, will bring full information concerning the services offered. Details can also be obtained from Branch secretaries who are located in the larger centres throughout Canada.

Brief announcements of men available and positions vacant will be published without charge in The Engineering Journal and the Bulletin. Replies addressed in care of the required box number will be forwarded to the advertiser without delay.

An additional service also offered those who are unemployed or wish to change their positions, is the opportunity of placing their names and records on file at 2050 Mansfield Street for consideration by employers wishing to employ engineers. This is of great assistance as many employers will not advertise or wish to locate a suitable man on short notice. If desired the information contained in these records can be kept confidential.

Forms for registration purposes may be obtained from The Institute Headquarters or Branch secretaries.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

ELECTRICAL ENGINEER, McGill '31, desires permanent position in engineering field. Experience includes draughting, designing and testing of induction motors, radio supervision and test, and some construction. Available immediately. Apply to Box No. 626-W.

ELECTRICAL ENGINEER, B.Sc., 1926. One year maintenance, one year operating, large hydro-electric plant. Five years hydro-electric construction, as wireman and foreman, on relay, metal, and remote control installations. Also conduit and switches. Three years maintenance electrician, in pulp and paper mill. Also small power system. Desires position of responsibility. Sober, reliable and not afraid of work. Available at once. Excellent references. Apply to Box No. 636-W.

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office experience including general design and plant layout. Also two years general shop work including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer, estimator. Available on short notice. Apply to Box No. 676-W.

ELECTRICAL AND RADIO ENGINEER, B.Sc. '30. Variously engaged on receiver development work, testing, and transformer development, under direction. More recent experience includes transmitter test room procedure and short wave beam transmission engineering. For further information apply to Box No. 680-W.

Situations Wanted

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.Sc. Elec. '29, B.Sc. Civil '33 Jr.E.I.C. Age 29. Experience includes four months with Can. Gen. Elec. Co., approximately three years in engineering office of large electrical manufacturing company in Montreal, the last six months of which was spent as commercial engineer. For the last year and a half employed in electrical repair shop. Best of references. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.Sc., '27, Jr.E.I.C. Four years maintenance of high speed Diesel engine units, 200 to 1,300 h.p. Also maintenance of d.c. and a.c. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.Sc. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W

CIVIL ENGINEER, M.Sc., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering. Read, write and talk French. Married. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

RADIO AND ELECTRICAL ENGINEER, B.Sc. '31, S.E.I.C. Age 27. Experience in installation of power and lighting equipment. Temporary operator in radio station; studio experience with part time announcing. Two summers in switchboard and installation department of telephone company, eight months on extensive survey layouts. Interested in sales work of electrical or radio equipment. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, B.Sc. '29, A.M.E.I.C. Married. One year building construction. One year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

MANAFACTURERS' REPRESENTATIVE, at present doing business with leading industrial organizations in Canada, wishes to represent manufacturers of mechanical equipment. Such work as would involve technical data, and the preparation of plans where necessary, would be handled by an engineer whose experience with outstanding firms and projects, would be valuable to those seeking representation. Apply to Box No. 764-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ. '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

Situations Wanted

PLANT ENGINEER or SUPERINTENDENT, capable of supervising all phases of industrial plant operation, graduate electrical, eleven years diversified industrial experience including test course, four years on large Quebec industrial development, on construction and operation, also six years with prominent consulting firm supervising electrical and mechanical engineering projects. Age 31, single. Apply to Box No. 795-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. '32 (Univ. of N.B.). Age 25. Married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.Sc. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

SALES ENGINEER, A.M.E.I.C., graduate engineer, age 34, practical experience in the manufacture of power plant equipment, thoroughly conversant with Canadian power plant practice and equipment for the metal working industries. Available on short notice. Apply to Box No. 860-W.

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

AGENCIES WANTED. Young engineer, B.A.Sc. in C.E., with business and sales experiences, speaking fluent French, would consider representing a firm as agent for Montreal or the province of Quebec. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

Situations Wanted

CIVIL ENGINEER, B.Sc., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

CIVIL ENGINEER, B.Sc. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, S.E.I.C., B.Sc., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No. 1010-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.Sc. (Queen's, '14), A.M.E.I.C., Dominion Land Surveyor, 5 months special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply to Box No. 1035-W.

ENGINEER, Jr.E.I.C., E.E. '29, is very interested in applying electrical methods to cement testing and research work. Apply to Box No. 1062-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.Sc. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

CIVIL ENGINEER, B.Sc., Sask. '30. S.E.I.C. Age 24 years. Experience in municipal engineering, including sewer and water construction, sidewalk construction, paving, storm sewer design, draughting, precise levelling, and reinforced concrete bridge construction. Unmarried. Available at once. Will go anywhere. Apply to Box No. 1115-W.

ELECTRICAL ENGINEER, B.Sc.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

MECHANICAL ENGINEER, B.A.Sc. (Univ. of B.C. '29); M.Sc. Age 27. Single. Four years experience in research work in applied mechanics and materials testing. Desires position involving analytical work in design, development or testing. Available on short notice. Apply to Box No. 1023-W.

PETROLEUM CHEMIST, B.Sc. in Chem. Eng. Age 25. Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

ELECTRICAL ENGINEER, B.Sc., Queen's '33. Single, age 23. Anxious to gain experience. Present experience installing small private hydro-electric plant. Location immaterial. Available at once. Apply to Box No. 1137-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

Situations Wanted

CIVIL ENGINEER, B.A.Sc., S.E.I.C., age 26, single. Experience includes one year in bridge construction, plain and reinforced concrete, pneumatic caissons and surveying. Available at once. Any location. Apply to Box No. 1204-W.

PHYSICIST ENGINEER, B.Sc.Mech. (Queen's 1913), M.Sc., Ph.D.Physics (McGill 1929, '30). Experience in municipal engineering, producer gas installation and operation, university plant maintenance. Experienced teacher of college physics. Industrial and pure physical research experience. Age 42. Married. Apply to Box No. 1207-W.

MECHANICAL ENGINEER, B.Sc. (Queen's Univ. '28), age 36, married, desires position of trust and responsibility. Experience includes fitting and assembly of machine tools, production, draughting, and maintenance. Five years teaching draughting and mathematics. Available on reasonable notice. Location immaterial. Apply to Box No. 1210-W.

CIVIL ENGINEER, B.A., B.A.Sc., S.E.I.C., Canadian, age 27, single. Experience includes eighteen months in general building construction. Writes and speaks both French and English fluently. Available at once for any suitable position in general engineering. Apply to Box No. 1211-W.

CIVIL ENGINEER, B.Sc. '34 (Univ. of N.B.), age 24. Experience includes construction and highway engineering. Desires position with contracting or manufacturing firm. Interested in design. References. Will consider any location. Apply to Box No. 1214-W.

ENGINEER, with twenty years experience in industrial, pulp and paper mill, and general engineering and design. Age 41. Last five years chief engineer of paper mill making newsprint specialties and toilet tissues. Apply to Box No. 1246-W.

ELECTRICAL ENGINEER, B.Sc. '34 (Univ. of N.B.), S.E.I.C. Age 21, single. Desires any kind of electrical work. Will consider any location. Apply to Box No. 1262-W.

CIVIL ENGINEER, Univ. Toronto '33, age 24, married. One year as instrumentman with provincial department of highways. Experience in concrete and retread construction grading, culverts, etc. Also draughting, estimating and general office practice. Apply to Box No. 1265-W.

ELECTRICAL GRADUATE, S.E.I.C., B.Sc. '32, M.Sc. '34. Experience includes four years as part time operator and announcer for a radio broadcast station. At present employed in radio repair dept. of a large wholesale firm. Apply to Box No. 1283-W.

ELECTRICAL ENGINEER, B.Sc., E.E., A.M.E.I.C. University of Manitoba '28. Age 32. Married. Experience one year power line construction, five years resident and assistant district engineer on highway construction; two years highway traffic regulation in charge of district office. Good connections in Manitoba and Saskatchewan. Excellent references. Available at once and will go anywhere. Located in Winnipeg. Apply to Box No. 1316-W.

ENGINEER AND DRAUGHTSMAN, Jr.E.I.C., age 33, married. Diplomas from Mtl Tech. Inst. in R.C. and Structural Design. 11½ years experience in civil engineering, draughting and instrument work. This includes 7 years with M.L.H. & P. Cons. as field engineer on construction and maintenance of gas mains. Present location Montreal. Available at once. Apply to Box No. 1326-W.

GRADUATE ENGINEER, (McGill), in responsible charge of design, construction and operation of hydro-electric plants. Also power design and mechanical maintenance of industrial plants. Apply to Box No. 1328-W.

MECHANICAL ENGINEER, recent grad. University of Toronto, B.A.Sc. in mech. engrg, 24 years old, S.E.I.C., now managing a chain store, desires engineering work. Present location So. Ontario. Location immaterial. Best of references. Apply to Box No. 1348-W.

CIVIL ENGINEER, A.M.E.I.C. Married. Age 38. Twenty years experience in organization, design and estimating, and cost accounting. Active service in France. Apply to Box No. 1367-W.

ENGINEERING PHYSICIST, B.Sc., M.Sc. (McGill), S.E.I.C. Age 26. Single. Summer experience power house maintenance, draughting and general work in small shop. Interested in development and research in radio or electrical work requiring more advanced theoretical training than usual electrical degree. Apply to Box. No. 1387-W.

FIRE PROTECTION AND SAFETY ENGINEER, A.M.E.I.C., B.Sc. '24 (Mech. Engrg.). Age 33. Bilingual. Ten years experience with insurance underwriters inspection bureau covering phases of field work. Thoroughly familiar with insurance requirements. Position desired industrial or other concern maintaining self insurance or relative departments. Location Montreal or vicinity preferred. Apply to Box No. 1395-W.

THE ENGINEERING JOURNAL

THE JOURNAL OF THE ENGINEERING INSTITUTE OF CANADA

Published monthly at 2050 Mansfield Street, Montreal, by The Engineering Institute of Canada, Incorporated in 1887 as The Canadian Society of Civil Engineers.

Entered at the Post Office, Montreal, as Second Class Matter.

"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."

April, 1936 **Volume XIX, No. 4**

CONTENTS

Price 50 cents a copy, $3.00 a year, in Canada, British Possessions, United States and Mexico. $4.50 a year in Foreign Countries.
To Members and Affiliates, 25 cents a copy, $2.00 a year.

Published Monthly at 2050 Mansfield St., Montreal

THE ENGINEERING INSTITUTE OF CANADA

Incorporated in 1887 as The Canadian Society of Civil Engineers

BRANCHES:

Halifax Branch, Halifax, N.S.
Cape Breton Branch, Sydney, Cape Breton.
Moncton, Branch, Moncton, N.B.
Saint John Branch, Saint John, N.B.
Saguenay Branch, Kenogami, Que.
Quebec Branch, Quebec, Que.
St. Maurice Valley Branch, Three Rivers, Que.
Montreal Branch, Montreal, Que.
Ottawa Branch, Ottawa, Ont.
Kingston Branch, Kingston, Ont.
Peterborough Branch, Peterborough, Ont.
Toronto Branch, Toronto, Ont.
Hamilton Branch, Hamilton, Ont.
Niagara Peninsula Branch, Niagara Falls, Ont.
London Branch, London, Ont.
Border Cities Branch, Windsor, Ont.
Sault Ste. Marie Branch, Sault Ste. Marie, Ont.
Lakehead Branch, Port Arthur, Ont.
Winnipeg Branch, Winnipeg, Man.
Saskatchewan Branch, Regina, Sask.
Lethbridge Branch, Lethbridge, Alta.
Edmonton Branch, Edmonton, Alta.
Calgary Branch, Calgary, Alta.
Vancouver Branch, Vancouver, B.C.
Victoria Branch, Victoria, B.C.

Members of Council 1936

PRESIDENT
E. A. CLEVELAND, Vancouver, B.C.

VICE-PRESIDENTS
*E. V. CATON, Winnipeg, Man.
†R. L. DOBBIN, Peterborough, Ont.
†H. W. McKIEL, Sackville, N.B.
†A. B. NORMANDIN, Quebec, Que.
*P. L. PRATLEY, Montreal, Que.

PAST-PRESIDENTS
F. A. GABY, Toronto, Ont.
O. O. LEFEBVRE, Montreal, Que.
F. P. SHEARWOOD, Montreal, Que.

COUNCILLORS
*C. G. R. ARMSTRONG, Windsor, Ont.
†Y. C. BARRINGTON, Sydney Mines, N.S.
*C. B. BROWN, Montreal, Que.
†G. S. BROWN, Lethbridge, Alta.
*G. H. BURBIDGE, Port Arthur, Ont.
†H. CIMON, Quebec, Que.
*A. COUSINEAU, Montreal, Que.
†A. B. CREALOCK, Toronto, Ont.
†T. H. DICKSON, Moncton, N.B.
†A. FRIGON, Montreal, Que.
†A. B. GATES, Peterborough, Ont.
*L. F. GOODWIN, Kingston, Ont.
*B. GRANDMONT, Three Rivers, Que.
†A. K. HAY, Ottawa, Ont.
‡F. S. B. HEWARD, Montreal, Que.
*G. H. KIRBY, Riverbend, Que.
*H. S. JOHNSTON, Halifax, N.S.
†T. C. MAIN, Winnipeg, Man.
†E. P. MUNTZ, Hamilton, Ont.
†E. P. MURPHY, Port Colborne, Ont.
†H. J. McLEAN, Calgary, Alta.
‡F. NEWELL, Montreal, Que.
†E. A. RYAN, Montreal, Que.
†F. SMALLWOOD, Sault Ste Marie, Ont.
*R. E. SMYTHE, Toronto, Ont.
*E. W. STEDMAN, Ottawa, Ont.
†H. L. SWAN, Victoria, B.C.
*J. A. VANCE, Woodstock, Ont.
*G. A. VANDERVOORT, Saint John, N.B.
*H. R. WEBB, Edmonton, Alta.
*A. S. WOOTTON, Vancouver, B.C.
*S. YOUNG, Regina, Sask.

*For 1936
†For 1936-37
‡For 1936-37-38

TREASURER
J. B. CHALLIES, Montreal, Que.

SECRETARY
R. J. DURLEY, Montreal, Que.

OFFICERS OF BRANCHES

HALIFAX
Chairman, C. S. BENNETT
Vice-Chair., C. SCRYMGEOUR
Sec.-Treas., R. R. MURRAY, 87 Cambridge St., Halifax, N.S.
Executive, J. R. KAYE, I. P. MACNAB, J. D. FRASER, J. F. F. MACKENZIE, W. H. NOONAN, J. W. McLEOD, J. B. HAYES
(Ex-Officio) H. FELLOWS, H. S. JOHNSTON

CAPE BRETON
Chairman, W. E. BOWN
Sec.-Treas., SYDNEY C. MIFFLEN, 60 Whitney Ave., Sydney, N.S.
Executive, M. R. CHAPPELL, W. S. WILSON, C. M. ANSON, W. E. CLARKE
(Ex-Officio) Y. C. BARRINGTON

SAINT JOHN
Chairman, V. S. CHESNUT
Vice-Chair., J. R. FREEMAN
Sec.-Treas., F. A. PATRIQUEN, 19 Horsfield St., Saint John, N.B.
Executive, S. HOGG, C. S. MACLEAN, G. H. THURBER
(Ex-Officio) E. J. OWENS, G. A. VANDERVOORT

MONCTON
Chairman, H. B. TITUS
Vice-Chair., G. L. DICKSON
Sec.-Treas., V. C. BLACKETT, Engrg. Dept., C.N.R., Moncton, N.B.
Executive, F. O. CONDON, JAS. PULLAR, T. H. DICKSON, C. S. G. ROGERS, A. S. GUNN, G. C. TORRENS
(Ex-Officio) H. W. McKIEL, J. G. MACKINNON

SAGUENAY
Chairman, J. SHANLY
Vice-Chair., S. J. FISHER
Sec.-Treas., L. R. BEATH, P.O. Box 211, Kenogami, Que.
Executive, W. L. YACK, E. LAVOIE, H. B. PELLETIER, M. G. SAUNDERS
(Ex-Officio) G. E. LAMOTHE, J. W. WARD, G. H. KIRBY

QUEBEC
Hon. Chair., A. R. DECARY
Chairman, ALEX. LARIVIERE
Vice-Chair., J. T. F. KING
Sec.-Treas., J. JOYAL, Quebec Public Service Comm., Court House, Quebec, Que.
Executive, R. B. McDUNNOUGH, L. P. METHE, L. BEAUDRY, A. G. SABOURIN, J. G. O'DONNELL, A. ROBERGE
(Ex-Officio) A. B. NORMANDIN, HECTOR CIMON

ST. MAURICE VALLEY
Chairman, B. GRANDMONT
Vice-Chair., J. E. FLEURY
Sec.-Treas., J. A. HAMEL, 642 Notre Dame St., Three Rivers, Que.
Executive, F. W. BRADSHAW, C. L. ARCAND, H. J. WARD

MONTREAL
Chairman, J. B. D'AETH
Vice-Chair., H. MASSUE
Sec.-Treas., C. K. McLEOD, 1440 St. Catherine St. W., Montreal, Que.
Executive, R. H. FINDLAY, C. C. LINDSAY, B. R. PERRY, T. C. THOMPSON, J. A. LALONDE, J. A. E. GOHIER
(Ex-Officio) F. S. B. HEWARD, A. COUSINEAU, C. B. BROWN, P. L. PRATLEY, O. O. LEFEBVRE, E. A. RYAN, F. NEWELL, A. FRIGON, F. P. SHEARWOOD

OTTAWA
Chairman, E. VIENS
Sec.-Treas., F. C. C. LYNCH, Dept. of Mines, Victoria Memorial Museum, Ottawa, Ont.
Executive, E. M. DENNIS, T. A. McELHANNEY, N. B. MACROSTIE, G. R. TURNER, B. F. HAANEL
(Ex-Officio) E. W. STEDMAN, R. W. BOYLE, A. K. HAY

PETERBOROUGH
Chairman, A. L. DICKIESON
Sec.-Treas., W. T. FANJOY, 223 Crescent St., Peterborough, Ont.
Executive, V. R. CURRIE, A. L. KILLALY, E. J. DAVIES, E. R. SHIRLEY
(Ex-Officio) J. W. PIERCE, H. R. SILLS, R. L. DOBBIN, A. B. GATES

KINGSTON
Chairman, R. A. LOW
Vice-Chair., Lt.-Col. N. C. SHERMAN
Sec.-Treas., Major L. F. GRANT, Royal Military College, Kingston, Ont.
Executive, G. G. CARR-HARRIS, S. STEPHENSON, J. E. GOODMAN
(Ex-Officio) W. CASEY, L. F. GOODWIN

TORONTO
Chairman, W. E. BONN
Vice-Chair., O. HOLDEN
Sec.-Treas., W. S. WILSON, Mining Bldg., University of Toronto, Toronto, Ont.
Executive, N. MACNICOL, W. G. CHACE, A. M. REID, J. M. OXLEY, C. E. SISSON, A. U. SANDERSON
(Ex-Officio) R. E. SMYTHE, A. B. CREALOCK

HAMILTON
Chairman, W. HOLLINGWORTH
Vice-Chair., E. G. MACKAY
Sec.-Treas., A. LOVE, 40 Paisley Ave. S., Hamilton, Ont.
Executive, W. J. W. REID, A. R. HANNAFORD, V. S. THOMPSON, D. W. CALLANDER
(Ex-Officio) E. P. MUNTZ

LONDON
Chairman, JAS. FERGUSON
Vice-Chair., A. O. WOLFF
Sec.-Treas., D. S. SCRYMGEOUR, London Structural Steel Co. Ltd., London, Ont.
Executive, E. V. BUCHANAN, W. C. MILLER, H. A. BRAZIER, H. A. McKAY
(Ex-Officio) S. W. ARCHIBALD, S. G. JOHRE, J. A. VANCE

NIAGARA PENINSULA
Chairman, P. E. BUSS
Vice-Chair., G. H. WOOD
Sec.-Treas., P. A. DEWEY, 1224 Ontario Ave., Niagara Falls, Ont.
Executive, C. G. MOON, E. P. MURPHY, C. W. WEST, C. S. BOYD, S. HAIRSINE, J. H. JACKSON, J. C. STREET, L. C. McMURTRY, H. WELLWOOD
(Ex-Officio) W. R. MANOCK

BORDER CITIES
Chairman, T. H. JENKINS
Vice-Chair., C. F. DAVISON
Sec.-Treas., BOYD CANDLISH, 170 Rankin Blvd., Sandwich, Ont.
Executive, E. M. KREBSER, D. T. ALEXANDER, C. G. WALTON
(Ex-Officio) C. G. R. ARMSTRONG, H. J. COULTER

SAULT STE. MARIE
Chairman, J. L. LANG
Vice-Chair., W. SEYMOUR
Sec.-Treas., N. C. COWIE, 15 Hearst St., Sault Ste. Marie, Ont.
Executive, H. O. BROWN, C. W. HOLMAN, T. FOULKES, H. W. SUTCLIFFE
(Ex-Officio) F. SMALLWOOD, A. E. PICKERING

LAKEHEAD
Chairman, R. J. ASKIN
Vice-Chair., F. C. GRAHAM
Sec.-Treas., G. R. McLENNAN, 80 High St., North, Port Arthur, Ont.
Executive, H. G. O'LEARY, K. A. DUNPHY, G. R. DUNCAN, G. ERICKSEN
(Ex-Officio) G. H. BURBIDGE, GEO. P. BROPHY

WINNIPEG
Chairman, G. E. COLE
Vice-Chair., A. E. MACDONALD
Sec.-Treas., J. F. CUNNINGHAM, 918 Somerset Ave., Fort Garry, Man.
Executive, F. W. ALEXANDER, H. L. BRIGGS, W. D. HURST, R. W. McKINNON, W. F. RIDDELL
(Ex-Officio) E. V. CATON, F. V. SEIBERT, T. C. MAIN

SASKATCHEWAN
Chairman, W. E. LOVELL
Vice-Chair., STEWART YOUNG
Sec.-Treas., R. J. FYFE, 618 Broder Bldg., Regina, Sask.
Executive, A. R. GREIG, J. W. D. FARRELL, J. McD. PATTON, H. S. CARPENTER, H. J. BYRD, S. R. MUIRHEAD
(Ex-Officio) A. P. LINTON

LETHBRIDGE
Chairman, W. L. McKENZIE
Vice-Chair., J. M. CAMPBELL
Sec.-Treas., E. A. LAWRENCE, 207-7th St. S., Lethbridge, Alta.
Executive, G. S. BROWN, R. F. P. BOWMAN, J. HAIMES
(Ex-Officio) C. S. DONALDSON, J. B. DEHART

EDMONTON
Chairman, E. STANSFIELD
Vice-Chair., A. RITCHIE
Sec.-Treas., M. L. GALE, 9914-111 St., Edmonton Alta.
Executive, J. D. BAKER, W. E. CORNISH, C. E. GARNETT, A. J. GAYFER, E. NELSON
(Ex-Officio) F. K. BEACH, H. R. WEBB

CALGARY
Chairman, JOHN DOW
Vice-Chair., H. W. TOOKER
Sec.-Treas., JAS. McMILLAN, 506 Insurance Exchange Bldg., Calgary, Alta.
Executive, J. J. HANNA, W. T. McFARLANE, H. J. McEWEN
(Ex-Officio) J. HADDIN, F. M. STEEL, H. J. McLEAN

VANCOUVER
Chairman, JAS. ROBERTSON
Vice-Chair., H. N. MACPHERSON
Sec.-Treas., T. V. BERRY, 3007-36th Ave. W., Vancouver, B.C.
Executive, E. C. THRUPP, P. SANDWELL, G. L. BOOKER, J. P. MACKENZIE, P. H. BUCHAN, C. P. HAMILTON, F. O. MILLS
(Ex-Officio) G. M. GILBERT, E. A. CLEVELAND, A. S. WOOTTON

VICTORIA
Chairman, I. C. BARLTROP
Vice-Chair., J. C. MACDONALD
Sec.-Treas., KENNETH REID, 1336 Carnsew St., Victoria, B.C.
Executive, G. M. DUNCAN, G. M. IRWIN, G. M. TRIPP, C. D. SCHULTZ
(Ex-Officio) D. MACBRIDE, H. L. SWAN

THE ENGINEERING JOURNAL

THE INSTITUTE as a body is not responsible either for the statements made
or for the opinions expressed in the following pages.

VOLUME XIX | MONTREAL, APRIL, 1936 | NUMBER 4

45,000 Kv.a. Vertical Shaft Frequency Changer

Description of Construction and Installation of Set Installed at Chats Falls

The late H. U. Hart, M.E.I.C., Vice-President and Chief Engineer,
and R. E. Day, Engineer, Canadian Westinghouse Company, Limited, Hamilton, Ontario.

Paper presented before the General Professional Meeting of The Engineering Institute of Canada, at Hamilton, Ontario, on March 7th, 1936.

SUMMARY.—A description of the largest vertical-shaft frequency changer yet built, consisting of a 45,000 kv.a. 13,200-volt, 60-cycle generator, and a 61,600-h.p. 25-cycle synchronous motor with the required accessories. Particulars are given as to welded construction, means for avoiding corona loss in the windings, arrangements to facilitate erection and starting efficiency, the transformer, the alterations in switching equipment and other important features.

Hydro electric energy is a phrase quite common in Canada. In fact it has become a custom to associate the name of hydro with the many blessings which have resulted from labour-saving devices and with the innumerable appliances which are responsible in no small measure for the luxury which this generation enjoys. Few, however, appreciate the problems of the pioneers whose untiring efforts to develop electrical energy from water power have made possible the huge power systems now in evidence in many of the provinces of this Dominion. Among the most vexing of their many problems was the determination of the most suitable frequency at which alternating current electrical energy should be developed. In these early times, the art of transmission progressed in such a manner that now it is necessary to face present conditions of power development of different frequencies, isolated at the time of their inception, growing to such size and extent that the territories served by each now overlap and present economic conditions make it very desirable for an interchange of energy between the two systems.

Such conditions are responsible for the conception of that form of electrical equipment spoken of as frequency changers, and this paper is devoted to the description of the construction and installation of the largest vertical shaft frequency changer set yet built, which was recently placed in service by the Hydro Electric Power Commission of Ontario to convert 25-cycle power, normally generated for their Niagara system, to 60-cycle energy for consumption by their Eastern Ontario system.

This set consists of a 45,000 kv.a, 100 per cent power factor, 13,200-volt, 3-phase, 60-cycle, generator driven by a 61,600 h.p., 100 per cent power factor, 13,200-volt, 3-phase, 25-cycle, 300 r.p.m. synchronous motor, and is installed in an extension of the Chats Falls generating station (see Fig. 1). The 25-cycle end of the set is connected normally to No. 2 and No. 3 generators in this station and the 60-cycle end supplies power to the Eastern Ontario system of the Commission. The set can, however, operate either way, both the 25-cycle and the 60-cycle end having been provided with a starting winding.

GENERAL DESCRIPTION

The complete unit has an over-all outside diameter of 19 feet 13 inches and is made up of two frames with a spacer between, an upper bracket with a Kingsbury thrust bearing and a guide bearing, an intermediate bracket in which is located the middle guide bearing and a lower bracket carrying the lower guide bearing. The height of the set above the pit floor is 40 feet 9 inches and its total weight is 560 tons. Figures 2 and 3 show general views,

Fig. 1—Exterior View of the Chats Falls Power Station.

and Fig. 4 a vertical cross section of the unit. The 60-cycle machine with the larger bore is mounted on top of the 25-cycle machine to facilitate erection and dismantling. The two rotors with a total weight of 240 tons are mounted on a common shaft weighing 20 tons and the total weight of the rotating part is carried by the Kingsbury thrust bearing mounted in the upper bracket. The total flywheel effect of the two rotors is approximately 11,000,000 pounds at one foot radius. The rotors have been designed for a maximum speed of 375 r.p.m. which is 125 per cent of normal.

Ventilation

Heat from the windings and the steel punching of the magnetic circuits is taken care of by a comprehensive ventilating system handling approximately 150,000 cubic feet of air every minute. The design of this ventilating system is of major importance, as it is imperative that the

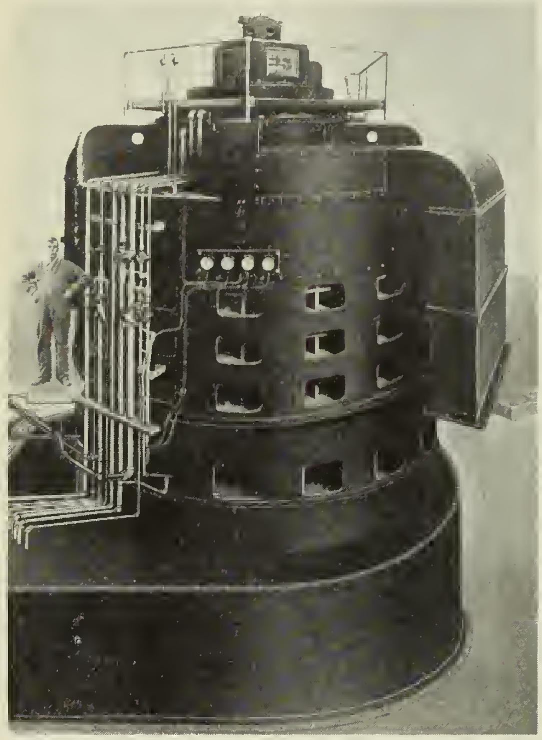


Fig. 2—Composite View of Unit.

temperature of all working parts of the complete machine, under all conditions, be kept within safe operating limits. Elaborate provision had to be made in the building as well as in the machine itself to handle such large quantities of cooling air and extreme care had to be exercised in the design of the duct system within the machines so that an adequate supply of cooling air could reach every part where heat might be generated. The rotors of the set furnish the energy to circulate the cooling air. Four blowers, one mounted on each side of each rotor, and specially designed to supply the required volume of air to each machine, perform this function. Ducts in the foundation of the building assure the basement of a continuous supply of cooling air from the outside. The blowers draw this fresh cool air from the basement through ducts to openings in the frame spacer, in the lower part of the frame of the 25-cycle motor and in the upper part of the frame of the 60-cycle generator. Inside the machine the air is forced between the poles and through the ventilating ducts in the stator cores. The heated air from the 60-cycle generator is discharged through the frame openings directly into the power house while that from the 25-cycle motor, on account of its location in the pit below the floor level, is conducted through a steel air casing to louvres in the power house wall from which it is discharged to the outside air.

Detail Description

Stator Frames

According to specifications the weight of the upper stator and brackets together with that of the whole rotating part of the set had to be carried by the lower frame, so that possible vibrations would not be transmitted to the intermediate floor. In order to secure greater rigidity the same outside diameter was adopted for both stator frames. Each frame is designed to carry its own armature core and windings, and is entirely of fabricated steel construction, being made from rolled steel plates, cut to the proper shape and size and electrically welded together. Both frames, as well as the frame spacer between them, consist of an outer shell inside of which are welded a number of vertical ribs and annular rings. The ribs take care of the vertical load while the rings and shell take care of the electrical torques. Endplates of heavier cross section at the top and bottom of each frame serve as supports for the armature core. The top endplate is composed of two concentric rings, the inner one being used as a clamping plate for the core. Each frame is divided in three sections to facilitate handling and transportation. In order to avoid joints dividing the core into three parts, the magnetic steel for both stators was stacked after the frames had been installed in the power house. To reduce the core losses the armature cores are made of high grade silicon sheet steel punchings. The bolts on which these are assembled pass through the frame endplates and are welded to the inner edges of the annular frame rings. The tie bolts are tightened up to clamp the laminations firmly together. A large number of air ducts are provided, using angle spacers as ventilating fingers. In addition to these ventilating ducts a one-inch duct is provided in the centre to facilitate the removal of the armature coils.

Armature Coils

The armature coils are of the conventional diamond shape type (see Fig. 5). They are insulated from ground with a wrapper of micarta folium on the straight parts which are embedded in the core slots and with mica tape and a final layer of varnished cloth on the extremities which project each end beyond the iron of the core. In order to preserve the flexibility of the ends this cloth is applied in the form of tape and is sealed by applications of insulating compound to exclude the possibility of dirt and oil finding their way between the layers. This type of coil insulation has successfully withstood a dielectric test to ground of 27,400 volts for one minute. Each coil of the 25-cycle

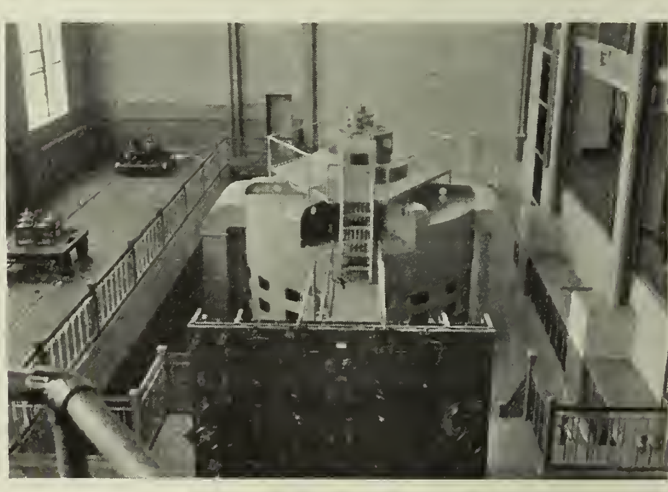


Fig. 3—General View of Unit in Power Station.

machine consists of two turns, the total copper for each turn being made up of twenty-four strands of wire. Likewise the coils of the 60-cycle machine are composed of five turns each made up of eight strands of wire. Every other strand is wrapped with mica tape in order to insulate each from any other. This procedure materially reduces the eddy current loss which would assume large proportions were the turns to consist of solid copper wire or strands not insulated from each other. In order to obtain a further reduction of losses the windings have been transposed once per coil throughout in both group and series connections. To eliminate the static discharge through air spaces between the coil insulation and the core iron which is known as corona, a novel form of slot insulation has been employed. The straight parts of the finished coils were wrapped with asbestos tape coated with a layer of graphite and then steam pressed. This coating gives the coil a semi-conducting surface which, being in direct contact with the iron, assumes

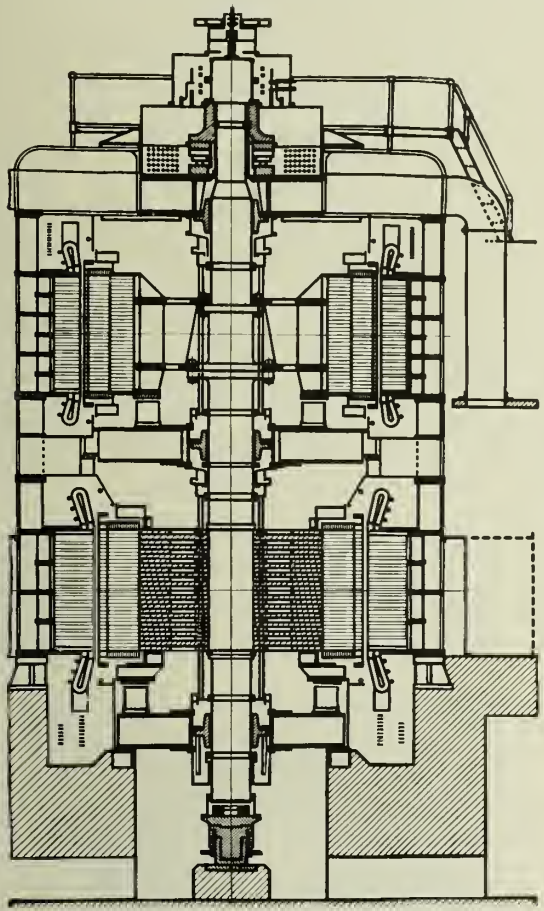


Fig. 4—Cross Section of Frequency Changer Unit.

the same potential therewith. Consequently, there can be no static discharge between any part of the coil surface and the core iron. The method of applying the asbestos tape and the subsequent steam pressing operation eliminate all voids and air pockets between the coil insulation and the graphite coated asbestos tape, thereby removing any possibility of static discharge between these parts. Consequently, coils equipped with this type of slot insulation are free from corona.

To prevent distortion of the coil ends under stresses present with short circuit conditions, they are firmly supported by insulated bronze rings braced against brackets which in turn are bolted to the stator end plates. Additional strength is secured by wooden spacer blocks tied in between the coil ends. Exploring coils for determining the temperature of the windings under operating conditions are embedded in the windings between the upper and lower coils in the centre of the core.

Bearing Brackets

Each of the three bearing brackets consists of six radial arms of I-beam section, clamped and keyed, or welded between two horizontal annular rings which support the bearing housing.

The upper bracket which weighs 17½ tons has a 19-foot 3-inch span and arms 36 inches deep and 16 inches wide. It supports the thrust bearing and upper guide bearing and is designed to carry the complete rotating unit of 270 tons weight with a calculated deflection of not more than $\frac{1}{16}$ inch. The six radial arms are bolted and keyed between the two horizontal supporting rings so that they may be removed for the shipment of the bracket.

The middle and lower brackets support their respective guide bearings and three air-operated brakes. The brakes are not intended to support the weight of the rotor during servicing operation, other provision being made for this purpose. The radial arms are of 18-inch deep sections welded between the two housing supporting rings. Each bracket will pass through the stator bores into position, the lower bracket before the shaft and lower rotor are dropped into place, while the middle bracket is designed to pass over the flanges on the shaft into its position in the frame spacer.

The bearing housing of the lower bracket is welded integral with the bracket, while that of the middle bracket is fitted into place between its supporting rings after the bracket has been lowered into position. A key ring is fitted around the shaft just below the middle bearing, so that the whole bracket, bearing and housing may be lifted together with the shaft and lower rotor during servicing operations, instead of each being dismantled separately.

Rotors

The two rotors are mounted on a common shaft (see Fig. 6), the 25-cycle rotor with the smaller diameter weighing approximately 130 tons being at the lower end. It consists of a plate steel spider shrunk and keyed on the shaft, having ten field poles dovetailed into it, and secured by tapered keys driven in between the pole dovetails and the corresponding slots in the spider. The poles are built up of laminations tightly clamped together between end-plates by suitable rivets. The field coils are made up of copper strap 3⅜ inches wide wound on edge. The insulation between turns consists of two layers of asbestos and the coils are insulated from the poles by mica and asbestos. Spring supports located between the poles and biased

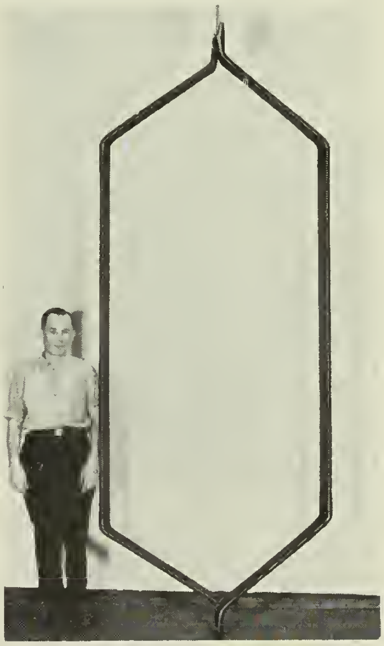


Fig. 5—Stator Coil of the 25-Cycle Motor.

against the coils, maintain sufficient pressure to keep them tight on the poles and take up any shrinkage in service.

The 60-cycle rotor with the larger diameter, weighing about 110 tons, is located at the upper end of the shaft. It consists of twenty-four poles dovetailed into a laminated rim which in turn is supported on a fabricated spider.

The laminated rim is built up of a large number of thin, high strength, steel plates tightly clamped together by means of through bolts, and is shrunk on to the spider with a predetermined fit in order that it will be tight on the spider until the overspeed is reached when it will float freely. The spider therefore serves only to transmit the torque and to support the rim and the poles, and is not subject to any centrifugal stresses other than those due to its own mass. Accordingly the stresses in the rotor can be definitely determined.

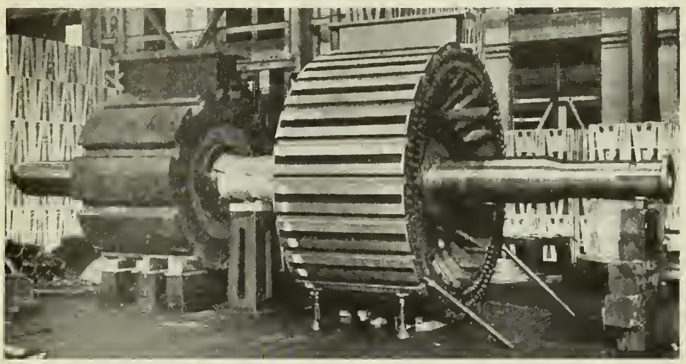


Fig. 6—Spiders of 25-Cycle Motor, and 60-Cycle Generator, mounted on Common Shaft, during Manufacture.

The 60-cycle spider is of fabricated construction consisting of two substantial steel discs spaced apart by means of webs and the bars in which the torque-carrying keys between the rim and the spider fit. The inner portions of the two spider discs are clamped by means of taper-fitted bolts to two flanges forged integral with the shaft, which bolts also serve to transmit the torque between the spider and the shaft. The reason for mounting the 60-cycle spider on the shaft in this manner, rather than the more conventional method of shrinking and keying, is that the crane capacity at the operating station is not sufficient to handle the weight of the two rotors and shaft together. Consequently the upper rotor has to be mounted on the shaft after the lower rotor and shaft have been lowered into position. For servicing, these operations are reversed.

Both sections of the rotor are designed so that when running at an overspeed of 375 r.p.m. the stresses in any part will not exceed one-half of the elastic limit of the material. The corresponding stresses at normal speed are a little less than two-thirds that of the overspeed values, so that during operation the stresses are less than one-third of the elastic limit of the materials, which condition is quite conservative.

Shaft

As already mentioned, the two rotors are mounted on one common shaft. This shaft has a diameter of 24 inches between the two rotors and 22 inches on either side. Under normal operating conditions the stresses do not exceed 13 per cent of the elastic limit and are slightly over 6.5 per cent of the ultimate strength of the material. The weight of the complete rotating element is carried by a cast steel thrust collar attached to the upper end of the shaft by means of a ring key.

Brakes and Jacks

The three air-operated brakes on each of the middle and lower brackets bear uniformly on segmental nickel steel tracks on each rotor and are designed to bring the rotors to rest from normal speed in approximately five minutes.

A 12-inch diameter hydraulic jack operating on the lower end of the shaft has been installed for lifting the rotating parts off the thrust bearing in order to allow a film of oil to flood the thrust bearing shoes when starting up the set from rest. A spherically seated roller thrust bearing is mounted on top of the jack ram for the shaft to rotate upon for a revolution or two when the rotor begins to move. Immediately motion has commenced, the release valve of the jack is opened either by hand or electrically, allowing the ram to descend and to lower the rotor upon the thrust bearing located in the upper bracket. The jack can be operated either by a hand pump or by a motor-driven pump. A mechanical device is fitted to the jack to definitely limit the lift of the ram, and a lock-nut is provided to support the ram in an elevated position while assembling or dismantling parts of the upper thrust bearing. This single central jack was preferred to the alternative of piping oil under high pressure to each of the six shoes of the thrust bearing in order to flood them when starting from rest, and of using the air brakes as hydraulic jacks for servicing purposes. The jack is oil-operated under a working pressure of approximately 5,000 pounds per square inch.

Thrust Bearing

The complete rotor is carried by means of the thrust collar at the upper end of the shaft, upon a thrust bearing mounted in the upper bracket (see Fig. 7). This thrust bearing is of the Kingsbury segmental shoe type, each shoe being pivoted on a jack screw which may be adjusted to equalize the pressure on all six shoes. The bearing is 46 inches in diameter and has a rated capacity amply sufficient to carry the weight of the rotating element. A thermometer bulb is located in the path of the hot oil as it leaves the bearing and electrical contacts associated with the thermometer operate a bell alarm should the temperature of the oil exceed a predetermined value.

Guide Bearings

The guide bearings are of the conventional babbit-lined sleeve type and are designed so that they can be removed if necessary, without disturbing the bearing housings and brackets. Owing to the high rubbing speeds of the shaft in these bearings, coils are embedded in the babbit through

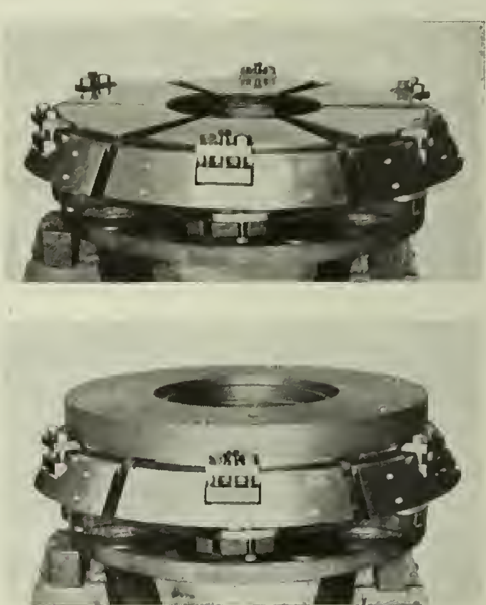


Fig. 7—Kingsbury Thrust Bearing.
Top—Without Runnerplate. Bottom—With Runnerplate.

which cooling water is circulated to carry away the excess heat and keep the bearing temperatures within safe operating limits. As a check on this cooling system, each bearing is equipped with a thermometer having electrical contacts and in the case of excessive temperature rise the contacts close and operate a bell alarm.

Lubrication

A self-contained system is provided for the lubrication of the thrust and guide bearings. Oil is drawn from a reservoir by one of two duplicate motor-driven pumps, and pumped to the thrust bearing housing and to each of the three guide bearings through flow sights. After passing through the guide bearings, the oil drains through a series of guides, catchers and pipes into an oil pan below the lower guide bearing. From there it flows back to the reservoir where it is joined by the oil overflow from the thrust bearing housing. A Pressuretrol with electrical contacts is located on the main oil feed line and in the event of the oil pump or its motor failing, the contacts operate a bell

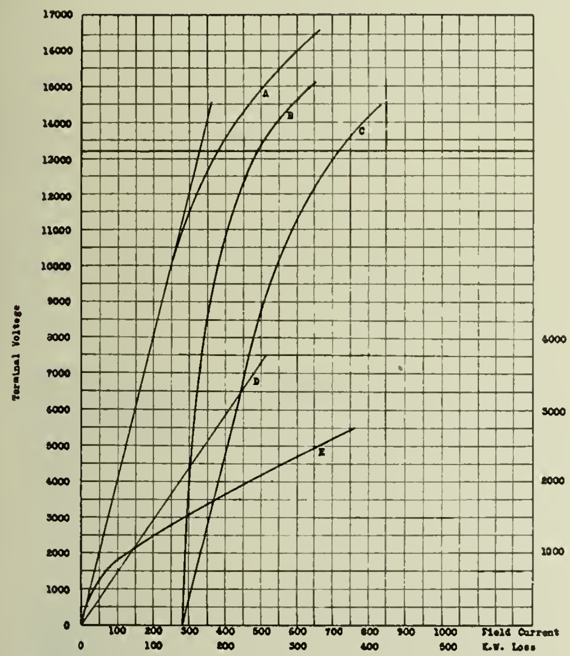


Fig. 8—Saturation Curves of the 25-Cycle Motor.
***A*—No load saturation.**
***B*—2,050 amp., 100 per cent P.F. leading saturation.**
***C*—2,050 amp., 0 per cent P.F. leading saturation.**
***D*—Short circuit saturation.**
***E*—Short circuit loss.**

alarm and a throw-over switch, which starts up the standby pump, the motor of which is connected to a separate source of power supply.

The thrust bearing is submerged in a bath of 350 gallons of oil and circulation is effected by the centrifugal pumping action of the rotating parts of the bearing. An oil retainer prevents any oil running down the shaft from the thrust bearing housing. The oil in the bath is kept to a predetermined temperature by means of cooling coils immersed therein and through which cold water is circulated. A Pressuretrol is located on the main cooling water feed line to the bearings and electrical contacts operate a bell alarm in case of pressure drop.

Fire Extinguishing System

Each machine is provided with a separate non-automatic fire extinguishing water supply system. The nozzles are trained directly on the armature windings and connections. Facilities for attaching supply hose are provided in convenient locations on the pipe lines outside the stator frames.

Staircase and Platform

A staircase leads to a platform mounted around and above the upper bracket for the purpose of providing access to the field lead collector rings and brush rigging, also to the synchronizing commutator and its brush rigging and the two speed limiting switches which are mounted around a stub shaft above the collector support.

No frame shift has been provided for on this set but in the event of a second set being built to synchronize therewith, such provision will probably have to be made, although the rotors and poles of the present set have been very carefully lined up in order that synchronism with a duplicate set may be the more readily obtained.

Electrical Characteristics

Separate loss tests were made in the power station to determine the efficiency of the set described. The efficiency calculated according to A.I.E.E. rules, based on the measured losses are 98.54 for the 25-cycle motor and 98.49 for the 60-cycle generator, or over 97 per cent for the set at full load, 96.6 per cent at ¾ load and 95.7 per cent at ½ load.

Figures 8 and 9 show the saturation curves and the short-circuit loss of the 25-cycle motor and the 60-cycle generator as obtained partly from test and partly from calculation.

Excitation

The excitation for the above machines is obtained from a separate three-unit, four-bearing motor generator set (see Fig. 10), consisting of two 200 kw., 250-volt shunt-wound d.c. generators driven by a 600-h.p., 3-phase, 550 volt, 25-cycle, 750-r.p.m. squirrel cage motor, mounted on a common bedplate. The excitation for the d.c. generators is furnished by a 10 kw., 250-volt pilot exciter, directly connected to one end of the shaft. No special high speed of response was required in the main exciter. The calculated speed of response is approximately 200 volts per second. The 600 h.p. motor is started on reduced voltage. This voltage is obtained from an auto transformer mounted in a metal-clad structure together with the magnetizing starting and running breakers. Transfer from start to run is automatic after a definite time.

Switching Equipment

The original Chats Falls plant consisted of eight generators of 23,000 kv.a. capacity feeding in pairs to four

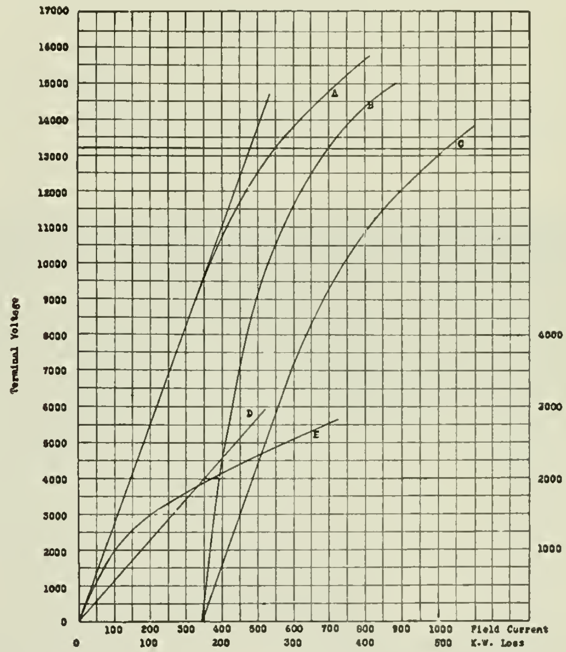


Fig. 9—Saturation Curves of 60-Cycle Generator.
***A*—No load saturation.**
***B*—1,965 amp., 100 per cent P.F. lagging saturation.**
***C*—1,965 amp., 0 per cent P.F. lagging saturation.**
***D*—Short circuit saturation.**
***E*—Short circuit loss.**

47,500 kv.a. banks of transformers, which in turn fed the 220 kv. 25-cycle system. The switching for these units consisted of a 15 kv., 1,500-ampere oil circuit breaker (CH-3A) for each generator feeding a common bus to which was connected the low-tension side of the transformer bank.

For the frequency changer set, existing generators 2 and 3 were utilized and to connect the frequency changer to these two generators it was necessary to break into the metal-clad structure for these generators and to install a 2,400-ampere motor-operated oil disconnecting switch directly behind the old structure (see Fig. 11). The line side of this disconnecting switch feeds the low tension of the 25-cycle, 220 kv. transformer bank. From the bus side

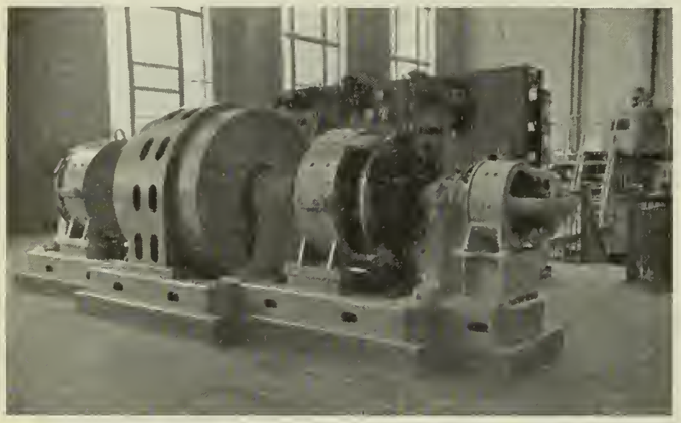


Fig. 10—Motor Generator Set for Excitation.

terminals of this disconnecting switch a metal-clad bus 54 feet long connects to a similar motor operated disconnecting switch which supplies the 25-cycle motor of the frequency changer set.

These two disconnecting switches are electrically interlocked so that neither can be closed unless the other is open. That is, generators 2 and 3 can be used to feed either the frequency changer or the 25-cycle 220 kv. transformer bank but not both simultaneously.

In order to provide flexibility of operation, a new metal-clad breaker was connected between generator No. 3 and the 25-cycle, 220 kv. transformer bank. This breaker is electrically interlocked with the existing breaker for generator No. 3 so that generator No. 3 may feed either the frequency changer or the 25-cycle 220 kv. transformer

Fig. 11—Metal Clad Switching Equipment for the Frequency Changer Set and Generators Nos. 2 and 3.

bank, independently of No. 2 generator, but not both simultaneously. That is, it is possible to connect generator No. 2 to the frequency changer and generator No. 3 to the transformer bank or both machines in parallel to either load. No provision is made in the present switching layout to feed the low tension of the 220 kv. 25-cycle transformer bank from the frequency changer set.

Transformer

The 60-cycle generator of the frequency changer supplies a 3-phase, 45,000 kv.a. transformer (see Fig. 12), through a 15 kv., 3,000-ampere type CH-3-A metal-clad oil circuit breaker.

This transformer embodies the shell-type construction with surge-proof insulation, the H.V. insulation and bushings being co-ordinated with a 38¼-inch protective gap. Graded insulation suitable for an induced test of 3.46 times normal voltage is used on the H.V. windings which are star-connected for positively grounded neutral operation. The normal voltage of the H.V. windings is 121,000 and there are full capacity taps for 127,000 and 115,000 volts. The L.V. windings are delta-connected for the application of 13,200 volts. Suitable starting taps have been arranged on the L.V. windings in the event of it being necessary in future to start the frequency changer set from the 60-cycle system.

The windings consist of interlaced groups of flat rectangular coils having paper-insulated sub-divided conductors. High grade fullerboard washers, channels, angles, etc., are placed between adjacent coils, adjacent groups and between windings and ground, in such a manner that the

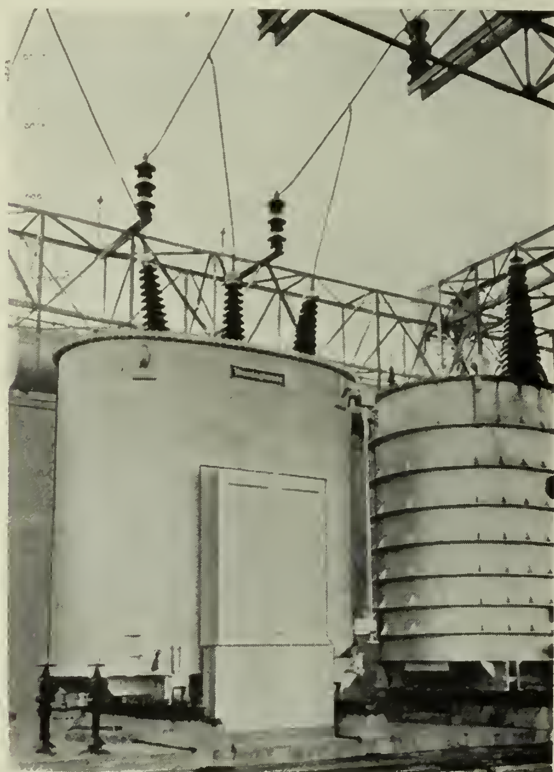


Fig. 12—45,000 kv.a. 3-phase, 60-cycle Westinghouse Transformer at Chats Falls.

surface of this fullerboard insulation is essentially at right angles to the electrostatic field, thus giving maximum impulse strength. By the use of the block type spacers specially arranged and cemented to adjacent washers, vertical oil ducts are formed such that a large portion of each turn of every coil is exposed to circulating oil and at the same time every turn is held rigidly in place. The assembled groups of coils and insulation have the sheet steel punchings built around them, and by the use of heavy coil supports, pressure plates, etc., are rigidly supported against distortion due to the stresses resulting from short-circuit currents.

The transformer is mounted in a single section boiler iron tank, oval in shape and having flat boiler plate cover and bottom, the latter being supported by a heavy structural steel base with wheels arranged for a rail gauge of 93½ inches. The complete transformer weighs 225,000 pounds, and has an overall height of 22 feet 6 inches, with a floor space of 16 feet by 14 feet 1 inch. The transformer was shipped in oil in its own tank with base, bushings and other fittings removed, a depressed centre car being used.

Control, Relaying and Metering

The several switchboards for the control and protection of the set are as follows:—

(*a*) Bench and meter board in the control room is of the miniature type (see Fig. 13). The control switches are mounted on the bench incorporated in a dummy bus layout. On the upright panel are the indicating meters being of the illuminated-dial, flush-mounting type.

(*b*) Regulator panel for the 60-cycle generator and the ground detector panels adjoin similar panels for the 25-cycle generators.

(*c*) Exciter switchboard is mounted adjacent to the exciter M.G. set itself near the frequency changer. On this are mounted the main field and exciter field breakers and exciter field motor-operated rheostats. On this board is also the control for exciter set motor and lubricating oil pumps.

(*d*) Protective and starting relay board is mounted overlooking the frequency changer. When starting, the control for the motor is transferred from the control room to this switch board. The starting operation is by hand control but each operation is supervised electrically to prevent incorrect sequence of operation.

When the motor of the set is on the line the control is transferred back to the control room for synchronizing the 60-cycle generator to its line.

A complete relay protective system is provided for both units of the frequency changer set and the 60-cycle transformer bank including differential protection for both machines and transformer, ground detectors on armature and field, overvoltage, overspeed, with standby or back-up protection on all units.

All relays are of the new high-speed type.

Starting

The preliminary operations required to start the set have been described above. No auto transformer has been supplied, as the set will be started from one of the 23,500 kv.-a., a.c. generators operating at reduced voltage. During starting tests the voltage of the starting generator connected to the motor was raised gradually, and it was found that a current of 1,100 amperes was required for the set to start revolving. A current of 1,500 amperes was sufficient to bring the set up to speed, but in order to reduce the starting time a voltage of approximately 1,200 volts was applied with a current of 1,800 amperes. The set came up to speed in eight minutes. The starting generator voltage was then raised to 9,000 volts, and the field of the 25-cycle motor applied, after which the voltages were adjusted to normal, and the generator of the set synchronized with the 60-cycle system.

Installation

The field assembly of the set was started on July 20th. The machines were stacked and wound in the field and the set was placed in service and carried practically full load on October 13th, 1935, the erection having been completed in an unusually short time.

Fig. 13—Control Desk and Metering Board in the Control Room.

An indication of the great care taken during manufacturing and the assembly in the field, and also in designing the foundations, is the fact that the rotating part of the set was found to be in practically perfect balance and required no balancing weights whatever. The total sideways movement was found to be 1¼ mils each way. With a clearance of 7 mils in the guide bearings, this can certainly be considered a very satisfactory result.

In all, two of these frequency changer sets have been built. The second one, for the James MacLaren Company, Limited, is now being installed in an extension of their power house at Masson, Quebec. The original designs for this set were worked up in collaboration with their engineers while those for the Chats Falls set were worked up with the engineers of the Hydro Electric Power Commission.

An installation of this magnitude requires the cooperative efforts of the entire engineering staff and a great deal of credit is due to these engineers and to the factory personnel for their excellent workmanship in building these machines to the close limits required by shop production.

The Blast Furnace Process

N. B. Clarke,
Assistant Superintendent of Blast Furnaces and Coke Ovens, Steel Company of Canada Limited, Hamilton, Ontario.

Paper presented before the General Professional Meeting of The Engineering Institute of Canada, at Hamilton, Ontario, on February 6th, 1936.

SUMMARY.—A general description of the arrangement and operation of the blast furnaces producing pig iron at the Hamilton works of the Steel Company of Canada Limited.

By means of the blast furnace iron ore is robbed of its oxygen, separated from its various impurities and converted into pig or cast iron. The product of the furnace is then made into steel or remelted in cupolas for various grades of foundry and malleable castings.

As yet no one has found a commercially profitable process for converting iron ore directly into steel. It must first be made into pig iron and then into steel. It is possible to make steel from ore in the laboratory but the difficulty is always the cost. The blast furnace always was, and is to-day, the most efficient of metallurgical processes.

The first iron furnaces were little more than piles of ore and wood or charcoal on the tops of hills where a brisk wind would make a hot fire. Later with the crudest of bellows the smelting was done in small holes in the side of banks of clay, charcoal being used as fuel. Indeed some furnaces of this type still exist and are operated to-day in remote districts in Western India and elsewhere, producing little balls of iron weighing from 5 to 100 pounds after many hours of tedious work.

The real forerunner of our modern blast furnace was the catalan forge, developed in and named from Catalonia, North Spain, where it originated. The catalan, however, and all such crude early furnaces produced a variable kind of what we know now as wrought iron. This metal never reached a molten form but became a pasty mass, which, when pounded and worked, had most of the slag worked out of it, leaving a piece of soft iron.

It was not until about 1350 that molten pig iron was produced. The Germans working with larger furnaces, an excess of charcoal, greater heat and other favourable conditions, found that the pasty high-temperature-melting metal could be made to absorb carbon enough to make it easily fusible, and this carbon absorption made it possible to produce molten iron which could be poured into moulds and cast into any desired shape. The German furnace in which this iron was produced had in a crude way the lines of the furnace of to-day. Instead of being built similar to those in England which were built like sketch "A," they were built like sketch "B." (See Fig. 1.) This type of furnace gradually became universal and the first furnaces built on this continent were of that shape. They were built of masonry and as they got higher they were built into the side of a hill so that the material of the charge could be hauled right to the top of the furnace by horse and wagon and dumped in.

Since that time there have been many gradual improvements in design and auxiliary equipment to give us the furnace of to-day.

Figure 2 is a diagram of an average size furnace with some of the auxiliary equipment. This is not the way an actual plant would be laid out but is shown in this manner to facilitate description.

The furnace shown in Fig. 2 would be capable of producing 700 tons in twenty-four hours. It is roughly 90 feet high and 20 feet in diameter, and has a volume of some 20,000 cubic feet. The walls are built about 36 inches thick of first quality fireclay brick.

The tuyeres through which the air is blown into the furnace are eight in number, symmetrically located around the furnace. Each tuyere fits inside a tuyere-cooler which comes flush with the outside of the furnace, the tuyere itself projecting into the furnace a short way (Fig. 3). Both tuyere and cooler are made of copper as pure as can be obtained and are water-cooled.

The inside diameter of the tuyere is from 5 inches to 7 inches while its outside diameter is such as to let it fit snugly into the cooler. The cast iron blow pipe makes a ball joint against the tuyere to conduct the air into the furnace. (See Fig. 4.)

The arrangement of the cinder notch, or opening through which the melted slag is withdrawn, is similar to that of the tuyere and tuyere-cooler, except that it has one more small cooler, called a monkey, which has a hole through it about 2 inches in diameter. Into this hole fits a steel plug called a bott, which serves to stop the flow of cinder.

The bosh, which is the zone immediately above the tuyeres, is the zone of the highest temperatures and therefore must be cooled. This is done by setting water-cooled copper plates into the brick work.

The hearth of the furnace, or crucible where the metal is held, is water-cooled all around the circumference with cast iron cooling plates. The brick work extends 7 feet below the bottom of the hearth and below this is about 7 feet of concrete. The tendency is for the iron to keep eating away this brickwork so that when a furnace is finally blown out for repairs the hearth level may be anywhere from 3 feet to 7 feet lower than when it was blown in.

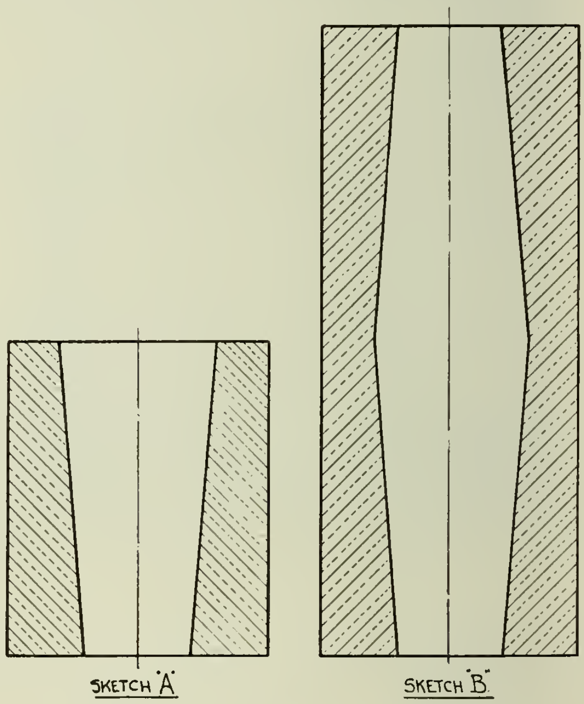


Fig. 1—Early Blast Furnace Lines.

The ores, limestone and coke are dumped from railway cars into bins. A transfer car with a scale hopper on it runs under these bins and collects the correct weights of each of the various ores as well as the stone. This car dumps its load into one of two skip cars which carries it to the top of the furnace. On each side of the skip pit is a coke bin. The coke passes from these bins into a scale-hopper and thence directly into the skip car. At the furnace operated by the Steel Company of Canada, Limited in Hamilton, these three items are charged in the following order and the seven skips constitute a charge:—Skip of ore, skip of coke, skip of coke, skip of ore, skip of stone, skip of coke, skip of coke. Thus, a skip of ore goes to the top of the furnace, dumps into the revolving hopper when the rear of the skip is pulled up in the air, is revolved its proper degree and dumped into the space between the two bells by lowering the small bell. The small bell is 5 feet 6 inches in diameter and the large one 12 feet. Their object is to enable the charge to be deposited in the furnace without permitting escape of furnace gas. When one skip of ore and two skips of coke are in the space between the two bells the big bell is dumped while the small bell remains closed. The last four skips (one ore, one stone and two coke) are now brought up, and the big bell lowered again. Other furnaces are charged in this general manner, but with some variation in detail. The weights of the materials making up this charge are approximately 30,000 pounds ore, 13,000 pounds coke and 6,300 pounds stone. When blowing full wind the furnace will take about four of these charges per hour.

The air for the furnace comes from a turbo-blower, which delivers about 45,000 cubic feet a minute under a pressure of 15 pounds per square inch. It then passes through a stove, where it is preheated to 1,200 to 1,500 degrees F., and is delivered through the bustlepipe, around the furnace and through each of the eight tuyeres into the furnace.

Many chemical reactions take place in the furnace but only a few of the simpler ones will be mentioned here. As J. E. Johnson, Jr., puts it, "The chemistry of the blast furnace is not a chemistry of definite atomic proportions. It is a chemistry of infinitely varying balances among conflicting tendencies."

Theoretically the oxygen of the air as it enters the tuyeres burns the white hot coke to carbon dioxide. Since this gas cannot exist in the presence of white hot carbon at these temperatures it is immediately converted to carbon monoxide, which is the important reducing agent in the process indicated by the following equation:

$$Fe_2O_3 + 3CO = 2Fe + 3CO_2.$$

All the carbon monoxide however cannot be utilized, and as a result the gas leaving the top of the furnace contains enough to make it readily combustible and it is used as fuel in metallurgical heating furnaces throughout the plant.

The analysis of the top gas will average:

CO_2	16.0 per cent
CO	23.0 " "
H_2	3.7 " "
N	57.3 " "

The nitrogen, which composes about 79 per cent of the entering air goes through the furnace unchanged chemically. It is a dead load, which, since it leaves the top of the furnace at a temperature of from 200 to 500 degrees carries considerable heat with it.

It only takes a few seconds for the hot gases to travel from the bottom of the furnace to the top. As they ascend they impart most of their heat to the slowly descending charge. Actually it takes eight to ten hours for a charge to travel from the top to the bottom of the furnace. The iron ore does not descend very far before it begins to be

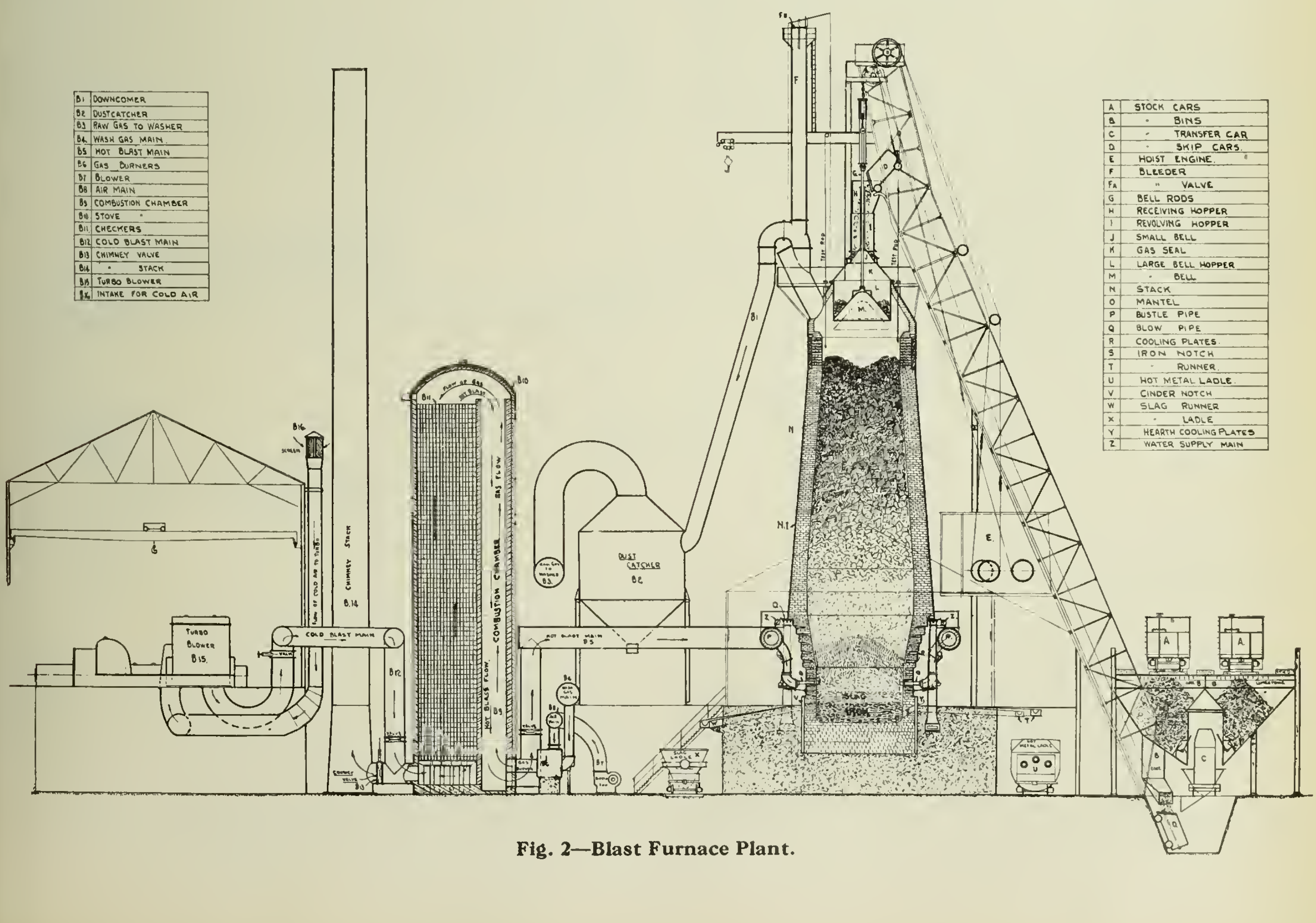


Fig. 2—Blast Furnace Plant.

reduced by the carbon monoxide, in fact reduction starts when it gets down to about point (N) in the drawing. The limestone begins to break up at point (N_1), the $CaCO_3$ changing to CaO plus CO_2 and the $MgCO_3$ into MgO plus CO_2.

The coke travelling downward gradually becomes hotter and some of it acts as a direct reducing agent on the ore.

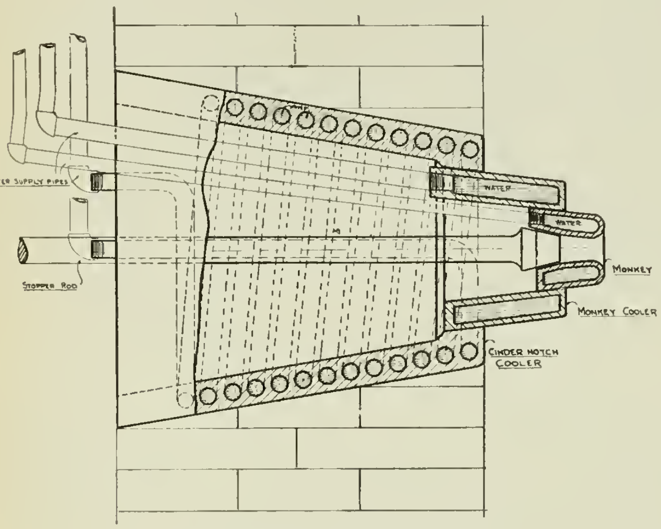


Fig. 3—Cinder Notch Coolers.

By the time the charge reaches point (O) in the drawing, which is called the mantle, the lime and magnesia of the stone begin to unite with the silica of the ore to form the silicates of the slag. Just below the mantle everything but the coke has become pretty well fused into a pasty mass. The coke however, while it may become impregnated with iron, changes little until it reaches the tuyeres where it is burned.

The iron and slag when they reach the high temperature zone of the tuyeres become molten and drop down into the hearth. The iron being the heaviest goes to the bottom with the slag lying on top.

The stock column gradually moves down as the coke is burned away, falling about ten feet an hour. Most furnaces have an automatic try rod resting on the stock which shows this movement to the operator. When the level reaches a designated point, say two feet below the theoretical stock line, the operator puts in another charge.

Running full, an average size furnace will require in twenty-four hours about 1,200 to 1,300 tons of ore, 500 to 600 tons of coke, 300 to 350 tons of limestone and 2,200 tons of air to make 700 tons of iron, 300 tons of slag, and 3,000 tons of gas.

The molten iron is tapped out through the iron notch, which is a hole at the bottom of the brick lining of the furnace. This hole is filled with a firm plug of clay which is put in after the finish of each cast by means of a high pressure clay gun. When ready to tap, a hole is drilled through the clay as far as an air drill will go, say, 4 feet, and then a bar is driven through the remaining shell of fireclay and iron skull. The iron as it comes from the furnace with the slag floating on top passes underneath a skimmer, which is an arrangement for holding back the lighter slag and deflecting it into slag pots. The iron after passing this skimmer goes down a runner to 60-ton capacity ladles. When most of the iron and slag are out of the furnace the gas starts to blow out of the hole with the iron and slag. The wind is now slacked down by signalling the engine room and the furnace is plugged by means of the clay gun.

The general practice is to tap a furnace about every four hours. However, since there is not enough room between the iron level and the tuyeres to hold all the iron and slag, about one-half of the slag must be drawn off through the cinder notch between casts.

The ladles of molten iron are now either taken to the open hearth department where the metal is poured into the furnaces there, for conversion into steel, or it is taken to the pig casting machine where it is cast into pigs.

The slag is waste material which is used for land filling. Most of the present ground at the Steel Company's plant is made from this and open hearth slag.

The gas leaves the top of the furnace through four downcomer pipes which come together to go into the primary dust catcher. This dust catcher, as the name implies, removes most of the dust from the gas. The principle involved in its construction is that of greatly reduced velocity accompanied by change in direction of the gas flow. The gas goes from here through a secondary dust catcher which catches a little more of the finer dust and then into the tower gas washer. In the tower gas washer the gas entering at the bottom flows in the opposite direction to the water coming down from the top. The washer has a series of baffles which cause the gas to pass through sheets of water many times in its upward travel and also a series of water whirlers which throw out a fine mist of water to mix with the gas and wash out the dust.

The gas as it leaves this washer is clean enough for use under the boilers and in the stoves, but not for use in the other metallurgical furnaces throughout the plant, such as the open hearth, blooming mills, etc. It is therefore put through another gas washer (the Theissen disintegrator) before going into the 1,000,000 cubic foot holder which feeds the rest of the plant. In this disintegrator the gas and water are whirled around and mixed together so forcibly that when the gas comes out the dust content is negligible.

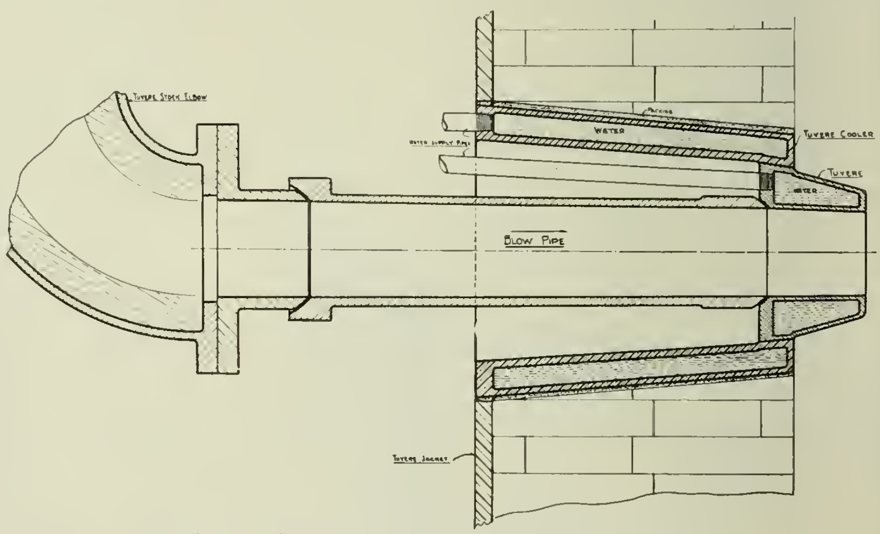


Fig. 4—Tuyere, Tuyere Cooler and Blow Pipe.

The majority of the gas, however, does not go through this Theissen washer, but is used in the boiler house and stoves as it comes from the tower washer. The stoves are towers filled with brick checker work which preheat the blast on its way from the turbo-blower to the furnace.

There are generally four stoves for a blast furnace, three burning gas and heating the brickwork while one is heating the blast. There are many different types of stoves with different styles of checkers, but the general principle is to have as many narrow openings as possible through a mass of checker brick. The gas burns in the combustion chamber, the products of combustion go to the top of the stove and are pulled down through these openings, giving off their heat to the brick work as they pass through. The stoves to-day are very efficient, the gases leaving the stove with a maximum temperature of 600 degrees.

The blast coming from the blower is passed through the previously heated stove in the opposite direction and absorbs the heat from the checker brick. When the blast is first turned into one of these stoves the blast heat goes as high as 1,700 degrees F. In order to level out this variation of temperature from say 1,700 degrees when the stove goes on, to 1,200 degrees, when it goes off, and also in order to carry the proper temperature for the furnace, a mixer valve is provided which allows any desired amount of the blast to by-pass the stove and join the part which has been heated just before it enters the furnace.

A stove is on the furnace about two hours and burning gas about six hours when four stoves are being used.

The dust as it comes out of the two dust catchers is high in iron content and so too valuable to waste. If it is put back in the furnace it will only blow out again because it is so light. The accepted manner of handling this to-day is to sinter it, as the dust has enough fine carbon in it so that it can be ignited and burned to a clinker. This sinter makes a nice material for the furnace and is not carried away by the blast.

A system has recently been tried in Germany, in which the dust is blown into the furnace with furnace gas, entering through special tuyeres just above the blast tuyeres. The dust as it goes in is taken up by the pasty iron and so is held down. Entry at higher levels was tried but without success.

The water that comes from the bottom of the gas washer is put through a settling tank (Dorr thickener) in which the fine ores are settled out as a sludge. This sludge is mixed with the ores and put back into the furnace again and being in a pasty condition most of it stays down.

The processes described above do not always run quite smoothly. Although furnace operations are under better control now than ever before, the furnaceman still refers to his furnace in the feminine gender because he knows she is a fickle maid capable of acting in most unexpected, incomprehensible, and astonishing ways.

The most important thing to keep a furnace running well is to have uniformity and regularity in raw materials and operations. A very small variation will cause trouble. In the operation of any furnace the operator's aim is to produce no off-grade iron and at the same time carry as great an amount of ore as possible with a given coke burden. The amount of coke put in each charge is seldom altered, but the ore and stone are changed to suit the situation. For instance, if the furnace begins to get cold, this is first indicated by a change in colour in the tuyeres, but the most positive indication is the appearance of the slag as it comes from the cinder notch. If this looks colder than the one before, the blast heat is immediately raised and generally this extra supply of heat brings the furnace back to normal, but sometimes this is not sufficient, and ore must be taken off, the degree of coldness determining the amount to be taken off. The effect of a change in burden is not immediate since it takes eight to ten hours for this lightened burden to arrive at the tuyeres. In the meantime the furnace may start to hang and slip, that is, the column of stock, instead of moving down regularly, stays suspended. The stock gradually packs down and it becomes harder for the wind to get through. The pressure gradually builds up from a normal fifteen pounds per square inch to twenty or twenty-five pounds per square inch and even higher at times. Now sometimes the stock will drop itself and it is easy to see what happens then. The stock dropping down into the empty space compresses the wind even higher and a small explosion results. If a furnace gets too hot it will hang up and slip also. Of course a furnace hanging and slipping is not working efficiently. More flue dust is being thrown over into the dust catcher, but the CO_2 coming out at the top drops, and the coke rate per ton of iron goes up.

When a furnace starts to hang the best procedure is to get it to move without a slip. To do this the blowing engine is slowed down, reducing the pressure of the wind going to the furnace, and this is generally sufficient to let the stock move down gently.

As a furnace gets old it is more inclined to move irregularly, and when this condition becomes so bad that the operation of the furnace is uneconomical, it is blown out and the furnace relined. During this relining all of the auxiliary equipment is given a complete overhauling with necessary replacements of worn parts.

It is not unusual practice to-day for a furnace to produce a million tons of iron before having to be blown out for relining, unless it is forced to stop on account of lack of business. It is to be hoped, however, that stoppage for the latter reason will not occur for a good many years and that the Hamilton furnaces will run until they fall apart.

Motor Truck Transportation

W. H. Male,
Director, Automotive Transport Association of Ontario, Toronto, Ont.

Paper presented before the General Professional Meeting of The Engineering Institute of Canada, at Hamilton, Ontario, on February 6th, 1936.

It is doubtful whether in the history of mankind there has been a more rapid advancement in any industry than in that of the motor vehicle.

The history of modern road transportation by motor begins about 1903. Conditions in those days may be judged from the fact that in the hub of the motor industry, the state of Michigan, the legal speed limit was then six miles per hour. Certain communities even tried to prohibit the use of motor cars. To-day the world demands and depends upon the flexibility afforded by motorized transportation. Our particular interest lies in the motor truck. Upon this servant of modern civilization the welfare of thousands is dependent.

In Canada, as elsewhere, the development of motorized transportation has been made possible by a remarkable extension and improvement in the highways system of the country. In 1934 there were 93,642 miles of surfaced roads in Canada and 315,627 miles of unimproved and improved earth roads, exclusive of streets. Of interest is the fact that in 1904 there were only 535 passenger cars registered in Canada, compared to 1,055,514 in 1930, the peak year, and 952,427 in 1934. Registration of trucks began in 1914, when 384 were in service in the entire Dominion, compared to 166,899 registered in 1934.

The value of the motor truck is almost entirely economic. In some cases its effects have been felt in unexpected directions. For instance the motor truck makes it possible for merchants to carry much smaller stocks of merchandise in their retail stores, so that they can sell their goods on a closer margin of profit. They can keep newer and fresher goods on their shelves and counters. It is no longer necessary to purchase and stock large amounts of staple goods in preparation for a possible sudden demand, a practice which may result in the customer's getting a certain amount which has become stale. Where one is in need of some particular article which is not found in the retail stores, he can now obtain it from the wholesale outlet without loss of time. This flexibility is probably the greatest asset of the motor truck.

The motor truck has been a great benefit to the farmer, particularly if he lives at some distance from his market. It is possible for him to place his fruits and vegetables on the market as early as the farmer living close by, and transport his livestock to the market without loss due to shrinkage and bad condition resulting from fatigue in transit. The milk industry has been greatly benefited by our highways and the use of the motor truck. In certain communities, all of the farmers' milk is brought to the dairies by truck. The motor vehicle to-day makes it possible for vegetables to be offered on the market within a few hours after they are gathered from the fields.

In many industries the motor truck is indispensable in bringing from various manufacturers to a point of assembly those materials or unit parts which are necessary for the construction of various pieces of equipment. Certain industries, particularly the motor car industry, have so timed their manufacturing schedules that parts reach the assembly plant just a few minutes before needed, thus reducing the inventory of parts to a negligible quantity. In the case of inter-urban traffic, there is a general impression that the motor truck is of great importance in moving a large proportion of the revenue freight in Canada. This is not true, for the amount thus carried by truck is less than 3 per cent of the total moved. The motor truck's real value is found in the kind of service it furnishes rather than the volume of that service.

The field in which the motor truck performs its most efficient service is in the short and medium haul of freight in what the railways call "less than carload" lots. The characteristics which qualify it for this type of haulage are its comparatively low capital cost, its speed, its low labour cost of operation, its flexibility, its convenience in door-to-door pick-up and delivery, its availability at any time of the day or night, and its reduction in the number of times goods have to be handled.

The internal combustion engine at present used by the majority of truck manufacturers has reached a very high state of efficiency. Experiments are continually going on with new ideas being rapidly developed. The entry of the Diesel engine promised to revolutionize a certain phase in the truck hauling industry. The resultant saving in fuel consumption has found many friends for the Diesel engine, although it is felt the tare weight of the vehicle could be reduced. Truck users desire to carry the maximum load, but with a heavy engine the pay load is naturally reduced.

The advent of the semi-trailer and the development of pneumatic tires have been the greatest development in the last decade. Ten years ago practically all trucks and trailers were equipped with solid rubber tires. They carried heavy loads over all kinds of roads. To-day, practically all commercial vehicles have pneumatic tires. Engineering brains have given us greatly improved spring suspension, scientific load distribution and other important improvements. Motor trucks have been stepped up in attractiveness of design, in speed and in safety. The drivers as a rule are men experienced and skillful in the handling of the motorized vehicle.

Two logical complements to the motor truck are the semi-trailer and the four-wheel trailer.

Motor trucks, in order to obtain lower cost and meet competition, are now largely standardized. They are built to move their rated capacity plus a fifty per cent overload through sand and unpaved roads. Paved roads and trailers have permitted the use of this reserve power, which everybody pays for in buying a motor truck, to such an extent that the trucks are now pulling, on trailers, three times their rated capacity, efficiently, economically, and with but little increased depreciation. Much larger loads can be handled, if necessary, and it is not unusual to see a truck rated at five tons capacity, pulling a trailer loaded with a steam shovel or trenching machine, with a load of twenty to thirty tons.

Truck-Railway Co-ordination

The railways are now realizing the possible advantages of truck transportation.

We now find railways both in Canada and the United States using an increasing number of motor vehicles. As a matter of fact some fifty thousand motor-trucks now are being used by the railways of these two countries, an increase of 2,800 per cent since 1925.

The way in which the railway and the truck can cooperate to the public advantage may be shown in several specific instances. One of the prominent American transport companies has a special arrangement with a railway whereby all their freight is carried between inter-urban centres by railway. The freight is picked up on a tractor-semi-trailer outfit and the semi trailer is loaded on a flat car and carried by the railway to the transport company's specified terminals. In this particular instance three semi-trailers are loaded on to one flat car. When the railway reaches the transport company's terminal a tractor is backed up to the flat car and the trailer is hooked up for delivery to its destination.

In Canada railways are availing themselves of motor-trucks, thereby speeding up their service. As an example the Canadian National Railways use a tractor with a closed type semi-trailer of nine tons capacity and a closed type trailer of eight tons capacity. This equipment is assigned to the Kitchener-Brantford service, a distance of 43 miles, serving three intermediate stations.

The tractor with the semi-trailer leaves Kitchener late in the afternoon, receiving freight at two of the intermediate stations, and picks up the trailer at Galt, thence proceeding to Brantford with all waybills and other necessary transportation documents accompanying shipments. It arrives at the Brantford freight shed of the railway about 8.30 o'clock p.m., when the goods are immediately transshipped into railway merchandise cars which are forwarded during the night in scheduled manifest trains. On the return run, the entire equipment leaves Brantford about 7.30 o'clock a.m., setting out the trailer at Galt about 9 o'clock a.m. The tractor with the semi-trailer then proceeds to Kitchener, unloading freight en route at the other two intermediate stations.

On still another service a truck operates between Kitchener and Elmira, 12 miles, handling L.C.L. traffic, government mail, express and milk. The operator, in addition, performs local cartage services for the railway at Elmira. Another truck operates between Kitchener and Waterloo (a municipality immediately adjacent to Kitchener city limits). It handles L.C.L. freight exclusively and does local cartage for the railway at Waterloo.

On the Toronto-Montreal run the Canadian National Railways avail themselves of the service of motor trucks, thereby saving at least 24 hours. These trucks, operated by transport companies under contract to the railway, cannot enter into any other inter-urban hauling. The service given is between Oshawa and Toronto, 33 miles: between Oshawa, Bowmanville, Whitby and Port Perry, 28 miles; between Port Hope and Cobourg, 5 miles, and between Belleville and Picton, 25 miles. Trucks and trailers used in the station-to-station service also perform pick-up and delivery work at local stations.

These experimental services have not only proved profitable to the railway and its contract agents, but profitable also to the users of transportation. Further experimentation is needed to judge of such developments in their relation to modern distribution methods.

Motor Truck Regulation

The growth of the business of motorized transport, particularly referring to the inter-urban functions of the motor-truck, has been so rapid that proper regulation is lacking. Motor-truck operation is in its infancy and the only regulation which it should be required to conform to, is regulation in the public interest.

It is clear that no regulation or restrictions should be imposed upon any form of transportation merely for the purpose of benefiting some other form of transportation. The test must be the public interest. On the other hand, whatever the interests of the general public may require ought to be done no matter how it may affect private interests. These are principles which no one is likely to gainsay. Yet they need emphasis, because private interests are vitally involved. Much of the demand for the regulation and restriction of the other transportation agencies has come from the railroads, for their own protection. Equally selfish interests are evident in the opposition. The controversy has been largely between private interests, but it is the public interest which must be paramount and controlling.

In the final analysis, the public interest requires a transportation system so administered and controlled that service can be furnished at the lowest possible charges consistent with adequate maintenance and ability to provide the facilities and the character of service which commerce and industry require.

In this important matter of regulation, attention may be called to the following principles, which should be borne in mind in considering any new laws or regulatory requirements:—

1. Regulatory measures should be adopted and put into effect only when there is a strong probability of public benefit. They should seldom, or never, be made effective as an experiment to see what will happen.

2. A minimum of regulation should be exercised by the government at all times and the number of regulatory laws should be the least possible required for the public good.

3. Regulation should never be enacted upon the theory that such action has some special virtue in itself, apart from its practical results. Articles, legal briefs and other documents not infrequently carry the implication that regulation should be enacted and made effective because of some fundamental principle which is exclusive and has no relation to our social structure.

4. In the past it has been the general practice to institute regulatory measures for the benefit of the users of a public utility, and in the transportation business upon complaint of the consignors or consignees. Regulation which is based on recommendations in which the desires of the shippers are not included, or constitute a small fraction of the recommendation, should be most carefully scrutinized before being adopted.

5. The specific regulation of one business is no criterion for the regulation of another business, either in kind or amount.

It seems fitting to conclude these notes by a quotation from James Russell Lowell, which was not written with any knowledge of transportation problems, but is singularly applicable to present conditions:—

"New times demand new measures and new men,
The world advances, and in time outgrows
The laws that in our fathers' day were best;
And, doubtless, after us, some purer scheme
Will be shaped out by wiser men than we,
Made wiser by the steady growth of truth."

An Outline of Commerce on the Great Lakes and St. Lawrence

C. G. Moon, A.M.E.I.C.,
St. Catharines, Ontario.

Paper presented before the General Professional Meeting of The Engineering Institute of Canada, at Hamilton, Ontario, on February 6th, 1936.

SUMMARY.—After giving a brief historical review and data as to distances, depths and levels on various routes, the paper presents in concise form information on tolls and treaties, commercial statistics, character of vessels and port facilities, and concludes with notes on costs and economic factors.

HISTORICAL NOTES

The St. Lawrence river was discovered at the beginning of the sixteenth century and, in 1535, Jacques Cartier ascended to Hochelaga (Montreal). Eighty years then elapsed before Lakes Huron and Ontario were surveyed by Champlain and yet another sixty-four years ere LaSalle commenced his famous voyage of discovery to the mouth of the Mississippi.

It is not certain that Champlain actually visited Niagara Falls, although his map of 1632 shows that their existence was then known.

LaSalle constructed Fort Conti, later called Fort Niagara, at the mouth of the river on the east side and developed the portage to the head of the falls.

After the English occupation, in 1763, an incline track was evidently built to the top of the escarpment as there is record of an agreement whereby the contractor undertook, for the sum of £10 each, to haul bateaux up the hill by means of a capstan and thence transport them on wagons to the river above the falls. The portage road, on the west side between Queenston and Chippawa was opened in 1792, just prior to the evacuation of what had then become United States territory.

Early Canals

The Seminary of St. Sulpice undertook to construct a canal at Lachine in the year 1700, but the work was never completed. In 1779-83 the Haldimand canals were built by the Royal Engineers between Lakes St. Louis and St. Francis. At Sault Ste. Marie, the Northwest Fur Company constructed a small canal and lock—1797-98—which was destroyed in 1814 by troops from Mackinac Island, thus causing a reversion to the portage method until 1855, when the first State canal was built.

The decade 1820-30 saw the construction of the Erie canal—now known as the New York State Barge canal—and the First Welland canal. Both have since undergone several enlargements; the new Welland Ship canal now being able to accommodate the largest steamers on the Great Lakes. In early years rivalry between the two routes was largely responsible for the gradual abolition of canal tolls. A reduction of tolls on the Welland canal generally caused American traffic to flow via Lake Ontario and the Oswego Lateral canal which joins the main Erie canal at Three Rivers, N.Y.

Before railroads were constructed to Chicago the westward migration provided a flourishing trade through Buffalo. In the year 1856 the Upper Lake fleet consisted of more than one thousand sailing vessels, about one hundred sidewheel steamers and one hundred and thirty-five screw-propelled vessels. Some of these boats, such as the "Empire State," the "Queen-of-the-West," "Crescent City", "Western World," "Commodore" and others were more than 300 feet long and thus too large to use either of the canals at the foot of Lake Erie.

By the year 1848, locks had been constructed all the way from Montreal to Prescott for 9-foot navigation, the other dimensions being 200 feet long and 45 feet wide. The Commission of 1871 recommended a uniform system between Montreal and Lake Erie which was immediately proceeded with, so that, in 1881, a 12-foot draught was possible and, in 1901, a draught of 14 feet. At Sault Ste. Marie the State canal, built in 1855, permitted a draught of 11½ feet between Lake Huron and Lake Superior.

TOPOGRAPHICAL DATA

In considering the St. Lawrence waterway system, a distinction is made between the river section, including Lake Ontario, and the Upper Lakes division which consists of Lakes Erie, Huron, Michigan and Superior. The former is the neck through which trade flows seaward and to a lesser extent inland. The latter is a trading unit within itself, carrying more than 90 per cent of the total tonnage for the system, having characteristics unknown elsewhere in the world.

From Liverpool to the Straits of Belle Isle the distance is 1,760 miles. Thence the St. Lawrence waterway penetrates a further 2,340 miles towards the interior of the continent with a rise of 600 feet to the waters of Lake Superior. The rise at Niagara is 327 feet, or 54 per cent of the total. At the head of Lake Superior lie the American iron ore deposits, while, some 300 miles further inland, the prairie wheat belt commences.

Following are the elevations at various points above established mean sea level:—

Montreal	18.0
Lake Ontario	243.0
Lake Erie	570.0
Lakes Huron and Michigan	578.5
Lake Superior	600.5

Canals

Between Montreal and Prescott there are six canals along the Canadian side of the river, having a total of 22 locks with a minimum dimension of 270 feet long, 43 feet 9 inches wide and 14 feet depth of water on the sills. At Niagara, the recently completed Welland Ship canal has eight locks,—seven of which have an average lift of 46 feet 6 inches,—with dimensions 820 feet long, 80 feet wide and 30 feet depth. The canal is 25 miles in length and can be navigated in less than eight hours.

The distance from Buffalo to New York, via the Barge canal, is 507 miles, of which 150 miles are clear navigation on the Hudson river. From Troy to Tonawanda, a distance of 342 miles, the canal has 35 locks with usable dimensions of 300 feet by 44 feet 6 inches by 12 feet depth. Headroom is restricted on account of low bridges and the commercial fleet consists of barges or specially designed propellor boats, some of which will carry a cargo of 2,600 tons at full draught, and about 1,800 tons at the limited canal draught.

Between Lakes Erie and Huron, the St. Clair and Detroit river channels are dredged to a depth of 21 feet and at Sault Ste. Marie there is one lock on the Canadian side, together with three parallel locks on the United States side. Two of the latter are modern, with dimensions of

1,350 feet in length, 80 feet in width and 24 feet 6 inches of water over the sills. Most of the principal harbours or channels on the lakes are dredged to 20 or 21 feet and a 19-foot 6-inch draught is used as the basis for estimating the carrying capacity of vessels.

TREATIES, ACTS AND TOLLS

For many years tolls have ceased to exist on boundary water canals and shipping is free to use any channel maintained by either the Canadian or United States government. As early as the year 1794 the Jay treaty provided for equality in portage rights. Subsequent treaties have emphasized this provision. The present Boundary Waters treaty of 1909 provides that tolls may be charged by either country but no discrimination may be thus made in favour of its own shipping. As before noted, rivalry between the Erie and the Welland canals led to abolition of tolls on the former in the year 1883 and in 1904 on the latter. At Sault Ste. Marie, tolls were charged to cover operating and maintenance expenses until the year 1881 when control was transferred from the State of Michigan to the Federal government and all fees were cancelled.

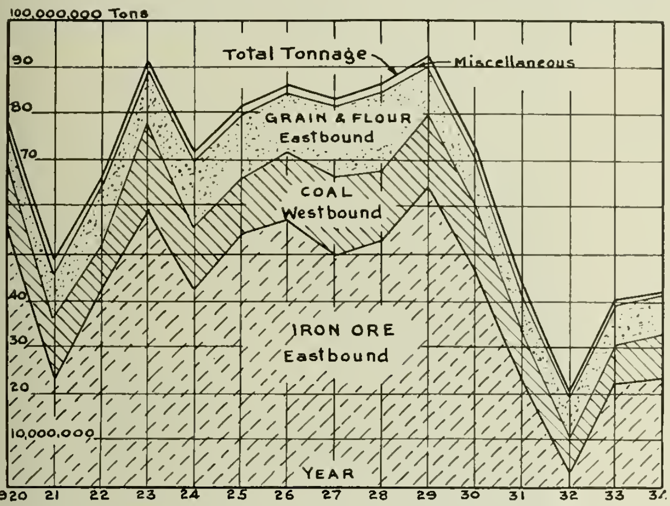


Fig. 1—Commerce Through Sault Ste. Marie Canals.

The Shipping Acts of both countries carry the customary provisions which protect their own vessels in the coastal trade. Latitude is occasionally allowed when there is a heavy carry-over of wheat and the vessels may be utilized for storage purposes during the winter months.

COMMERCE

The six years 1922-27 have been selected as illustrating the pre-depression era. During that period the annual freight movement amounted to 116,000,000 tons.

Relative importance in national economy may be gauged by the following comparison with rail traffic:—

Railway freight—
2,000,000,000 tons. Average haul 200 miles.
Waterway freight—
116,000,000 tons. Average haul 800 miles.

A short ton of 2,000 pounds is used throughout.

The four principal commodities were iron ore 57,000,000, coal 29,000,000, grain 14,000,000 and limestone 11,000,000 tons. Together with some 2,000,000 tons of miscellaneous bulk freight they constituted 97 per cent of the total. Package goods, estimated at 3 per cent by weight, accounted for 30 to 35 per cent of the $1,500,000,000 valuation.

These figures are an estimated yearly average of all unduplicated tonnage moving during the six-year period on the Great Lakes and St. Lawrence, but do not include imports and exports through Montreal and cities below, unless moving through the canals.

The development of the iron ore trade, which took place mainly between the years 1890 and 1916, has had its effect not only upon the type of vessel in use but upon the expenditures which have been made for navigation purposes. Most of the ore is mined in the Mesaba Range, Minnesota, and is shipped via Duluth-Superior to various ports along the south shore of Lake Erie to be used in the smelters of Ohio and Pennsylvania. The Gogebic, Menominee and other ranges in Wisconsin also yield ore, which is shipped either by way of Lake Superior or by the Lake Michigan route. The 1934 movement was 25,000,000 tons. Since the opening of the Welland Ship canal, in 1931, iron ore is being shipped through this channel to Lake Ontario.

Coal, mainly bituminous, is a westbound movement from ports such as Sandusky and Toledo to Lakes Michigan or Superior. In 1934 the movement consisted of 35,000,000 tons of which 10,000,000 passed through the Sault, thus more than balancing the eastward grain movement. Seventeen per cent of this coal was for Canadian consumption.

Limestone is quarried at Calcite or the Thunder Bay district in northern Michigan and used extensively for the fluxing of iron ore or in sugar, glass, chemical and paper manufacture. As with ore, the principal destination is along the south shore of Lake Erie. Delivery to industrial plants that are not equipped with special unloading machinery has led to the development of the self-unloading vessel, also utilized in the coal trade later in the season as the stone trade slackens. The 1934 figures are 7,400,000 tons for this commodity.

The movement of grain is not confined to the upper lakes and will be considered later in dealing with through traffic.

Sault Ste. Marie

With the exception of limestone, commerce passing Sault Ste. Marie is regarded as representative of the Upper Lakes in terms of tonnage. Figure 1 shows the yearly fluctuations between 1920 and 1934.

The following table gives the 1934 tonnage compared with peak years for various commodities:—

Commodity	1934 Tons	Peak Year	Peak Tons	
Total tonnage	42,200,000	1929	92,600,000	
Iron ore	22,900,000	1929	64,900,000	
Coal	10,400,000	1923	18,400,000	
Silver ore and bullion	Nil	1884	9,700	
Wood products	254,000	1902	1,600,000	
Copper	31,000	1915	156,000	
Salt	25,000	1914	116,000	
Manufactured iron and steel	184,000	1912	655,000	
Oil	528,000	1934	528,000	
Stone	156,000	1924	791,000	
General merchandise	847,000	1913	1,771,000	
All grain and flour	6,875,000	1928	16,400,000	
Wheat	5,196,000	1928	12,200,000	(404,760,000 bu.)
Flour	616,000	1924	1,100,000	(11,000,000 bbls.)
Barley		1928	1,580,000	(65,700,000 bu.)
Flax		1924	500,000	(18,000,000 bu.)
Oats	1,063,000 (Barley, Flax, Oats, Rye, Corn)	1925	1,150,000	(70,000,000 bu.)
Rye		1924	1,350,000	(49,000,000 bu.)
Corn		1922	340,000	(12,000,000 bu.)

During the six-year period, 1922-27, 13,000,000 tons of grain and flour expressed in wheat-tons,* passed eastward through the Sault locks and were joined by 2,000,000 tons coming from Lake Michigan. Distribution was then somewhat as follows:—3,500,000 to Georgian Bay ports and Point Edward, 8,000,000 to Buffalo, 3,000,000 to Port Colborne and the balance to other points. From Buffalo and Port Colborne 3,500,000 tons were transferred to the smaller canal boats for conveyance to Montreal. The years

*One ton of wheat has been taken as equivalent to 7.4 bbls. of flour, or one ton of flour as equivalent to 1.38 tons of wheat.

1927 and 1928 constituted peak years when more than 5,000,000 tons per annum were thus shipped down the St. Lawrence route.

Welland Canals

Referring to Fig. 2, which shows yearly freight movements through the Welland canals for fifteen seasons, the effect of opening the Ship canal is apparent. A dotted line has been superimposed showing total tonnage through the St. Lawrence canals below Prescott. Prior to 1931 the two lines of total tonnage were closely parallel with the St. Lawrence about 800,000 tons higher than the Welland. Since the year 1931 large upper lake freighters are able to enter Lake Ontario and now tonnage has increased beyond that of the lower canals.

Downbound grain has receded from the high mark of 1928 to less than three million tons but a new movement consisting of 160,000 tons of rye from Poland, Latvia and Russia to United States Upper Lake ports is noted. Coal and coke, of which 85 per cent is bituminous, has passed the three million-ton mark and mainly goes to Lake Ontario. This item accounts for the major part of the difference between the total tonnage as carried through the Welland canal and that shown for the St. Lawrence canals.

Other items grouped under the head of Miscellaneous in Fig. 2 may be mentioned. Gasoline and oils, 718,000 tons, is a two-way traffic for which special tank steamers are used. Iron ore, 530,000 tons, mainly goes to Lake Ontario. Pulpwood, 491,000 tons, is a westbound movement from the lower St. Lawrence. Woodpulp, 268,000 tons, also moves westward from below Montreal. Sugar, 153,000 tons, is carried both by the St. Lawrence canals and the Oswego Lateral to pass through the Welland canal upbound.

Montreal Harbour

Montreal harbour is the terminus for most of the lake shipping, being the principal point to which grain is carried and there transferred to the ocean vessels for export. In the peak year of 1928 nearly 50 per cent of the total ton-

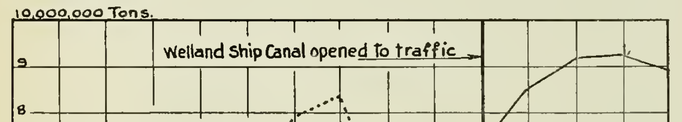


Fig. 2—Commerce Through Welland Canal.

nage was grain. The year 1934 saw this percentage reduced to one-eighth of the total or 60 per cent of the export tonnage. For this reason Fig. 3 has been prepared on a different basis from the others and shows the relative proportions of Domestic, Import and Export movements.

In the height of the grain trade, years 1927-28, a million or more tons were delivered to the elevators by rail, added to which were the five-million downbound through the Welland and St. Lawrence canals, thus making the total of more than 6,000,000 tons exported.

At present almost all grain is waterborne. The ocean tramp steamer which formerly came to Montreal in ballast for this trade now carries anthracite coal or crude oil and departs with ballast in the hold.

The following figures regarding domestic shipping, imports, exports, and grain, refer to the Port of Montreal, amd should be read with reference to Fig. 3.

Domestic Shipping

Tonnage, classed as domestic, includes as the principal item bituminous coal from Nova Scotia, with 1,660,000

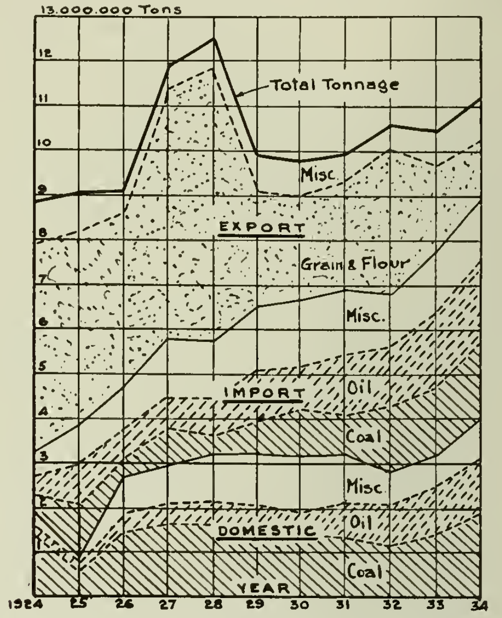


Fig. 3—Commerce Through Montreal Harbour.

tons in 1928, a minimum of 1,179,000 tons in 1932 rising to 1,921,000 in 1934. Gasoline and oils are next, rising steadily from 546,000 in 1928 to 1,236,000 tons. Grain delivered locally is an item of 165,000 tons.

Imports

Of the imports, British anthracite and crude petroleum oil now constitute 30 per cent of the activities at the port. The coal tonnage has increased from 367,000 tons (1928) to 1,417,000 tons while, during the same period, crude oil has risen from 798,000 to 1,822,000 tons. British bituminous coal and raw sugar are both items of which about 230,000 tons are imported. The Russian rye which was noted upbound through the Welland canal passed Montreal, also 44,000 tons of American rye were returned from Europe this way during the previous season. Woodpulp is an increasing import with 200,000 tons bound for the upper lakes. Gasoline, flax-seed, Argentine corn, fruit, tin plate, each amount to 50,000 tons or more. Sulphur and molasses are included with numerous other items which range between twenty and fifty thousand tons.

Exports

The heaviest export is grain with wheat at 1,000,000 tons, flour 202,000, barley 73,000, oats 46,000 or a total of 1,321,000 tons. Before the year 1933 rye also was classed as an export. Automobiles and parts with 117,000 tons have regained ground. Lard, copper, paper, fruit, cured meats remain steady from year to year each at about 50,000 tons as also woodpulp and cheese at the 30,000 mark.

Grain

The years 1922-28 saw the heaviest movement of grain and flour with more than 10,000,000 tons annually passing Sault Ste. Marie canals; 1921 was on a parity with the present year. As Figs. 1, 2 and 3 show commodities combined to form a total, Fig. 4 has been prepared to illustrate the grain trade alone. The study of the years 1922-27, before noted, indicates that most of the grain which passed the Sault went to Buffalo, there to be milled or shipped to the Atlantic seaboard by rail and barge. A study of Fig. 4 also indicates that for the last five or six years, much grain is passing Montreal and probably goes to Sorel or Quebec for export.

The 1933 report of the Harbour Commissioners gives the following comparison, for the years 1928 and 1933, of grain exported from Montreal:—

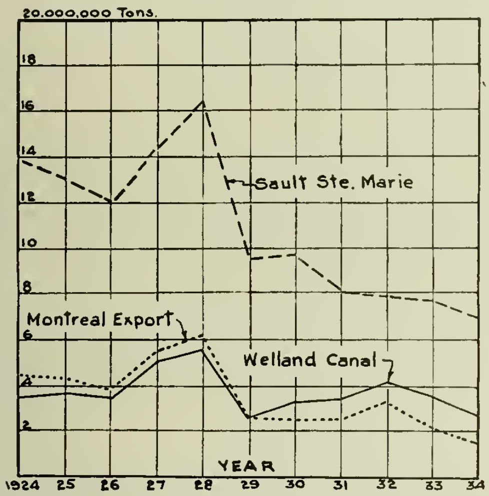


Fig. 4—Grain and Flour Movement.

To	In bushels 1928	1933
Great Britain	42,277,247	19,777,169
Holland	33,869,224	7,060,156
Germany	30,457,927	5,690,116
Italy	29,419,832	2,106,717
Belgium	23,282,921	7,378,507
Greece	7,913,456	191,305
Spain	6,631,913	nil
Norway	4,964,984	1,747,019
France	4,513,580	3,141,132

EQUIPMENT

Bulk-Freighters

Development of the ore, coal and grain trade on the upper lakes has resulted in a specially designed type of vessel known as the "bulk-freighter." They are built almost rectangular in midship section with very little radius at the bilges. The bow and stern are moulded to the conventional pattern. Lateral stiffness is obtained by means of two or three bulkheads which divide the hold into compartments. Fore and aft an inner keel, sometimes six feet in depth, runs the full length of the hull between the ship's skin and the double bottom. The floor and side tanks thus framed are utilized for water ballast.

Bridge and navigation quarters are at the bow while the power plant is located in the stern. Intervening deck space is occupied by numerous hatches through which cargo is handled.

Reliance is placed upon port facilities for loading or unloading, therefore no booms or derricks are provided as is the case with seagoing vessels. These freighters are generally equipped with Scotch boilers and triple expansion engines giving them a speed of ten or twelve miles an hour.

About three hundred and sixty of these vessels are small enough to use the St. Lawrence canals and ply mainly between the foot of Lake Erie and Montreal. The upper lakes are served by some four hundred and sixty boats of a similar type but ranging from 3,000 to 16,000 tons. The largest in capacity is the Canadian built and owned steamer "Lemoyne" illustrated in Fig. 5, a typical bulk-freighter. Her dimensions are 633 feet long, and 70 feet beam, with a draught of 20 feet, more or less, as the lake levels permit. In 1929 she is credited with carrying a cargo computed at 17,160 tons.

These vessels may be used for any of the bulk cargoes, but the ore fleet seldom handles either coal or grain, consequently most of their return trips are in ballast.

Commercial Fleet

In round figures twenty-five hundred craft of all sizes and descriptions sail upon these inland waters. The commercial fleet consists of nine hundred vessels such as the bulk-freighter, passenger and package freight boats, freight carrying barges, self-unloaders, oil tankers and car ferries. Boats which are not engaged in the actual carriage of cargo, such as lighters, scows and tugs, are not considered as part of the commercial fleet.

Self-unloaders

The self-unloader is a growing type engaged in the stone or coal trade to ports that are lacking in mechanical appliances. These boats carry a belt conveyor on a structural steel cantilever boom which is swung ashore and can deliver cargo on to the dock at a distance of 150 feet more or less. A boat of this class, Fig. 6, is shown passing through the Welland Ship canal.

Port Facilities

Bulk freighters on the upper lakes are part of a designed transportation unit which extends from source of supply to destination. At the head of the lakes iron ore is carried from the mines in special bottom-dumping cars which deposit their load into many elevated bins or pockets so spaced as to agree with the standard hatchways on the freighters. Thus loading by gravity into all hatches may take place simultaneously. At the other end of the run, the Lake Erie ports, unloading is accomplished by means of a travelling gantry spanning the railway tracks and provided with a cantilever arm which can be extended to overhang the hatchway. From this arm a clam-shell bucket picks up a load of 12 or 15 tons from the hold and may then be withdrawn to dump into cars, bins or on stock piles.

Fig. 5—Bulk Freighter in a Welland Canal Lock.

Coal, a reverse movement, is generally loaded by means of car dumping machinery either into pockets or directly to the hold. Unloading equipment, somewhat similar to that used for ore, is installed at the more important distributing centres on Lakes Michigan and Superior.

Bulk grain is carried to the head of the lakes in standard box cars where it is unloaded by means of mechanical scrapers to bins beneath the track. Thence it is elevated to the storage bins to be later loaded on the vessels by gravity through spouts. The total storage capacity of these elevators at the head of the lakes is stated to be 170,000,000 bushels or about 5,000,000 tons wheat measure.

Upon reaching the unloading or transfer point, the grain is again elevated by means of marine towers or legs from the hold of the ship.

Fig. 6—A Type of Self-Unloading Lake Freighter.

A loading rate of 5,000 tons an hour for iron ore is not uncommon while, under favourable conditions, 12,000 tons has been recorded. Unloading will be accomplished at a 2,000- to 4,000-ton rate. The ore fleet averages four hours stay in ports at the head of the lakes and eleven or twelve hours at the lower end of the run.

Coal is loaded at a 1,000- to 3,000-ton rate and discharged at 1,000 to 1,200 tons an hour.

In handling grain, loading rates of 2,000 to 3,900 tons an hour have been established at the Lake Superior ports. Transfer at Port Colborne has a record of 990 tons an hour unloading from the upper lake vessels and 1,360 tons loaded simultaneously into smaller boats for transport to Montreal. At the latter point 50,000 tons have been unloaded and 64,000 tons loaded in one day.

SOME ECONOMIC FACTORS

Ton-mile Rates

Gross earnings from all classes of railway freight average about 1.1 cent per ton mile. For bulk commodities, on hauls comparable with the lake trade, various estimates have been made, ranging from 0.5 to 0.7 cent. The larger bulk-freighter on the upper lakes with a one-way cargo carriage of 800 miles will charge on a basis of 0.1 cent whereas the smaller boats passing through the canals between Port Colborne and Montreal will charge 0.4 to 0.6 cent.

Lake rates are competitive and not subject to the same government regulations as rail carriers, hence monthly fluctuations occur which may vary 50 per cent in the course of a season.

A reference to Fig. 7 will illustrate rates for wheat carriage which have prevailed for the last fifteen years. These rates are an average for the eight months which comprise the shipping season.

Published basic rates for iron ore during the last six seasons average 70 cents a ton and for coal 35 cents. Both are movements of 800 miles or more, therefore the latter reflects the unbalanced trade and competitive bidding which favours westbound traffic.

Vessel Costs

Bulk-freighters of the St. Lawrence canal type will cost about $225,000 whereas the larger vessels on the upper lakes range up to $1,500,000; a unit price of $90 per ton of carrying capacity being representative. The latter will carry a crew of thirty to thirty-five men entailing seasonal operating charges in the order of $120,000, or $520 a day, made up of wages $40,000, coal $36,000, stores or provisions $14,000 and $30,000 for insurance.

The number of operating days during the year and the ratio of time in port are factors which bear a primary relation to cost. Speeds for loading and unloading have already been quoted. Round trips of 1,600 to 1,800 miles for the ore carriers range from eight to nine days whereas for coal or grain boats this time is increased to ten or eleven days. The St. Lawrence boats, with a round trip of 730 miles, are not as constant on account of unforeseen delays in the canals. Their trip times will average about ten days with a range from six to sixteen.

Fleet Records

The amount of paying work which these vessels perform in a season varies widely from year to year as the tonnage figures would indicate. Official records for the Upper Lake fleet will serve to show some of the higher limits:—

Year	Vessel	Record
1924	"Wm. K. Field"..........	459,415,456 ton-miles in one season
1929	"Lemoyne"...............	17,160 tons in one cargo
1929	"Wm. C. Atwater"........	557,020 tons in one season
1932	"Edward G. Seubert"......	54,384 miles in one season

Records such as these can be attained only under exceptional conditions: balanced cargoes and high water in the lakes.

Lake Levels

Low levels are the cause of partial loading on account of depth at the restricted channels and in some of the harbours. Each inch of level is closely marked so that maximum draught, both upbound or downbound, may be advantageously used. A difference of one foot to a freighter such as the "Lemoyne" will mean 1,200 tons of cargo. A difference of six inches will influence lake traffic to the extent of three or four million tons.

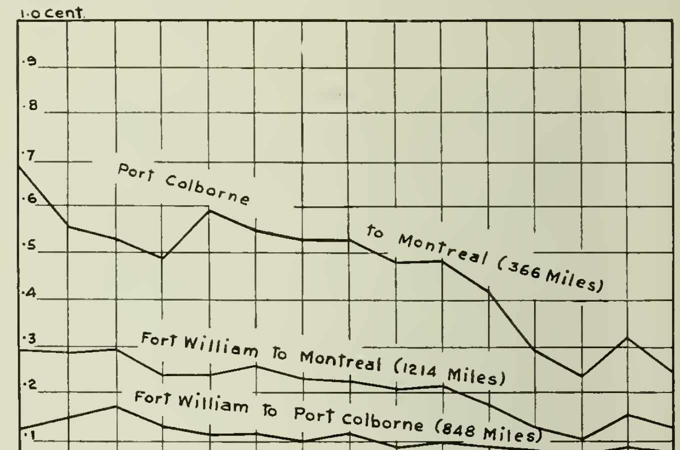


Fig. 7—Wheat Rates on a Ton-Mile Basis.

Values

Statistical reports of Sault Ste. Marie traffic give estimated values for the various commodities passing through the canals at that point. For the year 1934 these may be condensed as follows:—

Commodity	Tonnage	Per cent of tonnage	Value	Per cent of value
Grain and flour	6,875,000	16.3	$284,299,000	45.9
Iron ore	22,900,000	54.3	96,370,000	15.5
Coal	10,400,000	24.6	47,841,000	7.7
Other	2,025,000	4.8	191,550,000	30.9
	42,200,000	100	$620,060,000	100

In the preparation of this paper the following authorities and publications have been consulted: "The Canals of Canada" and "Canal Statistics" issued by the Dominion Government; annual reports issued by the Lake Carriers' Association, Cleveland, Ohio; annual reports issued by the Dominion Marine Association, Kingston, Ont.; statistical reports at Sault Ste. Marie and "Transportation on the Great Lakes," issued by the United States printing office at Washington, D.C.; "Survey of Commerce" for the Port of Oswego, prepared by Messrs. Fay, Spofford and Thorndike, consulting engineers of Boston, Mass.; "Green's Marine Directory," issued at Cleveland, Ohio; annual reports issued by the Harbour Commissioners of Montreal.

The Manufacture of High Voltage Porcelain Insulators

J. M. Somerville[1]

DISCUSSION

W. G. Worcester, M.E.I.C.[2]

The author's statements in the earlier part of his paper do not agree with Professor Worcester's views, nor do some of them seem to be in accord with what are quite generally accepted as the views of the geologist, the mineralogist and ceramist. However, these points are of little importance to the paper as a whole, which was intended to cover the manufacture of electrical porcelain and not to be a treatise on the geology and mineralogy of the raw materials used in the manufacture of porcelain wares.

Regarding the main portion of the paper, the writer wishes to compliment the author on the very clear and able manner in which he has covered the various steps and processes necessary to the production of high tension insulators. Through reading this paper one unfamiliar with the subject would obtain a fairly clear picture of the subject as a whole, also of the need for extreme care and watchfulness during the several stages of the manufacture in order that the product may pass the exacting tests imposed upon it before release to the trade.

R. J. Montgomery[3]

The presentation of the subject has been very well done. The author includes details of description and items of technical interest which are often omitted in such papers.

Has the author tried de-airing the porcelain body by the use of a vacuum during its preparation, or does he consider this to be unnecessary? One hears much about de-airing and that it will improve any clay body. Does this apply to porcelain insulators?

W. T. Fanjoy[4]

Will the author give a short description of the difference between the wet and the dry processes, and the difference in cost?

The Author

In reply to Professor Worcester, the author wishes to state that the first few paragraphs of his paper are devoted to an outline of the origin of the raw materials, that is accepted in many branches of the ceramic industry. There is some diversity of opinion among geologists and mineralogists as to the actual origin and production of these materials. The author is not a geologist and therefore cannot speak with authority on these matters. He has merely attempted to produce a general picture of the source and occurrence of the raw materials.

In answer to Mr. Montgomery, experiments have been conducted in de-airing liquid clay slip, but this technique has not been applied to the regular process. It has been found that in order to remove air from slip, a vacuum above 28 inches is necessary; as the vacuum is increased a point is reached where the slip boils and gives off water vapour. On the threshold of this condition it is extremely difficult without the use of expensive apparatus to ascertain which is air and which is water vapour leaving the slip. If the slip is cooled to avoid boiling, the resulting increase in viscosity makes it very reluctant to give up air. It has been noticed that boiling slip under a vacuum for a short period causes a reduction in the viscosity of the slip, allowing it to flow more freely. However, it is believed that this change may be attributed to the boiling action at low temperature rather than to the removal of air.

From an operating standpoint it has been observed that the majority of the air found in liquid slip arises from careless methods of preparation or leaky intake lines and glands on slip pumps. If slip is carefully prepared and subjected to slow agitation in a large tank before entering the press pumps, the amount of air carried by the slip is negligible and does not justify the use of the de-aeration process.

With regard to de-airing the plastic clay at the pug mill, observations on various installations of the vacuum pug mill in operation indicate that de-airing seems to improve the texture and strength of the plastic body. These qualities are particularly evident in the production of large tubes of heavy section. It has been found that the conventional pug mill does not apply anything like the pressure intended on the clay. If the mill is reconstructed in a manner which greatly increases the pressure on the clay, many of the advantages arising from the use of the vacuum pug mill are attained.

Replying to Mr. Fanjoy, the dry process method of porcelain production utilizes the same raw materials as the wet process, but in a mixture of different proportions. The dry process industry generally follows one of two methods of preparation. In the first, the materials are pulverized and mixed dry. The resulting dry powder is then slightly moistened with water and a mixture of oil, and pressed under high pressure to the desired shape.

In the second method the raw materials are mixed wet to form a slip which is pumped to a filter press. The resulting filter cakes are then dried and pulverized. The pulverized material is then slightly moistened with water and oil and pressed to the desired form. In both cases the pressed pieces are dried, trimmed, and heated to drive out the oil in a vapour form. The dried pieces are then glazed and fired.

The dry process lends itself to more rapid production with a great decrease in the number of operations to produce the finished piece as compared to the wet process method. However, dry process porcelain is porous and will absorb moisture and has a low dielectric and mechanical strength. These moisture characteristics limit its use to the insulation of low voltages. Wet process porcelain is very dense, which makes it impervious to moisture, with high dielectric and mechanical strength. The author has no authoritative figures on the cost of dry process production, but it is an accepted fact that dry process ware is much cheaper to produce than wet process. A comparison of the market price of dry and wet process insulators serves to indicate the difference in the cost of production.

[1] Canadian Porcelain Company Limited, Hamilton, Ontario.

[2] Professor of Ceramic Engineering, University of Saskatchewan, Saskatoon, Sask.

[3] Assistant Professor of Ceramics, University of Toronto, Toronto.

[4] Industrial Control Engineer, Canadian General Electric Co. Ltd., Peterborough, Ontario.

THE
ENGINEERING JOURNAL
THE JOURNAL OF
THE ENGINEERING INSTITUTE
OF CANADA

VOLUME XIX APRIL 1936 No. 4

Lord Tweedsmuir Acccepts Honorary Membership

The Institute has been honoured by His Excellency the Right Honourable Lord Tweedsmuir, G.C.M.G., C.H., Governor-General of Canada, who has graciously consented to accept Honorary Membership in The Institute. Council has accordingly added His Excellency's name to the list of Honorary Members.

In order to advise His Excellency officially and also to present the gold Honorary Membership badge of The Institute, Past-Presidents Dr. Charles Camsell, M.E.I.C. and Dr. F. A. Gaby, M.E.I.C. met His Excellency on Friday, March 20th, at 11.00 o'clock a.m. by appointment at Government House, at which time the Governor-General was again advised of the unanimous vote of the members of Council of The Engineering Institute of Canada on his election as an Honorary Member.

His Excellency was deeply interested in the aims and functions of The Engineering Institute, discussing its nation-wide extent and many of the important works that are being carried on in mining and other fields in Canada.

The Consolidation Debate

To the onlooker, the discussion on consolidation which took place at Hamilton on February 5th, 1936, at the Fiftieth Annual General Meeting of The Institute, was noteworthy for three reasons. The first was the manner in which the discussion held the sustained interest of everyone present, in spite of the fact that this involved listening to nine hours of almost continuous oratory. The second was the widely representative nature of the gathering, including as it did delegates from nearly all of The Institute branches from coast to coast, amongst whom were six of the original members of the recently established Dominion Council of the Professional Associations. Finally, it was evident from the tone of the speeches that the importance of the meeting was generally realized, for it was the occasion on which the discussions between The Institute and the Professional Associations, which were interrupted in 1931, were resumed under more favourable circumstances than before, and with an obvious desire on all sides to make real progress. The facts that such contact has been established and that for the first time the views of all parties have been so freely expressed are in themselves evidences of definite achievement.

At the close of the meeting there seemed a general impression that through the efforts of The Institute Committee on Consolidation during the past year, the consolidation question has really been brought into the "sphere of practical politics," as the saying goes. This idea was confirmed by the holding of a round table conference between The Institute's committee and the Dominion Council, which took place on February 7th, and was accompanied and followed by more personal and informal consultations. The results of these negotiations we shall no doubt learn in due course. In the interval, there will be time for members of The Institute to study and think over the many divergent views which were expressed at the Annual Meeting. The various speakers made no attempt to conceal the difficulties which stand in the way of a comprehensive scheme of consolidation. The position of all classes of engineers was duly set forth. There are those who belong only to The Institute; only to the Professional Associations; to both; to other organizations, or to no organization at all. The apparently discordant interests of these various classes must at least be understood before steps can be taken to reconcile them.

The final solution of the problem may be near at hand, as we hope, or it may come only after a period of further study. In either case all members of The Institute are urged to acquaint themselves with the present state of the question by reading the condensed report* of the Annual Meeting discussion which has been published in The Journal.

The final decision as to The Institute's future has to be made by ballot of its membership, who should therefore take the trouble to qualify themselves to form an intelligent judgment on the matter. Are the engineers of Canada to remain as at present, largely sectionalized in outlook, adherents to a multiplicity of organizations, and too often travelling along diverging rather than converging paths, or are we ready to merge our loyalties to individual societies in a broader devotion to the interests of all classes of engineers throughout the Dominion? To accomplish this everyone will have to sacrifice some of his cherished ideals, but the result, if it can be attained, will prove an ample recompense.

A real opportunity to co-ordinate the activities of existing societies and to consolidate at least some of these bodies, is before us for the first time. It remains to be seen whether engineers as a profession have the necessary breadth of vision, the willingness to see all sides of a question, and the ability to distinguish between proposals which are practicable and those which are merely visionary.

Past-Presidents' Prize 1935-1936

The subject prescribed by Council for this competition or the prize year July 1st, 1935, to June 30th, 1936, is

"The Engineer's Contribution to Transportation."

The rules governing the award of the prize are as follows:

The prize shall consist of a cash donation of the amount of one hundred dollars, or the winner may select books or instruments of no more than that value when suitably bound and printed, or engraved as the case may be.

---

*See Engineering Journal for March 1936, pages 156-170.

The prize shall be awarded for the best contribution submitted to the Council of The Institute by a member of The Institute of any grade on a subject to be selected and announced by the Council at the beginning of the prize year, which shall be July first to June thirtieth.

The papers entered for the competition shall be judged by a committee of five, to be called the Past-Presidents' Prize Committee, which shall be appointed by the Council as soon after the Annual Meeting of The Institute as practicable. Members and Honorary Members only shall be eligible to act on this committee.

It shall be within the discretion of the committee to refuse an award if they consider no paper of sufficient merit.

All papers eligible for the competition must be the bona fide work of the contributors and must not have been made public before submission to The Institute.

All papers to be entered for the competition must be received **not later than June 30th, 1936,** by the General Secretary of The Institute, either direct from the author or through a local Branch.

Students' and Juniors' Prizes

Students and Juniors of The Institute are reminded that five prizes each of the value of twenty-five dollars, may be awarded to Students and Juniors of The Institute for the prize year 1935-1936 as follows:

The H. N. Ruttan Prize in the four Western Provinces.

The John Galbraith Prize in the Province of Ontario.

The Phelps Johnson Prize for an English Student or Junior in the Province of Quebec.

The Ernest Marceau Prize for a French Student or Junior in the Province of Quebec.

The Martin Murphy Prize in the Maritime Provinces.

Papers in competition for these prizes must be received by Branch Secretaries before June 30th, 1936. Further information as to the requirements and rules may be obtained from the General Secretary.

Meeting of Council

A meeting of the Council of The Institute was held at Headquarters on Friday, March 6th, 1936, at eight o'clock p.m., with Vice-President P. L. Pratley, M.E.I.C., in the chair, and nine other members of Council present.

The committee appointed by Council to report as to participation in the Second Congress of the International Commission on Large Dams presented a report recommending that Canada's adherence to that Congress is desirable, and further recommended that The Engineering Institute of Canada form its own committee to study the very important subject of the deterioration of concrete in structures and its causes. Mr. R. B. Young, M.E.I.C., was appointed chairman of this committee.

The following committees were appointed for the year 1936.

Library and House Committee:

E. A. Ryan, M.E.I.C., *Chairman*
J. L. Clarke, M.E.I.C.
W. G. Hunt, M.E.I.C.
J. H. Landry, A.M.E.I.C.
H. W. Lea, A.M.E.I.C.

Publication Committee:

H. Cimon, M.E.I.C., *Chairman*
J. A. Duchastel, M.E.I.C.
A. A. MacDiarmid, M.E.I.C.
P. L. Pratley, M.E.I.C.
H. L. Trotter, M.E.I.C.

A memorandum was presented which had been prepared by Mr. J. L. Busfield, M.E.I.C., outlining the functions and organization of the proposed Committee on Transportation. It was unanimously decided to request Colonel E. G. M. Cape, M.E.I.C., to act as chairman of this committee.

The budget for the year 1936, as submitted by the Finance Committee, was approved.

On a suggestion received from Dr. L. F. Goodwin, M.E.I.C., it was unanimously resolved that a letter of condolence should be sent from The Engineering Institute of Canada to Mrs. Kipling, making reference to the fact that the late Mr. Rudyard Kipling was greatly interested in the engineering profession.

Approval was given to an amendment to the Calgary Branch by-laws.

The Secretary reported the resolution passed at the Annual General Meeting of The Institute on February 5th, adopting the report of the Committee on Consolidation in principle as a progress report, and empowering the committee to make certain additions to its numbers.

A letter was presented from Mr. Gordon McL. Pitts, A.M.E.I.C., transmitting a memorandum regarding an informal conference between members of the Committee on Consolidation and members of the Dominion Council of the Professional Associations held in Hamilton on February 7th. Discussion followed as to this document and the publicity which was being given to it.

Mr. P. L. Pratley, M.E.I.C., was nominated to represent The Engineering Institute of Canada on the reorganized Main Committee of the Canadian Engineering Standards Association.

Fifteen resignations were accepted; five members were reinstated; four members were placed on the Life Membership List, and a number of special cases were considered.

Council gave consideration to the case of those members who are in arrears of fees for 1934 and 1935 and the recommendations of the Finance Committee regarding them. In cases where further extension of credit seemed inadvisable removal from the membership list was directed, and in a number of special cases a further extension of credit to July 1st, 1936, was granted.

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

Elections		*Transfers*	
Members	3	Assoc. Member to Member	17
Assoc. Members	12	Junior to Assoc. Member	9
Juniors	2	Student to Assoc. Member	4
Students admitted	23	Student to Junior	9

The Council rose at eleven thirty p.m.

OBITUARIES

Walter Eardley Hyndman, M.E.I.C.

Deep regret is expressed in placing on record the death of Walter Eardley Hyndman, M.E.I.C., at Charlottetown, P.E.I., on February 29th, 1936.

Mr. Hyndman was born at Charlottetown, Prince Edward Island, on July 9th, 1875, and in 1892 entered the engineering works of the Robb Engineering Company at Amherst, N.S., where he was employed in the shops and testing department until 1895. From 1897 until 1899 Mr. Hyndman was a draughtsman in the office of the resident engineer of the Department of Public Works, P.E.I., and in addition made harbour and river surveys, examination of works for improvement, etc. In 1900 he was in Grand Forks, B.C., engaged on field and office work with C. H. Ellacott, D.L.S. In 1901 Mr. Hyndman returned to Charlottetown as assistant engineer to the resident engineer of the Department of Public Works and was engaged on surveys, supervising construction and maintenance work, and making plans, specifications and estimates of costs of various works. In 1913 he was appointed acting district engineer of the Department of Public Works, Canada, for Prince Edward Island. In June 1914 he became District engineer, which position he held until the time of his death.

Mr. Hyndman became a Member of The Institute on June 7th, 1924.

Harry Utler Hart, M.E.I.C.

It is with deep regret that we place on record the death on March 15th, 1936, at Hamilton, Ontario, of Harry Utler Hart, M.E.I.C.

Mr. Hart was born at Covington, Kentucky, on June 28th, 1874. In 1893 he enrolled as a student-apprentice of the Westinghouse Electric and Manufacturing Company at Pittsburgh, and in 1894-1895 he took a special course

H. U. Hart, M.E.I.C.

in electrical engineering at the Massachusetts Institute of Technology. From 1895 until 1898 Mr. Hart was engaged on the calculation of generators and motors in the engineering office of the Westinghouse Company at Pittsburgh. In 1899 he became connected with the French Westinghouse Company as designing electrical engineer, and was later appointed chief engineer. During this period Mr. Hart had charge of the design of some very large generators then being built for water power developments in France and Italy. In 1905 he was secured by the Canadian Westinghouse Company as chief engineer, and in 1923 his executive ability resulted in his appointment as general manager. In 1928 Mr. Hart became vice-president and chief engineer. He was primarily responsible for all designs at the Westinghouse and did a great deal of pioneering work in the fields of mining, pulp production and the generation and transmission of power. In recent years he had designed and supervised manufacture of equipment supplied to major power development projects including the Hydro-Electric Power Commission of Ontario at Queenston, the Gatineau Power Company at Ottawa, and the Duke-Price plant at Lake St. John, Quebec. Recently Mr. Hart had been engaged in the furtherance of improvement of many household devices and their adaptation as electrical appliances.

Mr. Hart joined The Institute (then the Canadian Society of Civil Engineers) as a Member on October 24th, 1907, and took a keen and active interest in its affairs. He was a charter member and past-chairman of the Hamilton Branch. At the Annual Meeting recently held in Hamilton he presented a paper on the 45,000 kv.a. Vertical Shaft Frequency Changer at Chats Falls, which appears on pages 189 to 195 of this issue of The Journal.

Max A. Zuercher, M.E.I.C.

Regret is expressed in placing on record the death of Max A. Zuercher, M.E.I.C., at Montreal on March 23rd, 1936.

Mr. Zuercher was born at Seelbach, Baden, Germany, on September 7th, 1849, and received his technical education at the Carlsruhe Engineering School in Germany. In 1872 he came to the United States, and until 1875 he was engaged as a draughtsman with various organizations. In 1875-1880 Mr. Zuercher was engineer in charge of the American Bridge Company's shops at Chicago, and was also principal assistant engineer in charge of the construction of the Point bridge at Pittsburgh. In 1882 Mr. Zuercher came to Canada and entered the service of the Canadian Pacific Railway Company at Winnipeg as bridge engineer, and during the following years was in charge of the construction of the temporary and permanent Assiniboine bridges at St. James. In 1888 he was transferred to the engineering department at the company's head office in Montreal where he remained until his retirement about nine years ago.

Mr. Zuercher was a member of many years standing, having joined the Canadian Society of Civil Engineers as a Member on December 19th, 1889, and was made a Life Member on April 23rd, 1918.

PERSONALS

Geo. A. Revell, S.E.I.C., has joined the staff of the Canadian Celanese Limited, at Drummondville, Que. Mr. Revell graduated from Queen's University in 1930 with the degree of B.Sc.

L. C. Williams, S.E.I.C., is now connected with Dominion Engineering Works, Limited, Montreal. Mr. Williams graduated from Queen's University in 1932 with the degree of B.Sc.

Moses Burpee, M.E.I.C., consulting engineer of Houlton, Maine, recently celebrated his eighty-ninth birthday. Mr. Burpee became a Member of The Institute on February 27th, 1890, and was made a Life Member on August 27th, 1923.

J. Sinton, A.M.E.I.C., who was formerly with Storms Contracting Company, Toronto, Ont., has joined the staff of Colas Roads Limited, and is located in Montreal. Mr. Sinton was at one time chief engineer of the Department of Northern Development, Toronto, and was later town engineer of North Bay, Ontario.

George Claxton, A.M.E.I.C., has joined the engineering department of the Ontario Paper Company Limited, at Thorold, Ontario. Mr. Claxton was at one time designing engineer with the Belgo Canadian Pulp and Paper Company at Shawinigan Falls, Que., and in 1930 became divisional engineer for the Canada Power and Paper Company, also at Shawinigan Falls. In 1933 he became connected with J. R. Booth and Company Limited, Ottawa, as designing engineer, from which position he has now resigned.

H. O. Brown, A.M.E.I.C., has joined the staff of the Ontario Paper Company Limited, at Thorold, Ontario. Mr. Brown graduated from the University of Toronto in 1912 with the degree of B.A.Sc. and following graduation joined the staff of the Department of the Interior at Calgary, Alta. In 1912-1913 he was engaged on a survey of stream flows under ice, and later became assistant engineer on irrigation works inspection and surveys. In 1915-1917 Mr. Brown was draughtsman and assistant engineer on construction at the McIntyre Mines in Ontario, and in 1919 he was with E. A. James and Company, Toronto, as inspection engineer on construction. From 1920 until 1925 Mr. Brown was designing draughtsman for pulp and paper mills, and in 1925 he became engineer in charge of the draughting office of the Abitibi Power and Paper Company at Iroquois Falls, Ont. Mr. Brown was later located in Toronto, and in 1933 he rejoined the staff of the Abitibi Power and Paper Company as assistant plant engineer at Sault Ste. Marie, Ontario, from which position he has now resigned.

Mr. Brown has taken an active interest in Institute affairs, and is immediate past secretary-treasurer of the Sault Ste. Marie Branch.

W. B. Scouler, A.M.E.I.C., who was formerly with the Dominion Bridge Company Limited, Montreal, is now assistant engineer to the Laurentide Division of the Consolidated Paper Corporation Limited at Grand'Mere, Que. Mr. Scouler graduated from Glasgow University in 1923 with the degree of B.Sc., and from 1921 until 1926 he was an apprentice with A. Barclay Sons and Company Limited, locomotive builders, Kilmarnock, Scotland. In 1926-1929 he was a designer with Glenfield and Kennedy, Limited, hydraulic engineers, at Kilmarnock and in 1929 Mr. Scouler came to this country where he joined the staff of the Dominion Bridge Company.

Elections and Transfers

At the meeting of Council held on March 6th, 1936, the following elections and transfers were effected:—

Members

AITKEN, George Griffiths, (Royal Academy, Edinburgh), chief geographer, Govt. of British Columbia, Victoria, B.C.

SKARIN, Emil Richard Ture, B.Sc., (Univ. of Alta.), president, Crown Paving and Constrn. Co. Ltd., and president, Alberta Concrete Products Ltd., Edmonton, Alta.

SMITH, Allan James, E.E., M.E., (Ohio State Univ.), M.A.Sc., (Univ. of B.C.), mgr. and chief engr., Windpass Gold Mining Co. Ltd., Vancouver, B.C.

Associate Members

ALEXANDER, George Burpee, B.Sc., (Univ. of N.B.), divn. engr., C.P.R., Revelstoke, B.C.

ANDERSON, Clifford Thomas, B.A.Sc., (Univ. of Toronto), asst. to chief of control, Thunder Bay Paper Co. Ltd., Port Arthur, Ont.

BOURGET, Maurice, B.A.Sc., C.E., (Ecole Polytech., Montreal), asst. engr., Dept. of Public Works, Quebec, Que.

CHEVALIER, J. Emile, B.A.Sc., C.E., (Ecole Polytech., Montreal), asst. engr., bridge mtce. divn., Dept. of Public Works, Quebec, Que.

DEAN, Curtis Milford, B.A.Sc., (Univ. of B.C.), mgr., Shellburn Refinery, Shell Oil Co. of B.C. Ltd., Vancouver, B.C.

FROST, Clifford Earl, B.Sc., (McGill Univ.), asst. engr., Harbour Commissioners of Montreal, 554a Notre Dame St., Lachine, Que.

JACQUES, Alfred George, B.Sc., (McGill Univ.), mill mgr., Lake St. John Power and Paper Co. Ltd., Dolbeau, Que.

McKECHNIE, Thomas Scott, B.E., (Univ. of Sask.), asst. engr., Imperial Oil Refinery, Regina, Sask.

POUDRIER, Louis Philippe, B.A.Sc., C.E., (Ecole Polytech., Montreal), asst. engr., Dept. of Public Works, Quebec, Que.

REID, Jean Marie, B.A.Sc., C.E., (Ecole Polytech., Montreal), res. engr., Dept. of Public Works, Quebec, Que.

SOMERVILLE, Archibald Laurence Harold, B.A.Sc., (Univ. of B.C.), engr. (unemployment relief), Dept. of National Defence, M.D. No. 13, Calgary, Alta.

WARD, Frank Noel, (A.M.Inst.M.E. (Gr. Britain)), vice-president and managing-director, Reavell & Co. (Canada) Ltd., Montreal, Que.

Juniors

deJONG, Sybren Henry, B.Sc., (Univ. of Man.), Fort Garry P.O., Man.

WALKER, Roy Edward, B.E., (Univ. of Sask.), 1034 Aird St., Saskatoon, Sask.

Transferred from the class of Associate Member to that of Member

ALLEN, Robert William, asst. city engr., Regina, Sask.

CAMERON, Evan Guthrie, (Grad., R.M.C.), (McGill Univ.), prin. asst. engr., Welland Ship Canal, St. Catharines, Ont.

CONWAY, Gilbert Stanley, chief engr., British Pacific Properties Ltd., Vancouver, B.C.

DUPUIS, Philippe Auguste, B.A.Sc., C.E., (Ecole Polytech., Montreal), senior engr., Dept. of Public Works, Quebec, Que.

FRAME, Stanley Howard, (McGill Univ.), hydraulic engr., Water Rights Br., Dept. of Lands, Prov. of B.C., Victoria, B.C.

JOYAL, Jules, B.A.Sc., C.E., (Ecole Polytech., Montreal), engr., Quebec Public Service Commission, Quebec, Que.

KILBURN, Daniel George, B.Sc., (Queen's Univ.), divn. engr., head office, Board of Rly. Commnrs. for Canada, Ottawa, Ont.

MacKENZIE, Hugh Ross, B.A.Sc., (Univ. of Toronto), chief engr. and acting Deputy Minister, Dept. of Highways, Prov. of Sask., Regina, Sask.

McGAVIN, Charles James, (West of Scotland Tech. Coll.), chief engr., Water Rights, Govt. of Sask., Regina, Sask.

McKINNON, Roderick Will, (Dalhousie Univ.), chief engr., reclamation br., Dept. of Public Works, Prov. of Man., Winnipeg, Man.

MUIRHEAD, Stuart Robert, B.A.Sc., (Univ. of Toronto), engr., Sask. Govt. Telephones, Regina, Sask.

ORR, Frederick Ormond, (Queen's Univ.), consltg. engr. and geologist, 833 Hastings St. W., Vancouver, B.C.

PARHAM, John Bright, B.Sc., (McGill Univ.), 2474 33rd Avenue West, Vancouver, B.C.

PATTON, John McDonald, B.A.Sc., (Univ. of Toronto), designing engr., bridge br., Dept. of Highways, Prov. of Sask., Regina, Sask.

RITCHIE, Hugh Crichton, (Grad., S.P.S., Univ. of Toronto), city engr. and commissioner, Moose Jaw, Sask.

SPRATT, Maynard James Campbell, B.Sc., (McGill Univ.), chief engr., Saskatchewan Pool Elevators Ltd., Regina, Sask.

WHITE, Joseph James, B.E., (Univ. of Sask.), bldg. inspector, City of Regina, Sask.

Transferred from the class of Junior to that of Associate Member

AULD, William Fraser, B.A.Sc., (Univ. of Toronto), elec. engr., asst. to the president, Lincoln Electric Co. of Canada Ltd., Toronto, Ont.

BIELER, Jacques Louis, B.Sc., (McGill Univ.), engr., Dominion Oilcloth and Linoleum Co. Ltd., Montreal, Que.

BRYANT, James Sanborn, B.Sc., (McGill Univ.), junior engr., Southern Canada Power Co., Drummondville, Que.

DAVIES, Ewart John, B.Sc., (N.S. Tech. Coll.), dfting instructor, Peterborough Collegiate and Vocational School, Peterborough, Ont.

DURLEY, Thomas Richard, B.Sc., (McGill Univ.), mech. engrg. dept., c/o Plant No. 5, Canada Cement Company, Belleville, Ont.

ELEY, Frederick Charles, B.A.Sc., (Univ. of Toronto), sales engr., Amalgamated Electric Corporation Ltd., Toronto, Ont.

EVANS, Charles Durward, B.Sc., (McGill Univ.), sales mgr. (Quebec and Maritimes District), Canadian Gypsum Co. Ltd., Montreal, Que.

HAGERMAN, Bernard Harrison, B.Sc., (Univ. of N.B.), asst. bridge engr., Dept. of Public Works, Fredericton, N.B.

PHILLIPS, Edward Kent, B.E., M.Sc., (Univ. of Sask.), lecturer in civil engrg., University of Saskatchewan, Saskatoon, Sask.

SHIELDS, Stanley, B.A.Sc., (Univ. of Toronto), supervisor, winding and insulation, Canadian General Electric Co. Ltd., Peterborough, Ont.

Transferred from the class of Student to that of Associate Member

BAUMAN, Bert Eric, B.Sc., (McGill Univ.), constrn. engr., Aluminum Company of Canada, Arvida, Que.

McDOUGALL, John Frederick, B.Sc., (Univ. of Alta.), M.Sc., (McGill Univ.), res. highway engr., Govt. of Alta., Edmonton, Alta.

SMITH, Eugene Lloyd, B.Sc., (Univ. of Alta.), chem. engr., City of Edmonton Power Plant, Edmonton, Alta.

WALKER, Robert Samuel, B.Sc., (Queen's Univ.), designing engr., Spruce Falls Power and Paper Co. Ltd., Kapuskasing, Ont.

Transferred from the class of Student to that of Junior

AKERLEY, William Burpee, B.Sc., (Univ. of N.B.), instr'man., Dept. of Highways, Prov. of N.B., Saint John, N.B.

BENNETT, George Francis, B.Sc., (McGill Univ.), sales engr., Canadian Westinghouse Co. Ltd., 158 Granville St., Halifax, N.S.

GIRDWOOD, Arthur James, B.A.Sc., (Univ. of Toronto), A.C. engrg. dept., Canadian General Electric Co. Ltd., Peterborough, Ont.

HAY, Edward Campbell, B.A.Sc., (Univ. of B.C.), sales correspondent, merchandise divn., Canadian Westinghouse Co. Ltd., Hamilton, Ont.

LINGLEY, Harold Percival, B.Sc., (Univ. of N.B.), junior engr., Dept. of Public Works Canada, Saint John, N.B.

MARTIN, Colin Hector, B.Sc., (Univ. of Man.), P.O. Box 355, Selkirk, Man.

PAINTER, Gilbert Walter, B.Eng., (McGill Univ.), student engr., Canadian General Electric Co. Ltd., Peterborough, Ont.

STRATTON, William Donald George, B.Sc., (Univ. of N.B.), instr'man., Dept. of Highways, Prov. of N.B., Saint John, N.B.

WORKMAN, William Ross, B.A.Sc., (Univ. of B.C.), Coal Creek, B.C.

Students admitted

BELANGER, Guy, B.A.Sc., C.E., (Ecole Polytech., Montreal), 249 St. Catherine Road, Outremont, Que.

BOWERING, Reginald, (Univ. of Man.), 1841 Ross Ave., Winnipeg, Man.

BRADLEY, Alan Edward, B.Sc., (Univ. of Man.), (McGill Univ.), 1019 Sherbrooke St. W., Montreal, Que.

BROSSEAU, Barry Roland, (McGill Univ.), 1050 Gilford St., Montreal, Que.
CAMERON, John McClellan, B.Sc., (Univ. of Alta.), 2054 Sherbrooke St. W., Montreal, Que.
CHARTERS, Stewart Anderson, (McGill Univ.), 218 Metcalfe Ave., Westmount, Que.
CORBETT, Bruce Sherwood, (Univ. of Alta.), 11109-86th Ave., Edmonton, Alta.
CUTHBERTSON, Wellington Blakeny, B.Sc., (Univ. of N.B.), Loch Lomond Road, East Saint John, N.B.
DALE, J. Munroe, B.Sc., (Univ. of Man.), (McGill Univ.), 1019 Sherbrooke St. W., Montreal, Que.
DESMARAIS, Jean René, (Ecole Polytech., Montreal), 4856 Christophe Colomb, Montreal, Que.
DUPUY, René, B.A.Sc., C.E., (Ecole Polytech., Montreal), 1310 Maisonneuve St., Montreal, Que.
ELLIOTT, John Milton, (McMaster Univ.), 80 Chedoke Ave., Hamilton, Ont.
HEWITT, Herbert Eugene, (Univ. of Alta.), Blairmore, Alta.
JARRETT, William Frederick, (Univ. of Man.), 474 Agnes St., Winnipeg, Man.
JORDAN, Edward Conrad, B.Sc., (Univ. of Alta.), 89 Pine St., Sudbury, Ont.
LAW, Earl Fredrick, (Queen's Univ.), 219a Division St., Kingston, Ont.
LEMIEUX, Denis, (Ecole Polytech., Montreal), 3676 St. Hubert St., Montreal, Que.
MANN, Oswald Nelson, B.Sc., (N.S. Tech. Coll.), 32 Tulip St., Dartmouth, N.S.
MILLER, Errol Leslie, (McGill Univ.), 5849 Jeanne Mance St., Montreal, Que.
McNALLY, Patrick Jessett, (McMaster Univ.), Bartonville, Ont.
OLIVER, James, (Univ. of Alta.), St. Joseph's College, Univ. of Alberta, Edmonton, Alta.
SOMERS, Claude Judson, (Univ. of N.B.), 88 Carleton St., Fredericton, N.B.
THOMAN, Russell Kenneth, (Queen's Univ.), 13 Barnesdale Ave. N., Hamilton, Ont.

Committee on Consolidation

Report for March 1936.

As recorded in the March issue of the "Journal," a most important conference in the interests of the engineers throughout Canada was held in Hamilton on Friday, February 7th, 1936, at which were present the following representatives:—

Members of the Dominion Council of Professional Engineers:

C. C. Kirby, (*President*).	Saint John, N.B.
Archie B. Crealock, (*Vice-President*).	Toronto, Ont.
Colonel F. H. G. Letson,	Vancouver, B.C.
P. M. Sauder,	Lethbridge, Alta.
D. A. R. McCannel,	Regina, Sask.
Professor F. R. Faulkner,	Halifax, N.S.

Other Representatives of the Provincial Professional Associations:

E. A. Wheatley,	Vancouver, B.C.
T. C. Main,	Winnipeg, Man.
J. M. H. Cimon,	Quebec, P.Q.
A. B. Normandin,	Quebec, P.Q.
G. Stead,	Saint John, N.B.

Members of the Committee on Consolidation, representing The Engineering Institute of Canada:

Dr. O. O. Lefebvre,
J. B. Challies,
Dr. F. A. Gaby,
Professor R. E. Jamieson,
Gordon McL. Pitts,
(*Chairman*).

The whole day was given over to a discussion of the many problems involved in the consummation of the consolidation of the profession in Canada, and a great step in this direction was achieved in the fullest spirit of cooperation.

The Committee on Consolidation held its sixteenth meeting in Montreal on Saturday, March 21st. Mr. A. B. Crealock, Vice-President of the Dominion Council and recently appointed by that Council as one of its representatives on the Committee on Consolidation, was present. Unfortunately, Mr. C. C. Kirby, President of the Council and its other representative on the Committee, was unable to be present as the railroad services from the Maritimes had been temporarily interrupted by the floods.

The Committee carefully considered the recommendations of the conference of February 7th, item by item, and it was unanimously agreed that they should form the basis for further progress in the development of a scheme of consolidation mutually acceptable to the whole profession, so that a complete consolidation throughout Canada may be achieved.

A statement of the proposed programme of the Committee will be prepared for the next issue of The Journal.

Gordon McL. Pitts, *Chairman.*

March 31, 1936.

Publications of Other Engineering Societies

From time to time announcements have appeared in The Engineering Journal regarding the exchange arrangements which exist between The Engineering Institute of Canada and the founder engineering societies of the United States, whereby members of The Institute may secure the publications of the American societies at special rates which in most instances are the same as charged to their own members. A list of these publications with the amounts charged is given below, and subscriptions may either be sent direct to New York or through Headquarters of The Institute.

	Rate to E.I.C. Members	*Rate to Non-Members*
American Society of Civil Engineers		
Proceedings, single copies	$ 0.50	$ 1.00
Per year	4.00*	8.00†
Civil Engineering, single copies	.50	.50
Per Year	4.00	5.00
(Plus $.75 to cover Canadian postage.)		
Transactions, per year	6.00‡	12.00¶
Year Book	1.00	2.00
(Other publications 50 per cent reduction on catalogue price to E.I.C. members.)		
American Institute of Electrical Engineers		
Electrical Engineering, single copies	$ 0.75	$ 1.50
Per year	6.00*	12.00*
(*Plus postage $1.00.)		
Transactions—annual, bound	6.00*	12.00*
(*Plus postage $1.00.)		
(The single copy price for Electrical Engineering includes postage charge.)		
The American Society of Mechanical Engineers		
Mechanical Engineering, single copies	$ 0.50	$ 0.60
Per year	4.00*	5.00
(*Additional Postage to Canada $.75, Outside United States and Canada, $1.50.)		
Transactions, bound, published annually, about May 15 (price of current volume)	10.00	15.00
(Other publications, same rate to E.I.C. members as to A.S.M.E. members.)		
Journal of Applied Mechanics—Quarterly publications. Dates of issue: March, June, Sept., Aug.	4.00	5.00
American Institute of Mining and Metallurgical Engineers		
Mining and Metallurgy, single copies	$ 0.50	$ 0.50
Per year	3.00*	3.00
(*Plus $1.00 for foreign postage.)		
Metals Technology, single copies	1.00	1.00
Per year	7.00*	7.00
(*Plus $.50 for foreign postage.)		
Transactions, per volume	5.00*	7.50
(*Plus $.60 for foreign postage.)		
Technical publications: Supplied at $.01 per page, with a minimum charge of $.25 for single copies, or at a subscription rate per year of	7.00*	7.00
(*Plus $1.00 for foreign postage.)		

* *If subscription is received before January 1st, otherwise $5.00.*
† *If subscription is received before January 1st, otherwise $10.00.*
‡ *If subscription is received before February 1st, otherwise $8.00.*
¶ *If subscription is received before February 1st, otherwise $16.00.*

Speakers for Branch Meetings

During this summer and fall there will no doubt be many members of The Institute travelling on business or pleasure throughout Canada.

It is suggested that advantage can be taken of this, and that those members who are willing to present papers, and can make arrangements to do so, will plan their itineraries to call on as many branches as time will permit.

This applies particularly to those branches so situated that interesting papers are difficult to obtain.

Great benefits result from such visits and all members who contemplate trips should communicate either with the General Secretary, or with R. L. Dobbin, M.E.I.C., chairman of the Papers Committee, c/o Peterborough Utilities Commission, Peterborough, Ontario.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

American Society of Mechanical Engineers: Transactions 1935, Vol. 57.
Institution of Water Engineers: Transactions 1935.
Junior Institution of Engineers: Transactions 1934-35.

Reports, etc.

McGill University: Annual report 1934-35.
Canada, Bureau of Statistics: Central Electric Stations in Canada, Census of Industry 1934.
International Tin Research and Development Council: The Corrosion of Tinplate, by T. P. Hoar.
Canada, Dept. of Labour: Strikes and Lockouts in Canada and other Countries during the year 1935.
New Brunswick Electric Power Commission: Annual Report for the year ending October 31st, 1935.

Technical Books, etc.

Montreal Special Libraries Association: Current List of Periodicals in Montreal and District.
Standard Handbook for Electrical Engineers, 6th edition. (*McGraw-Hill Book Company, New York.*)
Empire Development, by Sir Robert Hadfield, Bt. (*Chapman and Hall.*)
An Introduction to the Metallurgy of Iron and Steel, by H. M. Boylston. (*John Wiley and Sons, New York.*) (*Renouf Publishing Company, Montreal.*)
Mesure des Températures, by G. Ribaud. (*Librairie Armand Colin, Paris.*)

BOOK REVIEWS

Heat Engines

By S. H. Moorfield and H. H. Winstanley. Edward Arnold and Company (Longmans, Green and Company, Toronto). 1935. 2nd edition. 4¾ by 7½ inches. 326 pages. Diagrams, photos. $2.00.

Reviewed by Professor I. M. Fraser, A.M.E.I.C.*

This is the second edition of a book first published in 1931 and written by Moorfield and Winstanley, Technical College, Wigan. The book aims to provide a course in heat engines for students wishing to obtain the Ordinary National Certificate in mechanical engineering.

The chapter headings are Work, Power, Energy, Heat and its Measurement, Thermal Properties of Perfect Gases, Heat Changes in Gases, Expansion and Compression of Gases, the Working Cycle, Formation and Properties of Steam, Steam Boilers, the Steam Engine Plant, Hypothetical Indicator Diagrams, Entropy and Entropy Diagrams, Entropy Applications, Valves and Valve Gear, Combustion, Internal Combustion Engines, Heavy Oil Engines, Efficiencies, Engine Trials, Speed Control and Steam Turbines.

In order to give an idea of the treatment of the subject, the chapter headed The Steam Engine Plant is taken as an example. Five pages cover the essentials of a steam plant, the reciprocating engine, and steam movements; and include one full page diagrammatic sketch of the arrangement of the power plant; the remaining ten pages cover condensers and include two full pages of illustrations. Three examples are worked and nine problems are also given.

The treatment of the subject is extremely brief. The reviewer's principal criticisms of the book are the use of the Centigrade thermometer scale and Centigrade heat units, and the omission of any reference to the Mollier chart or its use.

The book will be useful to those wanting an elementary text on heat engines with a large number of problems.

*Professor of Mechanical Engineering, University of Saskatchewan, Saskatoon, Sask.

Materials Testing

By I. H. Cowdrey and R. G. Adams. John Wiley and Sons (Renouf Publishing Company, Montreal), New York. 1935. Second Edition. 5¾ by 9¼ inches. 144 pages. $1.75.

Reviewed by H. W. B. Swabey, M.E.I.C.*

This book is primarily intended for the student in the study of the testing of materials but may also be considered as a useful book of reference for the more advanced engineer engaged in such work. It commences with a short outline of the province of the testing engineer and a section covering advice in making up reports of materials tested. A description is given of the various types of testing machines and equipment with clear illustrations and diagrams and methods for carrying out the various tests.

It has not been the intention of the authors to cover the whole field of testing of materials but to include only the more common tests which have been generally adopted as standard. Most, if not all, the methods given follow those adopted by the American Society of Testing Materials and many references are given to the Standard Specifications of that Society.

In this second edition of their book, produced after a lapse of ten years, the authors have made revisions and have included many new improvements in equipment and practice which have been developed in the past few years. These for instance include the later methods and equipment used in the hardness testing of metals and more recent information on the testing of concrete.

A chapter is given on the "verification of testing machines" describing the various equipment and methods used for this purpose.

The appendix at the end of the book contains a number of tables and graphs including useful summaries of tests of metals and woods taken from the A.S.T.M. Standard Specifications and other works.

*Inspecting Engineer, Donald-Hunt Limited, Montreal.

International Conference on Soil Mechanics and Foundation Engineering

June 22nd-26th, 1936

To establish a closer relation between the Conference and those engineers who are interested in its aims but find themselves unable to attend in person, the Committee on Organization has created the grade of Absentee Member. In this way it is possible for engineers to obtain the Abstracts and Proceedings which are available only to members. The cost of printing the Abstracts and Proceedings will be at least five dollars per set, and the Committee has decided that the membership fee for absentee members as well as for participating members shall be five dollars.

In order for abstracts to be included in the volume which will be mailed to the members of the Conference before the meetings and which will be the subject of the discussions during the meetings, they must reach the Secretary before April 15th, 1936. In addition, the Committee on Organization has decided that particularly valuable abstracts received after April 15th and before June 6th, 1936, will be made available to the members of the Conference in printed form at the time of the meetings.

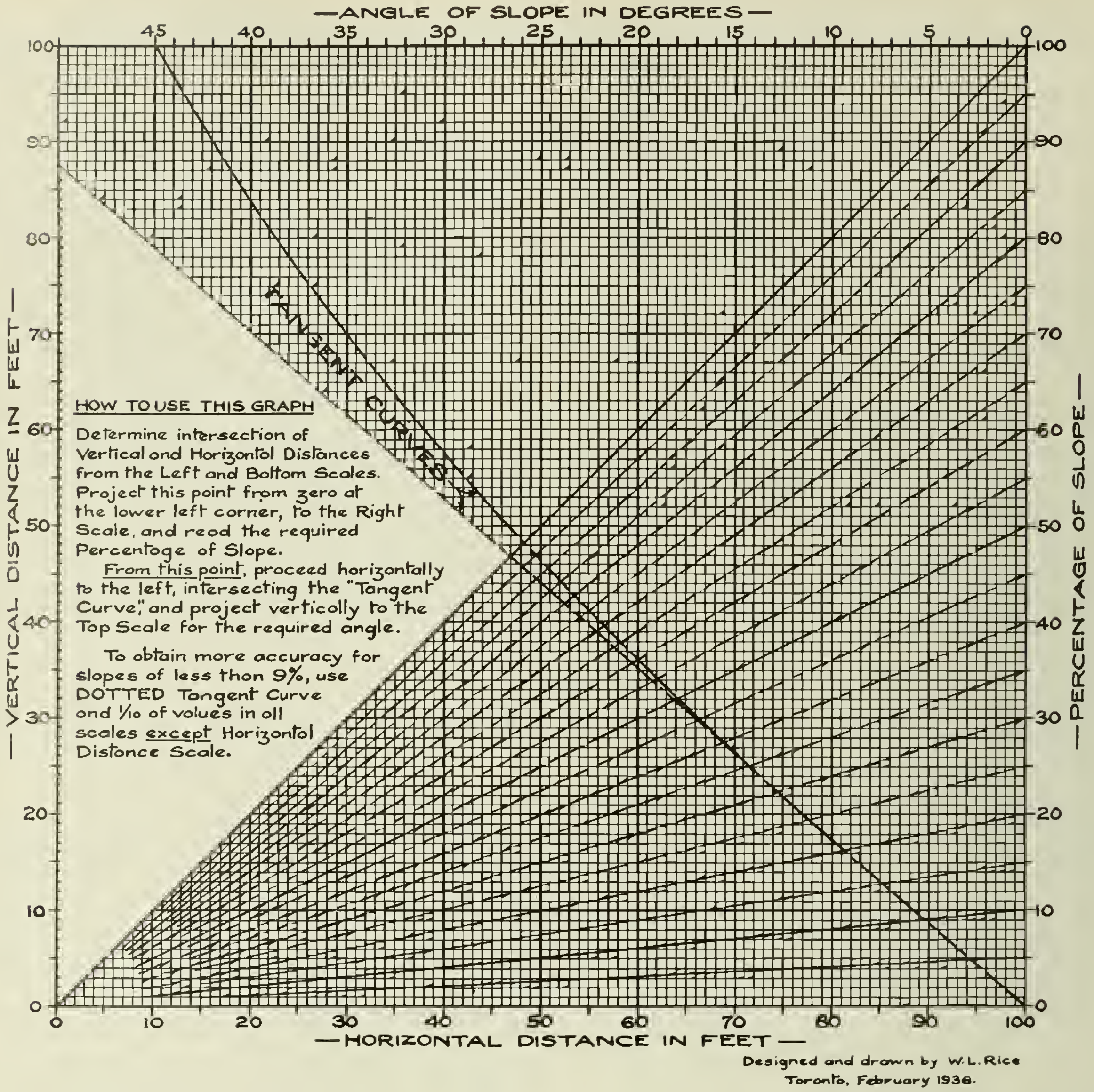
The Committee wishes to stress once more the importance of contributions containing accurate observation data on the behaviour of soils under various conditions. No observer should feel that the lack of a satisfactory theoretical explanation will render his contribution inferior. In the rapid development of Soil Mechanics new theories have been quickly created and again abandoned, while complete and accurate observation data possess a permanent and often increasing value, as further information relating to the same problem becomes available. These remarks are not intended to discourage the contribution of theoretical studies which have proved their value in advancing our knowledge.

The discussions are open to the absentee members as well as to the participating members of the Conference. Absentee members are requested to submit their discussions to the Secretary before June 20th, 1936. Written discussions from either grade of member must not exceed 1,000 words, but no restriction is placed on the number of necessary tables and figures.

It has been proposed that the Conference establish a committee for the standardization of symbols and methods of representation of observation data. All members interested in this subject are requested to assemble suggestions for the use of this committee.

Applications with the required fees, must reach the Secretary, Mr. Arthur Casagrande, Foundation Conference, Harvard Engineering School, Cambridge, Mass., not later than May 1st, 1936, to guarantee a right to a copy of the Abstracts and Proceedings of the Conference, and for participating members, to living accommodations at Harvard University during the period from June 21st to 27th, 1936.

Information on the programme of the Conference will be announced at a later date.



Percentages and Angles of Slopes

W. L. Rice, Jr.E.I.C.,
Water Supply Section, Department of Works, Toronto, Ont.

A simple graph has been devised which should prove very helpful to engineers who are required from time to time to estimate or check the percentages and angles of slopes or grades. The author has found it to be of great value in connection with pipe lines, and its usefulness can be extended in as many fields of practice as may be desired.

The graph consists of four scales and a superimposed tangent curve, laid out on ordinary squared paper.

First, a scale at the left side, reading upward from 0 to 100, for the vertical distance in feet.

Second, a scale at the bottom, reading left to right from 0 to 100, for the horizontal distance in feet.

Third, a scale at the right side, reading upward from 0 to 100, giving the percentage of slope.

Fourth, a scale at the top, reading right to left, from 0 to 45, giving the angle of slope in degrees.

The percentage of slope is obtained by projecting a line from 0 at the intersection of the vertical and horizontal scales, through the intersection point of the given vertical and horizontal distances, to meet the percentage of slope scale, at which point the required reading is taken.

As the vertical distance divided by the horizontal distance is the tangent of the angle subtended by the horizontal line and the sloping line, the Percentage of Slope Scale is also a scale of tangents multiplied by 100. The tangent corresponding to a 100 per cent slope is 1.0, giving an angle of 45 degrees.

The top scale being equally graduated between 0 and 45 degrees, the tangent curve is plotted from the different tangent values, and superimposed upon the graph. By proceeding horizontally to the left from the percentage of slope scale to intersect the tangent curve, and then projecting vertically upward to the top scale, the required angle of slope is found.

To obtain more accuracy for slopes less than 9 per cent, use the actual given horizontal value and ten times the given vertical value. Then take one-tenth of the result indicated by the scale for the required percentage of slope. For the corresponding angle of slope, use the dotted tangent curve, and one-tenth of the result indicated by that scale.

The Engineering Institute Library

An excellent collection of engineering literature is to be found in the library of The Engineering Institute, 2050 Mansfield Street, Montreal, Que.

This comprises some five thousand volumes, and nearly two hundred technical journals and magazines are received regularly.

A list of information readily available on any desired subject can be furnished on request. Technical books are loaned for a period of two weeks or longer if required, on deposit of $5.00 per volume. This deposit is refunded on return of the book to the library.

The library is open from 9 o'clock a.m. to 5 o'clock p.m. and the reading room from 9 o'clock a.m. to 6 o'clock p.m. On Saturday the hours are 9 a.m. to 1 p.m. and 9 a.m. to 6 p.m.

BRANCH NEWS

Edmonton Branch

R. M. Hardy, Jr.E.I.C., Secretary-Treasurer.
M. L. Gale, A.M.E.I.C., Branch News Editor.

A regular meeting of the Edmonton Branch of The Engineering Institute of Canada was held at the MacDonald hotel, Edmonton, on Tuesday, February 5th, 1936. After the business of the meeting had been dealt with, F. K. Beach, M.E.I.C., chairman, introduced Alex. Ritchie, A.M.E.I.C., Superintendent of the City of Edmonton Power Plant, who presented a paper on "Treatment of Water."

TREATMENT OF WATER

Mr. Ritchie introduced his subject by giving a synopsis of the progress made in the way of improved methods for the purification of water during the last forty years. The stage has now been reached where the public expect and demand the best.

The speaker then dealt with the Edmonton plant, tracing its growth from 1910 to the present day. In 1910, the plant consisted of a sedimentation basin and six wood-tub filters. Additions have been made at different periods, and today, Edmonton boasts of an efficient purification system. Mr. Ritchie presented a layout plan of the present plant to show the progress of the water from the time it was taken into the pump pit and delivered into the city mains.

The Saskatchewan river, from which Edmonton draws its water supply, has a wide variation in flow, and is, therefore, subject to a large amount of turbidity at different stages. The water-shed of the river covers considerable area, and the purification of the water presented several problems. In 1926 a start was made to study these problems. A model basin was constructed and experiments carried out to decrease the turbidity of the water. A system of settlement by artificial sedimentation with coagulation was developed. Since 1934, a qualified chemist has been employed and experiments have been carried out to remove certain tastes and to improve the colour of the water. As a result of these tests, the system of purification was changed with improved results.

The speaker read the research reports and showed graphically the benefits obtained. Figures were quoted to show the cost of the different treatments.

An interesting discussion followed the presentation of the paper.

THE USE OF TEMPERATURE STATISTICS IN THE GAS BUSINESS

On Thursday evening, February 27th, 1936, thirty-five members of the Branch gathered at the MacDonald hotel, Edmonton, to hear Julian Garrett, M.E.I.C., manager of the Northwestern Utilities Limited, give a paper on "The Use of Temperature Statistics in the Gas Business."

Any gas company operating in this province has to continually study the relation which exists between temperature and gas consumption. In Alberta, the quantity of gas used for space heating is a high percentage of the total amount used.

Temperature readings and weather statistics are supplied by the government meteorological station at Edmonton. The company keeps a record of the temperatures at its regulating stations located in different sections of the city. The government readings are used in all calculations.

With the use of slides, the speaker explained in detail the purpose and application of the study of the relationship between gas consumption and temperature. Although this study was chiefly concerned with mass consumption and in estimating the peak hourly demand, it was shown and explained how it was possible to apply the knowledge gained to many useful purposes. The company was able to make analyses of the gas consumption by individual customers; to estimate decrease in consumption because of greater efficiency; to make computations of unbilled revenue; and to make comparisons between estimated and actual sales. Budgeting, the forecasting of future sales, and future development were other features that were dealt with on a systematic basis. The speaker pointed out that this study could never be reduced to an exact science, due to the whims of human nature and the vagaries of temperature.

The paper was followed by a period of questions and discussion.

Hamilton Branch

A. Love, M.E.I.C., Secretary-Treasurer.
A. B. Dove, Jr.E.I.C., Branch News Editor.

The results of the Branch Students' contest held last December were announced at The Institute luncheon on February 6th, 1936. Mr. Hollingworth, chairman of the Branch, presented prizes to the successful contestants. W. Preston, S.E.I.C., received a cheque for $15. This was the first prize and was awarded for his paper on "Why That Kind of a Bridge?" E. C. Hay, S.E.I.C., obtained second place for his paper on "Selection Factors of Photo-Electric Cells," and received a cheque for $10.

The judges in this contest were L. W. Gill, M.E.I.C. (chairman), Professor Dawes, C. D. Meals, M.E.I.C., A. R. Hannaford, A.M.E.I.C., and G. Moes, A.M.E.I.C. This committee will make comments on the papers at the next Branch meeting.

The high light of the year for the Hamilton Branch was The Institute Annual Meeting just recently held in Hamilton. The registration of three hundred and thirty-five men and seventy-seven ladies was most gratifying; the interest shown in the technical sessions and visits to plants, and the splendid attendance at the social functions was most encouraging to those in charge of arrangements.

The next meeting of the Branch will be on March 26th, at which Professor T. R. Loudon, M.E.I.C., of Toronto University, will lecture on "Aircraft Development in Europe." The Hamilton Flying Club has been invited to attend this meeting, and it is anticipated there will be a large attendance.

On April 3rd, the annual joint meeting with the Toronto Section A.I.E.E. takes place in the Westinghouse Auditorium, Hamilton. The speaker will be Mr. R. H. Wright of the Westinghouse Electric and Manufacturing Company, Pittsburgh, U.S.A., and he will speak on "Electric Appliances for Steel Mills."

This joint meeting has become an annual institution and attracts a large number. Considering the magnitude of the steel industry in Hamilton, the subject should make a wide appeal.

Preparations are being made to have the subject of the "Grand River Conservation Scheme" presented at a Branch meeting in May. A group of Brantford, Galt and Kitchener engineers have been studying and planning this scheme for a number of years and have something of economic and engineering interest to show.

W. Hollingworth, M.E.I.C., the genial chairman of the Branch, is at present holidaying in England, but is expected back in Hamilton early in May. In addition to being chairman of the Branch, Mr. Hollingworth carried out most efficiently the duties of chairman of the Annual Meeting Committee and chairman of the Finance Sub-committee. He carries with him the best wishes of the members of the Branch for a pleasant voyage and an enjoyable holiday.

Lakehead Branch

G. R. McLennan, A.M.E.I.C., Secretary-Treasurer.

The regular monthly dinner meeting of the Lakehead Branch was held on March 18th, 1936, in the Royal Edward hotel, Fort William, Ten members and five guests attended, with the chairman, R. J. Askin, A.M.E.I.C., presiding.

The guest speaker was Mr. J. Murie, district manager of the Canadian General Electric Company. Mr. Murie gave an interesting lecture on the use of electric arc welding in industry and illustrated it with lantern slides. He showed also a moving picture dealing with the manufacture and the laying of electrically welded steel pipe.

Lethbridge Branch

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

Mr. E. J. Lemieux, Division Master Mechanic, of the Canadian Pacific Railway, Lethbridge Division, was the special speaker at the regular meeting of the Lethbridge Branch of The Institute, held in the Marquis hotel, on January 25th, 1936.

Chairman W. L. McKenzie, A.M.E.I.C., presided at the dinner with forty members, affiliates and guests present.

A pleasant duty was performed by the chairman of the Branch when he presented G. N. Houston, M.E.I.C., with a handsome travelling bag; a memento from the members of the Lethbridge Branch.

After a short intermission the chairman called on J. M. Campbell, A.M.E.I.C., to introduce the speaker of the evening, Mr. E. J. Lemieux, who spoke on the Canadian Pacific Railways "8000 Locomotive."

LOCOMOTIVE "8000"

There are only two of this particular type of locomotive on the North American continent, the New York Central operates one and the Canadian Pacific Railway the other, although the C.P.R. locomotive is of much larger construction.

The "8000" was built in the C.P.R. Angus shops at Montreal, and was designed throughout by C.P.R. engineers and designers except for the steam generating system. The engine is an oil burner, weighing approximately 300 tons, operates under power from ten drivers and on its present run between Field and Revelstoke, B.C., some sections of the run which have a 2.2 per cent grade for miles, makes a speed of 35 miles per hour. Its maximum load is approximately two hundred loaded cars. The tender carries 21,000 gallons of water and 4,100 gallons of fuel oil.

The multi-pressure steam generating system is different from the ordinary locomotive boiler in that it has three separate units, one carrying 250 pounds pressure per square inch, another 850 and a high pressure closed circuit carrying 1,350 to 1,700 pounds per square inch.

The closed circuit is made up of steel drums and tubes and forms the firebox and combustion chamber. This unit is filled to a certain level with distilled water and the high temperature steam passing through heat transfer coils generates steam in the high pressure (850 pounds per square inch) boiler.

Steam from the high pressure boiler is used to transmit power in the high pressure cylinder which is placed between the two outside low pressure cylinders.

The low pressure (250 pounds per square inch) boiler is of the ordinary shell type without a firebox, steam being generated by direct heat from the firebox and combustion chamber formed by the closed circuit unit. Steam from the low pressure boiler is used to operate the two low pressure cylinders.

At the conclusion of Mr. Lemieux's address three reels of motion pictures were screened illustrating this locomotive.

Following the films, Mr. J. M. Campbell moved a very hearty vote of thanks to Mr. Lemieux for his very interesting address, to the Canadian Pacific Railway for the loan of the films and to Mr. C. M. Watson for the operation of the motion picture projector.

London Branch

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

The regular monthly meeting of the Branch was held on February 20th, 1936, at 8.00 p.m. at the City Hall Auditorium.

The speaker was Ralph C. Manning, A.M.E.I.C., engineer for the Canadian Institute of Steel Construction, and his subject "The Steel Industry in Canada."

H. A. McKay, A.M.E.I.C., manager of the London Structural Steel Co., was called upon by the chairman, Jas. Ferguson, A.M.E.I.C., to introduce the speaker.

The Steel Industry in Canada

The importance of steel in every day life was first pointed out and was emphasized by describing what would take place if steel were to be suddenly eliminated from our civilization. Due to the great accuracy with which the chemical and physical properties can be controlled by the manufacturer steels can be made with properties suitable for any required purpose.

The new era of alloy steels was discussed with its effects upon the automobile industry as an example of what will occur in many other lines of business as these new materials come into more general use.

The steel mills in Ontario alone have a capital investment of 85 million dollars with an annual normal payroll of 14 million dollars, and the structural steel industry has 15 million dollars invested in it with a normal annual payroll of 5 million dollars.

The huge freight given to Canadian transportation systems can be better understood when it is remembered that each ton of steel made requires 6 tons of raw materials. In addition, structural steel must be carried from the mill to the fabricating shop and later from the shop to the job site.

The talk was followed by a series of pictures giving views in Canadian steel mills and of the operations in Canadian fabricating shops. Views of recent construction work showing the use of steel in many types of bridges, buildings and other structures were included.

The recent revamping of the old radial bridge at London and conversion into the new bridge at Richmond Street was described and illustrated. Great credit was given to both the city engineer and bridge engineer of London, who took advantage of that quality of steel which permits unforeseen problems of structural change to be readily solved.

Considerable interest centred around a display of structural steel sections made and rolled in Canada which had been brought by the speaker.

An interesting discussion then followed, many questions being asked and answered by the speaker.

Moncton Branch

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

Domestic air Conditioning

"Domestic Air Conditioning" was the subject of a very instructive illustrated address delivered before the Branch on February 28th by Professor H. W. McKiel, M.E.I.C. The meeting was held in the city hall. H. B. Titus, A.M.E.I.C., chairman of the Branch, presided.

The object of air conditioning is to make living conditions comfortable and more healthy. Formerly it was believed that ventilation meant nothing more than the prevention of an excessive accumulation of CO_2 in the air. Now it is known that CO_2 merely dilutes the oxygen of the air and increases the rate of breathing but up to 25 per cent is not not fatal. Six people sealed in a room 12 by 14 by 9 would, in ten hours, produce a CO_2 concentration of only 3½ per cent. They would, however, be very uncomfortable. Air conditioning is concerned not only with the oxygen content of the air but also with the circulation and relative temperature and humidity, all of which have a definite bearing on comfortable living conditions. A modern unit will automatically furnish a plentiful supply of fresh air (5 changes per hour), maintain a uniform temperature and humidity, summer and winter, filter dust, dirt and bacteria, and to a certain extent prevent odours. It will also keep the air in circulation.

Air conditioning of large buildings has been common for many years but has only recently come into use in private dwellings. Professor McKiel described, in detail, experimental work he had done in developing a unit suitable for the average family and which could be purchased for a price varying from $150 to $175.

A vote of thanks was extended the speaker on motion of G. E. Smith, A.M.E.I.C., seconded by R. H. Emmerson, A.M.E.I.C.

Concrete-Steel Composite Construction

On March 13th a paper on "Concrete-Steel Composite Construction" was read before the Branch by R. S. Eadie, A.M.E.I.C., designing engineer, Dominion Bridge Co., Montreal.

The type of construction described by Mr. Eadie differs from ordinary reinforced concrete in that the main reinforcement consists of light welded steel trusses which are used to support the forms and wet concrete. Advantages claimed for this system are, elimination of shoring and the placing of reinforcing. The fire hazard is reduced and all parts of the job made more accessible. Cracks are avoided since the greater part of the defliction takes place as soon as the concrete is poured. The address was illustrated with numerous lantern slides.

A vote of thanks to Mr. Eadie was moved by H. J. Crudge, A.M.E.I.C., seconded by J. A. Godfrey, Branch Affiliate.

Montreal Branch

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

Junior Section Night

On February 6th the Branch held its semi-annual Junior Section Night, at which two papers were presented: "La Détermination des Coefficients de Débit des Barrages Déversoirs à l'Aide de Modèles Réduits" by Raymond Boucher, Jr.E.I.C., and "Economical Quantity Inventory Control" by Mr. R. F. Brosseau.

Mr. Louis Trudel was formally presented with the certificate which carries with it a prize of $25.00, presented by The Engineering Institute for high academic standing in his year at the Ecole Polytechnique. A number of these prizes are presented each year to students in the various universities throughout the country.

Mr. C. E. Frost was in the chair.

Wave Filters

Mr. C. E. Lane of the technical staff of the Bell Telephone Laboratories, New York, presented a paper entitled "Wave Filters—Their Uses and Characteristics" on February 13th. The paper described in detail the theory and application, performance characteristics and practical application of filter networks. The paper was well illustrated with slides. Prior to the meeting an informal dinner was held at the Windsor hotel. Professor G. A. Wallace, A.M.E.I.C., was chairman.

Junior Section

On February 17th two papers were presented before the Junior Section of the Montreal Branch, one entitled "Various Types of Anti-Friction Bearings" by H. Little, S.E.I.C., sales engineer with R. and M. Bearings Canada Limited, and the other "Petroleum Products with Particular Reference to their Use in Modern Automobiles" by R. S. Weir, Jr.E.I.C., assistant engineer with the Industrial Lubrication Division of the Imperial Oil Company Limited, Montreal.

H. C. Butler, Jr.E.I.C., acted as chairman.

Fire and Explosion Hazards

At a meeting of the Branch held on February 20th, J. R. Donald, M.E.I.C., president of Donald-Hunt Limited, Montreal, presented a paper entitled "Fire and Explosion Hazards from Industrial Products." The speaker attributed sewer fires and explosions in part to the lack of proper insulation of gasoline tanks and the like. This has become an important problem in all municipalities and is a matter demanding the recognition and study of engineers so that adequate regulations can be enforced.

The Boulder Dam

On February 27th, 1936, Dr. W. Munroe White, chief engineer of the hydraulic division of Allis-Chalmers Manufacturing Company in Milwaukee, addressed the Branch, describing the technical aspects of the development which has for its primary purpose the regulation of the Colorado river. The paper was most interesting, and was illustrated with a large number of slides. Prior to the meeting an informal dinner was held at the Windsor hotel. J. A. McCrory, M.E.I.C., presided.

Junior Section

On March 2nd an interesting discussion took place on the recent trend towards employing engineers in connection with plant operation, supervision and maintenance, and the possibility of increasing the demand for this type of engineering service. The principal speakers were R. J. Durley, M.E.I.C., who spoke on "Experience of the Institute Employment Service"; Dean Ernest Brown, M.E.I.C., on "The University Viewpoint"; J. B. D'Aeth, M.E.I.C., on "Viewpoint of Engineers Generally," and T. Moran, manager of the Papineau factory of the Dominion Rubber Company on "Actual Experience in Employment of Engineers in a Manufacturing Plant."

There was a large attendance. E. R. Smallhorn, A.M.E.I.C., was in the chair.

The Life and Inventions of James Watt

Professor R. W. Angus, M.E.I.C., head of the Department of Mechanical Engineering at the University of Toronto, addressed the Branch on March 5th, his subject being "The Life and Inventions of James Watt." The speaker outlined the story of James Watt's early difficulties, his later successes, and his lasting influence on modern life and industry. January 19th, 1936, was the 200th anniversary of the birth of James Watt. The paper was illustrated with slides.

An informal dinner was held at the Windsor hotel before the meeting. Professor C. M. McKergow, M.E.I.C., presided.

SYNCHRONOUS MOTORS AND THEIR APPLICATION

On March 9th Mr. J. A. H. Leach-Porter of the Canadian Westinghouse Company's engineering staff spoke on the characteristics, design and application of synchronous motors in industry. Slides illustrated the paper. H. C. Karn, A.M.E.I.C., was in the chair.

FIFTY YEARS OF SHIPBUILDING

F. W. Bridges, M.E.I.C., Port Warden of the Port of Sorel, spoke on March 12th, his subject being "Fifty Years of Shipbuilding, a Retrospect." Mr. Bridges gave a most interesting talk, covering shipbuilding in general and in Canada for the past fifty years. He discussed comparisons of equipment and tools in shipyards; naval vessels, their changes and development; improvements and developments in propelling machinery; mercantile marine; and the changes and developments in passenger liners and cargo vessels. Slides and photographs illustrated this talk. R. Ramsay, A.M.E.I.C., was chairman.

ACOUSTICS AND SOUND CONTROL

On March 19th, Mr. Carl W. Meyer, staff engineer of the Johns-Manville Company, New York, spoke on "Acoustics and Sound Control," which included a demonstration covering sound waves and their actions, acoustics, the use of the noise meter, and the psychological effect of noise on workers.

Prior to the meeting an informal dinner was held at the Windsor hotel. G. McL. Pitts, A.M.E.I.C., presided.

Niagara Peninsula Branch

P. A. Dewey, A.M.E.I.C., Secretary-Treasurer.
C. G. Moon, A.M.E.I.C., Branch News Editor.

A Branch meeting was held at the King Edward hotel, Niagara Falls, on February 24th, 1936, at which T. Kennard Thomson, M.E.I.C., of New York, was the principal speaker.

Chairman Paul Buss, A.M.E.I.C., and vice-chairman George Wood, A.M.E.I.C., reported upon the activities at the recent Annual Meeting in Hamilton and intimated that, in their opinion, the problems of consolidation had been definitely advanced by the opportunities for discussion there presented.

Mr. Thomson, who is a native of the Niagara District, told something of the difficulties which beset a consulting engineer in the New York area.

Aided by slides, Mr. Thomson explained some of the technical details in caisson sinking and clay jointing, and emphasized the caution with which piles should be driven by showing pictures of many which had been dug up with their lower ends broomed and useless for a length of several feet due to overdriving. The largest single-compartment caissons measuring 46 feet by 131 feet were recently built and successfully launched at Hartford, Conn.

The author then showed his audience many pictures of the early days in and around Manhattan.

New engineering work as a cure for depressed conditions has been a popular theme for many years. These should be technical schemes which are economically sound and will bring a return upon the money invested. Among such proposed works which Mr. Thomson has investigated from an engineering and financial standpoint are the following:—

(1) An extension of Manhattan Island for a distance of six miles down the river, thus adding a valuable area for an airport, parks and new building.
(2) A three-deck belt line road around the waterfront of the island, having six tracks on the ground level and ramps inclined from the upper decks to adjoining streets carried via arcades through the nearby buildings.
(3) A dam in the lower Niagara river, above Queenston, creating a hundred foot head which is now wasted in the rapids and generating some two million horse power.
(4) The creation of three new rivers paralleling the Mississippi and draining that area which lies between Ohio on the east and Wyoming on the west. Surplus waters during the flood season could be diverted to these channels and stored for irrigation or power use.

At the close of the meeting Harold Bucke, M.E.I.C., thanked the speaker on behalf of the Branch for a very pleasant evening.

Ottawa Branch

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

INSULATION OF HOUSES

At one of the largest attended luncheon meetings of the season, C. D. Niven, Ph.D., of the National Research Council, spoke at the Chateau Laurier on February 13th, 1936, to the Ottawa members on "The Insulation of Houses and Allied Problems." E. Viens, M.E.I.C., chairman, presided and additional head table guests included: Col. the Rev. R. H. Steacy, Dr. Charles Camsell, M.E.I.C., Col. A. F. Duguid, A.M.E.I.C., Col. C. J. Burritt, C. A. Bowman, A.M.E.I.C., Dr. J. D. Babbitt, L. L. Bolton, M.E.I.C., Dr. R. W. Boyle, M.E.I.C., H. F. Lambert, A.M.E.I.C., F. H. Peters, M.E.I.C., and Alan K. Hay, A.M.E.I.C.

The insulation of houses against loss of heat is attracting attention due to the saving in fuel which can thereby be effected. Dr. Niven dealt with the subject under three headings: (1) what parts of the house to insulate, (2) what kinds of insulation to use, and (3) how much to put on.

The type of house construction, whether or not the attic is to be occupied, the desirability of utilizing the fire-protection possibilities of the insulator to the best advantage (providing it is fire-resisting), and cost are the considerations which should be taken into account in determining what parts of the house to insulate.

The choice of insulating material is not a simple proposition as in addition to the above such things must be considered as whether or not the material is moisture and vermin-proof, and whether it can be easily handled.

Dr. Niven at this point dealt with the technical points involved in determining these and referred to methods used at the National Research Laboratories for obtaining the K value of insulators under test. The K value he defined as a measure of the British Thermal Units of heat transferred in an hour through a one-foot-square and one-inch-thick slab of the material under test when the difference in temperature between the two surfaces during the test is one degree Fahrenheit. The apparatus used may be a "hot plate apparatus" or a "hot box apparatus." In the former an electrically-heated hot plate is placed between two identical slabs of the material under test, the latter being cooled on the outside by a brine circulation. In the "hot box apparatus" a single sample of the material under test is placed between two air chambers.

In the Ottawa area the economical thickness of insulation is said to be the equivalent of one and a half inches of fibre board. The head of a large insulation firm, however, held that three inches were necessary. Professor Hoffman of Purdue University considered one-half inch of fibre board sufficient in that part of the continent and this implied an expenditure of from 2 to 3 per cent of the cost of the building. In Canada one should reckon on an expenditure of at least 6 or 7 per cent of the total cost of construction. One must never expect 100 per cent efficiency in heat saving by insulation and furthermore, the saving in fuel is not proportional to the amount of insulation put on. For this reason the one and a half inches fibre board insulation thickness is given as the economical thickness.

Toward the latter part of the address the speaker briefly touched upon problems allied to house insulation, such as ventilation and heating for comfort and health.

TRANSPORTATION IN SOUTH AFRICA

David de Waal Meyer, Trade Commissioner at Montreal for the Government of the Union of South Africa, spoke at the noon luncheon on February 27th at the Chateau Laurier on "Transportation in South Africa." Dr. R. W. Boyle, M.E.I.C., acted as chairman and head table guests also included: Sir Francis Floud, Hon. Grote Stirling, M.E.I.C., Dr. Charles Camsell, M.E.I.C., Col. A. E. Dubuc, M.E.I.C., J. G. Parmalee, L. D. Wilgress, F. H. Peters, M.E.I.C., John Murphy, M.E.I.C., and A. R. Whittier, A.M.E.I.C.

Of the four provinces comprising the Union—Cape Colony, Orange Free State, Transvaal, and Natal—the last is the only one with a more or less tropical climate. Twenty miles inland from the Coast, sugar cane and oranges are produced. Farther inland in the Transvaal higher elevations temper the climate considerably. In the Union there are six million blacks and two million whites.

Primitive modes of transportation in the early days, survivals of which still exist, were the ox wagon, the mule wagon, the Cape cart, and horseback. Sometimes the ox wagon, itself capable of hauling some 3½ tons and drawn by as many as sixteen oxen, was replaced by the mule wagon, a lighter conveyance, which required from six to eight mules; and the Cape cart, lighter still, which could attain a speed up to 7 or 8 miles an hour.

The first railways were laid into the country in 1860 but little progress was made in construction until after the discovery of diamonds in 1867. Railways, privately built, began to converge into the diamond country from Cape Town and East London. In order to prevent duplication and to follow along definite policies of development, the government took over the railways in 1873. In 1885 with the discovery of gold in the Transvaal, a great impetus was given to railway construction. Farming and other development has subsequently had its share in bringing about railway construction but minerals have been the chief stimulus.

At the time of the Union in 1910, the railways were brought under one administration. Now with 13,500 miles of line, some 500 track miles of which are electrified, the country on a population and area basis, is in advance of both Canada and Australia. First class passenger rates are slightly lower than those of Canada. As an example, it is possible to obtain sleeping accommodation on the trains for 75 cents while three excellent meals per day may be obtained for $2.15. The distance of about 1,000 miles from Cape Town to Johannesburg with a rise in elevation over the route of 6,000 feet is accomplished in about thirty hours.

In order that the railways might not suffer unduly from motor truck competition the Motor Carrier Transportation Act of 1930 provides definite safeguards for the railways and in addition, the railways also operate their own lorries over certain areas. So rigid is the control over private motor carriers where railway interests are affected that there is a tendency to turn back to the ox wagon as a means of transport.

South Africa's gold production served to assist that country out of the depression once it went off the gold standard in 1932.

As for the railways, by the end of 1932, previous deficits gave way to a fairly substantial surplus; by 1933 they were able to liquidate all accumulated deficits; and by 1934 to restore wage cuts and to create a wage stabilization fund and other funds for the benefit of their employees.

If gold maintains its present position, it is possible that the government may undertake an extensive policy of tarring the 73,000 miles of more important roads in the country, utilizing a by-product of the steel industry for the purpose and half of the twelve cents per gallon tax on gasoline has been allocated for road improvement.

In addition to local aeroplane services operated under the South Africa Railways, Airways and Harbours Administration (SARAH), the Imperial Airways under a subsidy of $200,000 per year operate a bi-weekly service from England to South Africa. This subsidy is to be doubled next year so that by the end of 1937 a four and a half day service by flying boat between London and Durban, carrying mail at regular postal rates, will be in force.

Peterborough Branch

W. T. Fanjoy, A.M.E.I.C., Secretary-Treasurer.
E. J. Davies, A.M.E.I.C., Branch News Editor.

Nickel-Cast Iron Alloys

At the regular monthly meeting of this Branch on Thursday, February 20th, 1936, the speaker was Mr. Hugh G. Watson, foundry engineer of Peckovers, Limited, distributors for International Nickel.

The story in brief of nickel itself was an interesting part of the metallurgist's address. The existence of the metal later to be known as nickel was known by the Chinese many centuries before Christ, although it was not then recognized as a separate substance and its properties were not known. In the early centuries, man found nickel in alloys in meteorites.

The alloying of nickel in grey cast irons is one of the latest advances in nickel's spectacular rise in the world of metallurgy.

The fact that Canada produces 98 per cent of the world's nickel and that after 1918 there was a decided slump in the demand for nickel for war purposes, necessitated exhaustive research for domestic uses. Among the many uses which were discovered for nickel was that of alloying nickel and cast iron.

Mr. Watson discussed the mechanics of cast iron, the chemical compositions of hard and soft irons. The addition of nickel to castings produces a fine machinable metal in parts that are to be machined and yet permits the parts which require hardness to have the desired hardness. The addition of up to 1 per cent of nickel will refine the granular grain of the iron, but a greater amount than this may coarsen the grain. The added nickel increases the wear and strength of the alloy and permits a more equal distribution of stresses throughout the different sections of the casting.

Mr. Watson emphasized particularly the necessity of determining the correct amount of nickel to be added for each particular requirement.

Slides were shown covering applications of this alloy, among which were cylinder walls, gears under steady load, large dies such as automobile fender dies, refrigerator panels, and dies for drop forgings. In mentioning the use of nickel-molybdenum-cast iron crank shafts for small engines used for starting large tractor engines, Mr. Watson predicted a much wider use of nickel cast iron shafts in internal combustion engines in the future.

The speaker emphasized that up-to-date designers should base their designs for castings on the metals available to-day, because modern metals have higher tensile strengths and are more uniform through the section than formerly. This permits lower factors of safety with greater strength, lighter sections and lighter casting weights to offset the greater metal costs.

Ni-Resist metal which contains 14 per cent of nickel and is a non-magnetic, heat resisting up to 1,500 degrees F., corrosion resisting alloy, was recommended as a substitute for cast iron where a better metal was required. Its particular application includes cylinder lines for auto bus engines to resist corrosion, and grate bars to resist warping and burning.

Quebec Branch

Jules Joyal, A.M.E.I.C., Secretary-Treasurer.

At a luncheon-meeting held at Chateau Frontenac, on February 17th, 1936, the members of the Quebec Branch had the pleasure of hearing P. S. Gregory, M.E.I.C., assistant general manager, Shawinigan Water and Power Company, Montreal, deliver a very interesting lecture entitled

Utilization of Secondary Electric Energy for the Production of Steam

The speaker was introduced by Alex. Larivière, M.E.I.C., chairman of the Quebec Branch, and at the conclusion of his talk he was thanked by J. A. Duchastel, M.E.I.C., on behalf of those present.

The development in this country of the electric boiler for the purpose of using waste or secondary electric energy for the production of steam, is due largely to the work of F. T. Kaelin, M.E.I.C., in 1918.

The electric boiler consists of a closed tank connected to a water supply from which water may be drawn off at the bottom and steam at the top. In the electric boiler there is no heating surface, the generation of steam taking place throughout the water; as a consequence, no portion of the apparatus is at a higher temperature than the temperature of the steam which means that electric boilers have long lives and are inexpensive to maintain.

The price which the usual consumer can afford to pay for electric energy to replace coal is easy to calculate and, in the province of Quebec, under present conditions, a power company can obtain 0.8 to 1.2 mils per kilowatt-hour for secondary energy used to replace coal.

The contracts for the sale of such energy provide that the amount to be furnished for the generation of steam may be reduced or entirely discontinued at the sole discretion of the power company; therefore, the latter usually feels obliged to install at its own expense the necessary boiler to utilize the power.

The cost of electric boilers ranges from three to five dollars per kilowatt of capacity, including transformers.

The electric generation of steam is advantageous, both to the power company and to the user. The power company at least obtains something for energy that would otherwise go to waste. The user saves in several ways: the rate paid for electric energy is below the cost of the fuel it replaces; there are also incidental and substantial savings made by the user in operating and maintenance costs, and usually in labour costs.

The sale of secondary energy by the Shawinigan Water and Power Company for the production of steam has grown from 34,000,000 kilowatt-hours in 1921 to 2,219,000,000 kilowatt-hours in 1935, or in a period of fourteen years it has increased sixty-five times.

Saint John Branch

F. A. Patriquen, Jr.E.I.C., Secretary-Treasurer.

February 20th—The Branch held a very successful and enjoyable dinner and dance at the Admiral Beatty hotel. The dinner started at 7.30 p.m. and everyone seems of the opinion that the Engineers' Dinner Dance should be an annual event.

The Foundation Scarboro

March 5th—D. O. Turnbull, Jr.E.I.C., of the Foundation Company of Canada, addressed the Branch on the "Foundation Scarboro," the Foundation Company's hugh floating crane. The crane has a 150-ton capacity on its present job on the reconstruction of berths 1, 2, 3 and 4 at Saint John but can and has been rigged for a 300-ton lift. The details of the boat were illustrated by slides and were very interesting. The "Scarboro," besides being used as a crane, can supply high pressure air for air tools of all kinds, also air for caisson work and divers and can also supply electric power. Every precaution has been taken to deliver clean air to caisson workers and divers such as a specially ventilated and separate compressor room, oil separators, etc.

Vancouver Branch

T. V. Berry, A.M.E.I.C., Secretary-Treasurer.

Complimentary Dinner to the President

The President of The Engineering Institute of Canada for the year 1936, Ernest A. Cleveland, M.E.I.C., Chief Commissioner of the Greater Vancouver Water District and Chairman of the Vancouver and Districts Joint Sewerage and Drainage Board, was the guest of honour at a dinner held at the Terminal City Club, Vancouver, by the Vancouver Branch on Thursday, February 27th.

James Robertson, M.E.I.C., chairman of the Branch, acted as toastmaster. The toast to the honoured guest was proposed by Major W. G. Swan, M.E.I.C., a past chairman of the Branch. The toast to The Engineering Institute of Canada was proposed by Chas. Brakenridge, M.E.I.C., Vancouver City Engineer, and responded to by A. S. Wootton, M.E.I.C., Vancouver Parks Board Engineer, both past chairmen of the Vancouver Branch.

Short contributions to the programme were given by the following gentlemen: E. A. Wheatley, M.E.I.C., Registrar of the Association of Professional Engineers of B.C.; W. H. Powell, M.E.I.C.; H. B. Muckleston, M.E.I.C.; Newton J. Kerr, M.E.I.C.; and A. E. Foreman, M.E.I.C.

The President, Mr. Cleveland, in his address, gave a short account of the proceedings at the Annual Meeting of The Institute held at Hamilton, with special reference to the deliberations at these meetings with respect to "Consolidation in Canada."

Mr. Cleveland then gave a very interesting résumé of the presidential address of the first President of The Engineering Institute, Mr. Thos. C. Keefer, C.M.G., delivered on the occasion of the first Annual General Meeting of the Canadian Society of Civil Engineers on January 12th, 1888.

In this first presidential address Mr. Keefer reviewed the engineering progress in Canada during his year of tenure of office under the following heads:—Railway, Hydraulic, Civic, Mechanical, Mining and Electrical. Many interesting details and statistics in connection with engineering projects completed, under construction or contemplated in Canada in

1887, were mentioned. Mr. Keefer closed his address with a reference to electricity—a great and important power in nature. He said in part, "we cannot forecast its future or limit its possibilities of production. Economically, it may yet become the cheapest source of power with the exception of wind, water, gravity or the sun, and by chemical energy may become as constant and universal in application as the sun itself, to which, in common with the other natural powers, we may ascribe its origin, even though that be the limit of our knowledge concerning it."

The singing of "Auld Lang Syne" then terminated a very pleasant function.

Victoria Branch

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

By the kind invitation of the Officer Commanding Military District No. 11 the Victoria Branch of The Engineering Institute of Canada met at the Garrison Officers' Mess, Work Point Barracks, Esquimalt, on February 7th, 1936, at 8 p.m., to hear an address delivered by Lt.-Col. E. C. G. Chambers, A.M.E.I.C., District Engineer Officer, on "The Development of an Air Mail Route Through B.C."

The chairman of the Branch, I. C. Barltrop, A.M.E.I.C., presided.

The Development of an Air Mail Route Through B.C.

There are many factors to be taken into consideration in the preliminary plans for the development of an air mail route, the chief of these being the selection of aerodromes or intermediate landing fields and their preparation. The advantage of as direct a route between terminals as possible is paramount especially when radio beacons are being considered. The availability of electric power for the illumination of landing fields and for radio beacons is also a consideration which has to be taken into account. The distance between beacons is such that at 1,000 feet elevation over a beacon the next beacon should be visible. Owing to the rugged nature of the topography of British Columbia many beacons will be necessary.

Preliminary surveys to determine the most feasible route were made in 1929 and 1930 by Squadron Leader Tudhope and the Lethbridge-Princeton-Vancouver, or southern route of approximately 568 miles was finally chosen. In 1930 the principal sites of the intermediate landing fields were secured and the work started. This route included landing fields at Fernie, Cranbrooke, Yahk, Kitchener, Creston, Salmo, Columbia Gardens (Trail), Grand Forks, Midway, Rock Creek, Osyoos, Oliver, Keremos, Princeton, Hope, and Vancouver. Emergency fields at Merritt, Lytton, and Boston Bar were included as an alternative to the shorter though more hazardous Princeton-Hope section.

Runways in all directions are advantageous if possible, but the fields have been generally laid out 600 feet wide by 2,700 feet in length running in the direction of the valleys and prevailing winds. The fields are finished to a two per cent grade.

The following is the present state of development of the various landing fields under consideration:—

Fernie, Yahk and Creston	Finished.
Columbia Gardens	Available.
Rough Creek and Midway	To be finished this year.
Osyoos	Not yet started.
Oliver	Being developed.
Keremos	Site located.
Princeton	Complete, but to be extended 300 feet.
Merritt	Site selected.
Lytton	Site obtained.
Boston Bar	Should be finished this year.
Hope	Finished except for seeding.

The maintenance of the fields is left for the present to local residents who have been given grazing privileges. The route is primarily for air mail service, although it will be available for all traffic. The Hope to Princeton section is particularly hazardous due to the high altitude and heavy precipitation, and all types of aircraft may not be able to use it, hence the alternative route via Merritt, Lytton, and Boston Bar.

The aerodrome at Hope as yet is the only one to be drained, where an experiment is being carried out with ordinary agricultural tile. Western rye, brome grass, and crested wheat are the principal grasses used for seeding the fields. The two maximum elevations are attained at the fields at Fernie which is 3,306 feet, and at Rock Creek which is 1,992 feet in elevation.

Colonel Chambers' address was profusely illustrated with slides depicting the development of the undertaking which is being carried out under the direction of the Department of National Defence.

J. N. Anderson, A.M.E.I.C., moved a hearty vote of thanks to the speaker both for his excellent address and the invitation to Work Point Barracks.

The members of the Victoria Branch spent a very pleasant social evening on March 17th, 1936, on the occasion of their fifth annual bridge party, which was held at the home of Duncan MacBride, A.M.E.I.C., past chairman of the Branch. The spacious home was tastefully decorated in appropriate colours for Saint Patrick's day. Forty members, their wives and friends, were accommodated at ten tables of contract bridge.

Following a delightful refreshment hour Mrs. MacBride graciously presented the evening's prizes to the respective winners, these being as follows:—

1st ladies'	Mrs. E. I. W. Jardine
1st gentlemen's	Mr. H. C. Kinghorn
Consolation	Mrs. I. C. Barltrop
	Mr. George Phillips
Hidden prizes	Mrs. J. C. MacDonald
	Mrs. R. F. Davy
	Mr. I. C. Barltrop

The table arrangements and catering were left in the hands of a committee of ladies consisting of the wives of the Branch Executive Committee.

At the conclusion of the evening the chairman, I. C. Barltrop, A.M.E.I.C., proposed a hearty vote of thanks on behalf of all present to Mr. and Mrs. MacBride for their kind hospitality in acting as hosts for the evening. Mr. MacBride replied expressing the hope that many more such occasions might in the future be enjoyed by the members of the Victoria Branch.

Winnipeg Branch

T. J. F. Cunningham, A.M.E.I.C., Secretary-Treasurer.
H. L. Briggs, A.M.E.I.C., Branch News Editor.

Annual Supper Dance

The Winnipeg Branch combined with the Association of Professional Engineers of the Province of Manitoba for the annual engineering supper dance, held February 10th in the Crystal ballroom of the Royal Alexandra hotel. On this occasion the event met with even more than the usual success. S. E. McColl, A.M.E.I.C., was in charge of the arrangements.

At the annual meeting of the Branch, held on February 20th, 1936, the result of the election of officers was announced.

Sewer and Water Lines in the Frozen North

Mr. Frank Simmons presented a paper describing the water and sewer installation for the town of Flin Flon, Manitoba, which has grown up beside the site of the Hudson Bay Mining and Smelting Company's plant.

The town pumping plant is fed from a small lake through a 20-inch uninsulated wood stave pipeline. In the winter season, a 60-h.p. boiler is used to heat the water—initially 34 degrees F.—to 58 degrees F. before it is pumped into the 6-inch high pressure main supplying the town. The high pressure main is looped through the town back to the pumping plant, and circulation around the loop adjusted by means of a throttle valve so that the temperature of the return water can be regulated within limits. To prevent freezing, services are also circulated by means of one or more small orifices which allow a certain amount of water to flow continually through the service pipes. This water is not wasted, but returned to the pumping plant by a low pressure pipeline.

The water mains, together with the sewer line, are installed in boxing. Sawdust is used for insulation where the boxing is above ground which is largely the case, and cinders where the system is below ground level. The installation has been very successful, little trouble having been experienced from freezing.

Water consumption is 25 to 30 gallons per day per capita.

The sewage sumps are controlled by automatic float valves. Any heat in the sewer lines assists in preventing the freezing of the water mains by reason of laying alongside each other. The sewage is at present treated in the plant of the Hudson Bay Mining and Smelting Company before being discharged into another small lake.

Even in the summer time, the muskeg underlying the greater part of the town is frozen at depths greater than three feet. One situation worthy of note which was met with at the time of the installation was a depth of 13 feet of frozen muskeg, then a stratum of 1½ feet of running quicksand, then an additional 12 feet of frozen muskeg.

The vote of thanks to the speaker was moved by N. M. Hall, M.E.I.C.

T. C. Main, A.M.E.I.C., Branch representative to the annual meeting of The Institute held at Hamilton, presented his report regarding the considerable progress which had been made toward the consolidation of the engineering profession at a special meeting on March 9th.

Scalebuoys, and Scale Removal from Boilers

The speaker of the evening was Dr. A. D. Blackhurst, of Toronto.

It was observed years ago that the presence of an electric eel in water would cause clarification to take place. The same effect has been developed in the scalebuoy, which consists of a bulb of special glass, filled with various inert gases at 5 inches vacuum and a small amount of mercury. When the scalebuoy is agitated, static electric effects are produced by friction of the mercury on the glass or by breaking up of the mercury droplets. In some as yet unexplained manner the scale forming solids in steam boiler feedwater previously exposed, settle out as mud which can readily be blown out instead of forming scale as with unexposed water.

Scalebuoy effect can be imparted to water by 15 seconds of influence time. The effect will last twenty minutes, after which the desired results begin to disappear unless the water is re-exposed. Treatment must take place close to the boiler. The greatest effect is obtained in water at 125 degrees F., it is slightly less at 180 degrees F., while increasing the temperature at the time of treatment still further results in the effect quickly becoming negligible.

It has been found that scalebuoy effect results in reduced surface tension at the water surface. Measurement of surface tension, and comparing it with that of untreated water, is the present method of detecting scalebuoy influence. Scalebuoy treatment does not change the *PH* or the dielectric constant of the water.

After a lengthy discussion of the paper by the meeting, a vote of thanks to the speaker was moved by E. V. Caton, M.E.I.C. The meeting then adjourned for light refreshments.

List of New and Revised British Standard Specifications

(Issued during December, 1935)

B.S.S. No.

239—1935. *White Pigments for Paints.* (Revision.)
Embodies all B.S. Specifications relating to white pigments and includes the revised form of No. 239, Genuine White Lead; No. 254, Zinc Oxide (Types 1 and 2); No. 296, Lithopone; No. 338, Antimony Oxide; No. 392, Titanium Dioxide; and two new specifications: No. 636, Titanium White; No. 637, Basic Sulphate of Lead.

241—1935. *White Oil Pastes for Paints.* (Revision.)
Embodying all the B.S. Specifications for white oil pastes and includes the revised form of No. 241, Genuine White Lead Oil Paste; No. 273, Zinc Oxide Oil Paste; No. 297, Lithopone Oil Paste.

434—1935. *Asphaltic Bitumen Rood Emulsion for Penetration (Grouting and Semi-Grouting) ond Surfoce Dressing.* (Revision.)
Requirements tightened and a further test, the liability test, added.

449—1935. *The Use of Structural Steel in Building.* (Revision.)
Provides for the use of high tensile steel conforming to B.S.S. No. 548 and to remove ambiguities. The appendix on materials has been revised and higher pressures for both concrete and brickwork are now permitted under specified conditions.

638—1935. *Rating of Electric Arc Welding Plant and Equipment for Welding Accessories.*
Provides for the rating of metal arc welding plant, such as welding sets, motors, resistances, reactors, transformers and flexible leads. Also deals with the requirements for welding accessories, such as electrode holders, hand shields, helmets, gloves and aprons from the aspect of ensuring safety.

639—1935. *Covered Electrodes for Metal Arc Welding Wrought Iron and Mild Steel (for Hond Operation).*
Provides for four grades of electrodes which are differentiated according to their mechanical properties.
Other requirements included relate to the strength and stability of the covering, and the size and workability of the electrodes. Detailed method of obtaining the all-weld-metal test piece on which the mechanical properties are determined is given in an appendix.

640—1935. *Bare Rod or Wire Electrodes for Metal Arc Welding Wrought Iron and Mild Steel.*
Provides for three grades of electrodes which are differentiated according to their chemical composition. For general information mechanical properties obtainable from all-weld-metal test pieces of each grade are given and a description of method of obtaining test pieces.

643—1935. *Capping Metol for Steel Wire Ropes.*
Provides for the quality, methods of sampling, and socketing of wire ropes by means of fusible metal. Applicable to colliery ropes and to steel wire ropes for general engineering purposes.

648—1935. *Schedule of Unit Weights of Building Materials.*
Provides for a schedule of agreed weights for the most generally used building materials. The weights are intended for use in calculations when actual weights are not available.
Variation in weights of different materials with thickness and moisture as well as the weights of individual specimens of materials also given.

649—1935. *Internal Combustion Engines for Stationory and Industriol Purposes and for Auxiliary Purposes on Shipboord, Excluding Carburettor-Type Engines.*
Covers all internal combustion engines of the non-carburettor type and is in line with proposals being considered internationally. (This Specification supersedes B.S.S. Nos. 120—1925, 211—1925, 212—1925 and 213—1925.)

Copies of these new specifications may be obtained from the Publications Department, British Standards Institution, 28 Victoria Street, London, S.W.1, and in Canada from the Canadian Engineering Standards Association, 79 Sussex Street, Ottawa, Ont.

Seventeenth Annual Meeting of the Corporation of Professional Engineers of Quebec

The Corporation of Professional Engineers of Quebec held its seventeenth Annual Meeting in Montreal, at the headquarters of The Engineering Institute of Canada, on Wednesday, March 25th, 1936, under the presidency of Dr. A. R. Decary, M.E.I.C., of Quebec.

The meeting brought a large attendance of engineers from all parts of the province of Quebec. The reports of Council and of the various committees show a great deal of activity within the Corporation. Thirteen cases of illegal practice of the engineering profession were reported to the Corporation and acted upon. At the Quebec Legislature the Council of the Corporation has carefully followed the legislation and succeeded in preventing the adoption of a number of laws that might be detrimental to the interest of the profession.

The report of the Committee on Code of Ethics contained several proposed changes and additions to the present Code, which will be submitted to the membership at large, by letter ballot, for approval.

A lively discussion took place regarding the misuse of the term "Engineer" in the daily newspapers of the province when referring to machinists or mechanics, and it was suggested that the editors be circularized calling their attention to the fact that only the members of the Corporation have the right by law to take the title of "Engineer" in the province of Quebec.

The much debated question of consolidation of the engineering profession in the Dominion was again discussed, and it was proposed that the meeting request the Council to continue its efforts towards consolidation following the lines of the report adopted at the Annual Meeting of the Corporation in 1935, and that the Council not agree to the setting up of any council or committee representing all the professional associations of the Dominion other than as a temporary organization to facilitate consolidation of the engineering profession in Canada.

Immediately after the meeting the Council met and elected the following officers: President, Dr. A. R. Decary, M.E.I.C., Vice-President, Mr. J. M. Robertson, M.E.I.C., Honorary Secretary-Treasurer, Mr. S. F. Rutherford, A.M.E.I.C. The other members of Council are: Dr. O. O. Lefebvre, M.E.I.C., Col. C. N. Monsarrat, M.E.I.C., and Messrs. A. B. Normandin, M.E.I.C., Hector Cimon, M.E.I.C., and Jas. A. Kearns, A.M.E.I.C.

The Royal Funeral and London Transport

Figures issued by the London Passenger Transport Board show that on the day of the Royal funeral the number of passengers carried on the underground totalled 2,000,000 and, though this was equalled on Silver Jubilee Day, on that occasion it was spread over nineteen hours instead of over only nine. Actually, most of the traffic was handled between 5.30 a.m. and 8.30 a.m. Some 120,000 passengers used Hammersmith station during the nine-hour period, while the 100,000 mark was reached at Piccadilly Circus and Liverpool street. Victoria and Hyde Park Corner each accounted for 80,000 and Waterloo and Charing Cross for 60,000. For six hours trains passed through Charing Cross underground station at the rate of 206 per hour, the District Railway accounting for 80, the Morden-Edgware line for 70, and the Bakerloo Railway for 56. The passenger density for the system was 160,000 per hour for nine hours, compared with 56,000 on an ordinary working day.

Midwest Power Engineering Conference

This Conference will be held in Chicago from April 20th to 23rd inclusive, 1936, and an invitation has been extended through the Canadian Legation at Washington to all the power engineers of Canada to participate therein.

The programme of the Conference, covering four days, will deal with practically every phase of power engineering, including Diesel power, power piping, fuels, refrigeration, etc.

An Engineering and Power Exposition will be held during the same week and in conjunction with the Power Conference, and will contain exhibits featuring the newest developments in modern equipment for industrial and utility plants.

Further information may be obtained from the Secretary, Midwest Power Engineering Conference, 308 West Washington Street, Chicago, Illinois.

Canadian Chemical Association

Arrangements have been made to hold the next convention of the Canadian Chemical Association at the General Brock Hotel, Niagara Falls, Ontario, on June 9th, 10th, and 11th, 1936.

This convention will be a joint meeting of the Canadian Chemical Association and the Canadian Institute of Chemistry, and will be under the management of the Niagara District Chemical and Industrial Association.

Preliminary Notice

of Applications for Admission and for Transfer

March 26th, 1936

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, 1936.

R. J. Durley, Secretary.

*The professional requirements are as follows:—

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

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

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

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

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

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

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

FOR ADMISSION

DAVIS—GEORGE CLARK, of Winnipeg, Man., Born at Winnipeg, May 8th, 1907; Educ., B.S. (C.E.), Univ. of Man., 1933; 1925-27, with Carter Halls Aldinger Co. as material checker, and as asst. to supt. on various jobs; 1928 (summer), demonstrating road surfacing materials to Alberta; 1929, in charge of surfacing 300 miles Alberta roads; 1930, supt. in charge of gravel crushing plant, Regina; 1933-34, in charge of central heating substations; 1934 to date, asst. to vice-president in charge of new installations and of improvements to existing heating plants in apartment blocks, theatres, churches and private dwellings, etc., Northern Public Service Corporation Ltd., Winnipeg, Man.

References: C. S. Clendening, E. V. Caton, A. W. Fosness, G. H. Herriot, F. V. Seibert, J. N. Finlayson.

HALLIDAY—JOHN CURRIE, of 21 Carleton St., Thorold, Ont., Born at Southwick, Scotland, May 31st, 1885; Educ., Technical training in connection with apprenticeship.; 1902-07, 5 years apprenticeship mechanical engineering, J. & R. Wallace,, Engineers, Castle Douglas, Scotland; 1910-13, machine shop foreman, The Manson Company, engrs. and mfrs., Thorold; 1913-16, machine shop foreman, Confederation Construction Co., Contractors, Thorold; 1916 to date, master mechanic, Beaver Wood Fibre Company, Ltd., Thorold, Ont.

References: C. W. West, P. E. Buss, E. P. Murphy, G. E. Griffiths, S. Bowen.

KNIGHT—CLARENCE ARCHIBALD, of St. John's, Nfld., Born at St. John's Jan. 18th, 1913; Educ., B.Sc. (Civil), N.S. Tech. Coll., 1935; 1933 (Oct.-Dec.), Nfld. Dockyards; 1934 (Jan.-July), United Nail and Foundry Co. Ltd.; 1934 (July-Sept.), surveying, land settlement project; at present, attached to the engrg. staff, dept. of public utilities, Highways Dept., St. John's, Nfld.

References: J. W. Morris, S. Ball, F. R. Faulkner, C. H. Wright, F. W. Angel.

LETSON—HARRY FARNHAM GERMAINE, Lieut.-Col., of 172 Alexander St., Vancouver, B.C., Born at Vancouver, Sept. 26th, 1896; Educ., B.Sc., Univ. of B.C.,1919. Ph.D. (Engrg.), Univ. of London, England, 1923. R.P.E. of B.C. A.M. Inst.M.E.; 1910-13, ap'ticeship, and 1919-21, asst. engr., Letson & Burpee, Ltd., Vancouver; 1916-18, overseas, Lieut., M.C.; 1923-31, asst. prof., and 1931-34, associate professor of mech'l. engrg., Univ. of British Columbia; 1934 to date, chief engr. and managing director, Letson & Burpee, Ltd., Vancouver. President, Assn. of Prof. Engrs. of B.C.

References: E. A. Cleveland, F. A. Gaby, J. M. R. Fairbairn, G. A. Walkem, E. A. Wheatley.

LUNDIE—JAMES, of Moose Jaw, Sask., Born at St. Thomas, Ont., April 10th, 1907; Educ., B.Sc. (C.E.), Univ. of Sask., 1930. Canadian Commercial Pilot's Licence; 1928 to date, transitman, C.P.R.

References: J. M. Campbell, H. R. Miles, H. C. Ritchie, P. C. Perry, C. J. Mackenzie, W. E. Lovell, R. A. Spencer, H. J. A. Bird.

OLSSON—HAROLD MATIAS, of Port Arthur, Ont., Born at Sjonkem; Gotland, Sweden, Feb. 24th, 1898; Educ., 1921-25, Technikum Strelitz, Mecklenburg, Bldg. Engr., 1925; 1918-20, field constrn. work, and mach. shop work in Sweden; 1925-26, with Carter Halls Aldinger Co., Winnipeg, on office bldg. constrn., field work, bldg. of concrete forms, etc.; 1926, with Dom. Bridge Co., Winnipeg, dftsman. on struct'l. steel detail; 1934 (2 mos.), design of malting plant for MacDonald Engrg. Co., Toronto; 1934-35 (4 mos.), with Anglin Norcross Ltd., Toronto; 1926 to 1931, and Sept. 1935 to date, with C. D. Howe & Co. Ltd., Consltg. Engrs., Port Arthur, Ont., on design and checking of reinforced concrete, struct'l. steel and mech'l. work in connection with grain elevators, flour and feed mills, docks, power houses, etc.

References: J. M. Fleming, G. R McLennan, B. A. Culpeper, R. B. Chandler, H. Os, G. Eriksen

PHELPS—GEORGE DYSON, of Turner Valley, Alta., Born at Crescent Lake, April 3rd, 1887; Educ., 1905-07, S.P.S., Univ. of Toronto; 1907-11, Alta. Prov. Govt., dftsman. and surveys; 1911-15, private dfting. office, Jackson & Phelps; 1916-19, overseas, Labour and Constrn. Units; 1920-23, production dept., Imperial Oil, mostly drawing; 1923-25, Tropical Oil, Colombia, S.A., mostly drawing; 1925-29, International Petroleum Co., Peru, S.A., mostly instrument work; 1929 to date, field engr., Royalite Oil Co., Turner Valley, Alta.

References: W. Jackson, S. G. Coultis, F. G. Bird, J. Haddin, F. J. Heuperman, R. S. Trowsdale.

ROGERS—JOSEPH VICTOR, of Island Falls, Sask., Born at Victoria, B.C., Feb. 13th, 1911; Edc., B.A.Sc. (E.E.), Univ. of B.C., 1933; 1933-34, engr. dftsman, on highway projects, etc., Work Point Barracks, Victoria, B.C.; 1934-35, power plant operator, and Sept. 1935 to date, asst. engr., dftsman., and instr'man., constrn. of power plant extension leading to installn. of 19,000 H.P. generator at plant of Churchill River Power Co., Island Falls, Sask.

References: F. S. Small, E. C. G. Chambers, W. H. Powell.

RUGGLES—EDGAR LENFEST, of 2032 Athol St., Regina, Sask., Born at Regina, Aug. 12th, 1913; Educ., B.Sc. (C.E.), Univ. of Sask., 1935; Summers 1930, 1931 and 1934, with Dept. of Highways, as gravel checker, rodman on registration survey, and asst. on ground water survey; Summer 1935, head of party, Dept. of Mines. Not employed at present.

References: C. J. Mackenzie, H. R. MacKenzie, C. J. McGavin, R. A. Spencer, E. K. Phillips.

TROREY—LYLE GRAEME, of Vancouver, B.C., Born at Vancouver, Feb. 9th, 1902; Educ., B.Sc. (Eng.), Univ. of London, England, 1927. A.M.Inst.M.E.; R.P.E. of B.C.; 1923-25, junior, 1925-27, sectional engr., Kingston and Sutton By-pass Roads Constrn.; 1929-31, dftsman., 1931-33, engr. asst., Forest Surveys Divn., B.C. Forest Service; 1934, private practice, Vancouver; 1935, highway location survey, Columbia River; 1933-36 (not continuous), with Dept. of National Defence, i/c highway constrn. At present, foreman-in-charge, Camp 345, Yale, B.C.

References: E. A. Wheatley, J. Robertson, H. N. Macpherson, A. S. Wootton, P. H. Buchan.

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

BATES—CHARLES LYNN, of Squamish, B.C., Born at Mason City, Iowa, June 10th, 1880; Educ., B.Sc., Mass. Inst. Tech., 1903; 1903-04, masonry inspr. at Mattoon, Ill.; with the C.P.R. as follows: 1904-07, res. engr., constrn. dept.; 1908, asst. engr. in engrg. dept.; 1908-09, res. engr., engrg. dept. (Ft. William to Winnipeg); 1909-15, asst. engr., constrn. dept.; 1920-21, chief inspr. on pier in B.C.; 1915-20, private practice, consltg. engr. for rural municipalities in Sask.; 1921-26, consltg. engr., engr. and supt. in charge of drilling operations, and chief engr. for North Western Dredging Co. of Vancouver, and the W. D. Grant Co. of Portland, Oregon; with the Pacific Great Eastern Rly. at Squamish, B.C., as follows: 1927 (Mar.-Aug.), asst. engr., 1927 (Aug.-Nov.), engr., and 1927 to date, mtce. of way engr. (The title of chief engr. was abolished on the P.G.E. in Aug. 1927); Licenced Professional Engineer of British Columbia. (*A.M. 1907.*)

References: J. G. Sullivan, J. M. R. Fairbairn, E. A. Wheatley, F. Lee, A. L. Carruthers, J. Robertson, H. N. Macpherson, P. H. Buchan.

CHAPPELL—FRANK, of 45 Connaught St., Oshawa, Ont., Born at Cardiff, Wales, Dec. 1st, 1883; Educ., Diploma in Civil Engrg., Univ. College, South Wales; 1908-09, post-graduate work in municipal engrg., McGill Univ.; 1909-15, town engr., supt. of waterworks, Oshawa; 1915-16, industrial engr., Chevrolet Motor Co., Oshawa; 1916-19, overseas, Can. Engrs., Colonel; 1920 to date, with the General Motors Products of Canada Ltd., Oshawa, as follows: 1920-21, supt., radiator plant; 1921-30, asst. factory manager; 1930-33, factory manager; 1934 to date, public relations manager. (*St. 1908, A.M. 1913.*)
References: C. H. Mitchell, N. M. Hall, C. S. L. Hertzberg, H. N. Gzowski, H. Hadley, W. S. Wilson.

FLEMING—DAVID HOWARD, of 125 Ranleigh Ave., Toronto 12, Ont., Born at Pelee Island, Ont., Apr. 1st, 1888; Educ., B.A.Sc., Univ. of Toronto, 1913; 1913-19, asst. to city engr., St. Catharines, and instr'man., sewer section, Toronto; 1919-24, city engr., Owen Sound; 1924-29, municipal engr., with A. W. Connor, M.E.I.C., Consltg. Engr.; 1927-29, consltg. engr.; 1929-31, sales engr., Layne Canadian Co.; 1931 to date, consltg. engr., Toronto, Ont. (*St. 1912, A.M. 1916.*)
References: W. P. Near, A. W. Connor, C. R. Young, E. H. Darling, W. Hollingworth, W. L. McFaul, W. H. Magwood, A. E. Berry.

MacQUARRIE—EDISON MALCOLM, of 620 Queen St. E., Sault Ste. Marie, Ont., Born at Sault Ste. Marie, Dec. 7th, 1894; Educ., B.A.Sc., Univ. of Toronto, 1924. O.L.S. 1925; 1917-19, overseas, Can. Engrs.; 1917 (Mar.-Sept.), asst. field engr., Chester Shipbldg. Co., Chester, Pa.; with Lang & Ross Ltd., Sault Ste. Marie, as follows: 1912-14, chainman, rodman, dftsman; 1915-17, dftsman and transitman in charge of various surveys; 1919-20, transitman; 1920-24 (summers); in charge of field work; 1924-26, in charge of field work on various land surveys; roads and power lines; 1927, in charge of field work; 1926-27, dfting. and designing, Spanish River Pulp & Paper Co.; June 1927 to date, in private practice, surveying, designs, reports on engrg. works. (*St. 1920, A.M. 1927.*)
References: J. L. Lang, K. G. Ross, A. E. Pickering, H. F. Bennett, R. S. McCormick, J. W. LeB. Ross.

FOR TRANSFER FROM THE CLASS OF JUNIOR

BOYD—JOHN WILLIAM GAMBLE, of 37 Hilton Ave., Toronto, Ont., Born at Teddington, England, Feb. 10th, 1897; Educ., Toronto Technical School. Aeronautical School, Reading; 1915-18, overseas, Flight-Lieut., R.F.C.; 1918, asst. technical inspection dept., raw materials, Canadian Aeroplanes; 1919, set up and took charge of repair dept. for Can. Gen. Elec. Co. Ltd. Also with supply dept. and production engr's dept. for same company; 1921, Northern Development surveys; 1921-22, asst. and instr'man., and on subdivn. layouts for Speight & Van Nostrand; 1923, transitman, high level contours, Island Falls Development; 1923-24, charge of party on transmission line location for Kerry and Chace; 1924, asst. in plant engr's. dept., also lab. asst. and research work, Canadian National Carbon Co.; 1930, modernization and design of broadcast equipment, and 1931-34, chief engr., Canadian Broadcasting System for same company; 1935 to date, machine design, engrg. dept., Aluminum Company of Canada, Toronto, Ont. (*Jr. 1922.*)
References: M. N. Hay, R. E. Smythe, W. J. Smither, W.S. Wilson, L. A. Badgley, A. U. Sanderson.

HENDERSON—IAN GORDON, of Williamstown, Ont., Born at Mimico, Ont., Sept. 26th, 1902; Educ., B.Sc., McGill Univ., 1926; 1925, leveller, Thurso & National Valley Rly.; 1926, struct'l. steel detailer, Canadian Bridge Co.; 1927, civil engr., Anticosti Corpn.; 1927-29, field engr. and detailer, Dominion Bridge Co.; 1929-30, office engr., William I. Bishop Ltd.; 1930 (June-Dec.), office engr., Spruce Falls Power & Paper Co. (Since 1930 not engaged in engrg. work.) (*St. 1925, Jr. 1928.*)
References: D. T. Alexander, A. Peden, D. Boyd, R. E. Jamieson, J. Weir.

HUNT—ALBERT BREWER, of Montreal, Que., Born at London, Ont., June 15th, 1902; Educ., B.A.Sc., Univ. of Toronto, 1928; 1928 to date, with the Northern Electric Company, Ltd., as follows: 1928-30, engr. in charge of development and mfture of theatre equipment apparatus; 1930-31, engr. in charge of vacuum tube mfture; 1931-33, asst. operating supt.; 1933 to date, special products mfg. supt., responsible for all special products manufacturing, including design and engrg. of radio receiving sets. (*St. 1926, Jr. 1931.*)
References: W. A. Duff, J. S. Cameron, W. H. Eastlake, H. J. Vennes, J. W. Fagan, H. H. Vroom.

REEKIE—WILLIAM GEORGE, of St. Catharines, Ont., Born at Lyleton, Man., July 5th, 1898; Educ., B.Sc. (E.E.), Univ. of Man., 1926; 1926-28, dftsman., Fort William Paper Co.; 1928-29, dftsman., Backus Brookes, Fort William; 1929-34, plant engr., Murray Bay Paper Co., La Malbaie, Que.; 1935, temp. engr., Manitoba Paper Co., Pine Falls, Man.; 1935-36, engr. and Brandon Mgr., Manitoba Power Commission; at present, mech'l. engr. on Comeau Bay development, for Ontario Paper Co , Thorold, Ont. (*St. 1924, Jr. 1927.*)
References: J. P. Fraser, M. W. Turner, M. H. Jones, N. M. Hall, F. M. Corneil.

SHELTON—JAMES FREDERICK, of St. Catharines, Ont., Born at St. Helens, Lancs., England, April 26th, 1895; Educ., Oxford and Cambridge Junior Exams. In 1919 accepted as second year student in engrg. at Liverpool Univ., unable to continue on account of sickness. 1924-29, attended five fullsessions of six months each, evening classes, at St. Catharines Collegiate and Vocational School. Received Diploma, 5th year, in architectural drawing, etc.; 1910-12, junior dfting room and study of plant, Doulton & Co. Ltd., St. Helens; 1912-14, rodman, etc., C.P.R. Bassano-Empress Branch, engrg. dept.; 1915-19, overseas, Royal Engrs., Act'g. C.Q.M. Sergt., company dftsman and surveyor, senior section Sergt., military engrg. work in England and France; 1921-27, dftsman., constrn. dept., 1927-35, senior dftsman., i/c. dfting. room, Sections 3, 4 and 4b, and June 1935 to date, dftsman., Welland Ship Canal, Thorold, Ont., (*Jr. 1922.*)
References: C. W. West, P. E. Buss, F. S. Lazier, E. P. Murphy, J. C. Moyers, C. G. Moon, E. C. Little, S. Bowen.

SIMON—ROBERT CARLETON, of 4451 Notre Dame St. East, Montreal, Que., Born at Brittonville, Que., Aug. 24th, 1902; Educ., B.Sc. (Mech.), McGill Univ., 1926; with the Imperial Oil Limited, Mfg. Dept., Montreal East, as follows: 1920, mach. shop work; 1920-22, dfting. office; 1926, combustion dept.; 1926-28, designing and estimating; 1929, engr. on constrn.; 1930, special work; 1930-33, designing and estimating; 1934, estimating, and Jan. 1935 to date, inspector of refinery dept. (*St. 1925, Jr. 1931.*)
References: A. R. Roberts, F. C. Mechin, J. E. Letson, J. J. R. Scanlan, T. O. Evans, H. G. Thompson.

THICKE—JAMES ERNEST, of 4853 Western Ave., Westmount, Que., Born at New Liskeard, Ont., Aug. 8th, 1902; Educ., B.Sc., Queen's Univ., 1928; 1923-24, chainman on engrg. party, Northern Canada Power Co., Timmins, Ont.; 1925-26 (summers), transitman and asst. to res. engr. and transitman, Abitibi Power & Paper Co., Iroquois Falls, Ont.; 1927 (summer), transitman in charge of survey party, for J. S. Lanning, O.L.S.; 1928-30, student engr., General Electric Co., Schenectady, N.Y.; 1930, engrg. dept., and from 1931 to date, asst. in charge of engrg. dept., Aluminium Limited, Montreal, Que. (*St. 1926, Jr. 1931.*)
References: J. M. Gilchrist, W. B. Crombie, D. M. Jemmett, L. T. Rutledge, G. K. Waterhouse, L. L. O'Sullivan.

FOR TRANSFER FROM THE CLASS OF STUDENT

ABBOTT—HAROLD FELCH, of Beauharnois, Que., Born at St. Albans, Vt., July 3rd, 1907; Educ., B.Sc., McGill Univ., 1928; 1927 (summers), timber cruising, B.C. Forestry Dept.; 1928-29, armature winding, Messenger & Young, Auto Sales; 1929-30, engrg. dftsman., C.N.R.; 1930-32, engrg. dftsman., and designer, Beauharnois Constrn. Co.; 1932-35, mech'l. dftsman. and designer, Beauharnois Light Heat & Power Co., and 1935 to date, relay and meter supervision with same company. (*St. 1926.*)
References: B. K. Boulton, M. V. Sauer, F. H. Cothran, L. H. Burpee, P. H. Morgan, J. P. Chapleau.

AGNEW—T. CHARLES, of 350 Concord Ave., Toronto, Ont., Born at Toronto, Sept. 9th, 1906; Educ., B.Sc. (Mech.), Queen's Univ., 1929; 1925-29 (summers), master mechanic on constrn. work; 1929-32, erection engr., steam power plant equipment, Riley Engrg. & Supply Co. Ltd.; 1933, completed one year specializing at Johns Hopkins Univ.; 1934 to date, with the Minneapolis Honeywell Regulator Co., Toronto, Ont., engr., automatic controls, indicating and recording instruments. (*St. 1928.*)
References: L. T. Rutledge, G. A. Cunningham, J. H. Fox.

BERGER—BERNARD A., of 94 Windermere Rd., Windsor, Ont., Born at Montreal, Dec. 28th, 1908; Educ., B.Sc., McGill Univ., 1930; 1928, surveyor and leveller, Laurentide Constrn. Co.; 1929-31, toolmaker ap'tice; 1931-32, shopwork ap'tice, and 1932 to date, designing dftsman., Ford Motor Co. of Canada Ltd., Windsor, Ont. (*St. 1928.*)
References: W. A. Dawson, B. Candlish, J. E. Porter, H. J. A. Chambers, E. M. Krebser.

CONN—HUGH GORDON, of 41 Carrick Ave , Hamilton, Ont., Born at Napanee, Ont., Oct. 6th, 1908; Educ., B.Sc. (Mech.), Queen's Univ., 1931; 1928-31 (summers), instr'ment work, Sudbury Basin; gen. mach. shop assembly, J. Bertram & Sons; assembling and calibrating meters, Bailey Meter Co. Ltd.; assembling hydraulic lab. equipment, Queen's Univ.; 1931-32, demonstrating, physics dept., Queen's Univ.; with Proctor Gamble Co. Ltd. as follows: 1932-33, foreman in training, grease and oil refinery; 1933-34, steam, water and power engr., respons. for costs and operation of equipment. Also in charge of steam, water and power economy programme; 1934-35, master mechanic, Hamilton Plant, i/c. plant mtce., incl. installn. of new equipment, estimating, etc., from Mar. to May 1935, in same capacity at Montreal plant; Sept. 1935 to date, plant engr., Hamilton Plant, supervising all mech'l. work throughout the plant. (*St. 1931.*)
References: H. G. Bertram, F. W. Paulin, D. S. Ellis, L. M. Arkley, D. M. Jemmett, W. Hollingworth, W. B. Ford.

DUNLAP—CLARENCE RUPERT, Fl. Lieut., R.C.A.F., of Eastchurch, Kent, England, Born at Sydney Mines, N.S., Jan. 1st, 1908; Educ., B.Sc. (E.E.), N.S. Tech. Coll., 1928. One year's study at Air Armament School, Eastchurch; 1928, student course, Canadian Westinghouse Co., Hamilton; with the Dept. of National Defence as follows: 1928-29, Flying Training Courses, R.C.A.F.; 1929-32, Second in Command, and 1932-34, Commanding, Air Survey Detachment; part of 1934, chief instructor, Air Survey Course; 1934-35, O.C., Armament Flight, Camp Borden. At present attached Air Armament School, Eastchurch. Upon return to Canada, April 1936, will be instructor "Air Gunnery" at Camp Borden, Ont. (*St. 1928.*)
References: E. A. Cleveland, W. H. Powell, C. H. Taggart, F. R. Faulkner.

McLEOD—WILSON CHURCHILL, of Bourlamaque, Que., Born at Caledonia, N.S., Dec. 29th, 1908; Educ., B.Sc. (Elec.), 1930, B.Sc. (Mech.), 1934, N.S. Tech. Coll.; 1928 (summer), rodman, Geol. Survey; 1929 (4 mos.), dftsman., 1930-33, engrg. ap'tice, test, correspondence, switchboard design, Canadian Westinghouse Co., Hamilton; 1935 to date, steel heater, Lamaque Gold Mines, Bourlamaque, Que. (*St. 1930.*)
References: W. P. Copp, G. H. Burchill, P. A. Lovett, D. W. Callander, W. F. McLaren.

POWELL—JOHN GILES, of 11 Duggan Ave., Toronto, Ont., Born at Toronto, May 8th, 1909; Educ., B.A.Sc., Univ. of Toronto, 1932; 1929-31 (summers), instrument work in the field and from 1932 to date, engr. with Gore, Nasmith & Storrie, Consltg. Engrs., Toronto. Estimating and design work on filtration plants and sewage disposals, etc. (*St. 1932.*)
References: W. Storrie, N. G. McDonald, C. R. Young, J. F. MacLaren, G. G. Powell.

THOM—JAMES EDWIN, of 2220 College Ave., Regina, Sask., Born at Regina, May 28th, 1910; Educ., B.A.Sc., Univ. of Toronto, 1932; 1928-31 (summers), chainman, C.P.R., rodman, City of Regina, student welder, Steel Company of Canada; 1934 to date, mech'l. engr., engrg. dept., Imperial Oil Ltd., Regina Refinery, Regina, Sask. (*St. 1932.*)
References: E. A. Duschak, H. S. Carpenter, S. Young, A. P. Linton, J. J. White.

THOMPSON—ELIHU, of 695 Grosvenor Ave., Westmount, Que., Born at Westmount, Dec. 28th, 1908; Educ., B.Sc. (Mech.), McGill Univ., 1931; 1927-30 (summers), dftsman., Fred Thomson Co. Ltd., Northern Electric Co. Ltd., and Dominion Bridge Co.; 1931-34, mech'l. engr., Fred Thomson Co. Ltd., Montreal; 1934 to date, industrial engrg. in capacity of order analyst and asst. production engr., special products dept., Northern Electric Co. Ltd., Montreal. (*St. 1929.*)
References: C. Thomson, A. Walker, J. H. Hunter, C. M. McKergow.

VOGIN—MAURICE ALFRED, of Montreal, Que., Born at Montreal, Feb. 3rd, 1906; Educ., B.Eng., McGill Univ., 1933; 1928-31 (summers), surveying expeditions and astronomical observations; 1933-34, asst. engr., Caughnawaga bridge, St. Louis Lake Bridge Corpn.; 1934, surveying for Quebec Streams Comm.; 1935 (4 mos.), asst. engr., Raymond McDonnel; 1935 to date, junior engr., Dept. Public Works of Canada, Montreal, Que. (*St. 1930.*)
References: O. O. Lefebvre, R. DeL. French, R. E. Jamieson, E. Brown, L. H Landry, J. A. Beauchemin, J. A. L. Dansereau, J. Adam, L. V. Denis.

WATIER—ARTHUR HUBERT, of Rapide Blanc, Que., Born at Montreal, Aug. 18th, 1907; Educ., B. Eng. (Elec.), McGill Univ., 1932; 1929-30 (summers), dfting. and cable testing lab., Northern Electric Co. Ltd.; 1931 (summer), meter shop, Shaw. Water & Power Co.; 1932-33, design of installns., industrial oil burning equipment, W. N. Best Corpn. (Canada); 1933-34, inspection and report on transmission line, St. Timothee to Montreal, Canadian Light & Power Co.; 1934 to date, control operator, Shaw. Water & Power Co., Rapide Blanc, Que. (*St. 1931.*)
References: J. Morse, C. V. Christie, E. Brown, G. A. Wallace, G. R. Rinfret.

WOODS—FRANCIS CEDRIC, of 759 Moffat Ave., Verdun, Que., Born at Welsford, N.B., April 10th, 1903; Educ., B.Sc., Univ. of N.B., 1927; summer work on Geol. Surveys and with C.P.R.; 1927-30, forestry and surveying, International Paper Co.; 1930 to date, engrs. dept., City of Westmount, Westmount, Que. (*St. 1927.*)
References: P. E. Jarman, M. Wolff, P. G. Delgado, E. O. Turner, J. Stephens.

EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada

2050 Mansfield Street, Montreal

Situations Vacant

SALES ENGINEER, engineering graduate with four or five years sales experience in heating and ventilating equipment or similar work. In replying give full information as to training and experience. Apply to Box No. 1279-V.

SALES ENGINEER, young man in capacity of sales engineer and department manager for automatic sprinkler contractors. Should have experience in selling and estimating in mechanical equipment for old and new buildings. Knowledge of French preferred. State qualifications and experience. Location Montreal. Apply to Box No. 1291-V.

Situations Wanted

PURCHASING AGENT. Graduate mechanical engineer, Canadian, married, age 36, with fourteen years experience in industrial field, including design, construction and operation, eight years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on sale of surplus construction equipment. Full details on request. At present employed. Apply to Box No. 161-W.

SALES ENGINEER, S.E.I.C.; B.SC. C.E., 1930 (Univ. N.B.), P.E.N.B. Age 28. Experience includes building inspection, structural detailing, road construction, and chemical operation. Interested in sales work on the sales staff of some manufacturing or wholesale concern. Apply to Box No. 225-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

ENGINEER AND ACCOUNTANT, JR.E.I.C., (Capt. Can. Engrs., reserve). Age 35, Canadian. Experienced in mechanical and civil engineering, Diploma; general office, draughting and instrument work; assistant engineer erection Royal York hotel; assistant resident engineer T. & N.O. Ry. const. Desires position in Toronto where combination of technical and business experience will be of value, as have been director and accountant last three years. Apply to Box No. 377-W.

ENGINEER, A.M.E.I.C. Age 30. Single. Employed. Civil and mining experience, capable of designing and superintending construction of timber, concrete and steel structures, rock crushing and ore plants. Would consider position with mining or engineering company designing and building mills. Apply to Box No. 431-W.

CIVIL ENGINEER, B.A.SC. and C.E.; A.M.E.I.C., A.M. A.S.C.E., age 32, married. Experience over twelve years as assistant and resident engineer on the construction of hydro-electric, railway, and aerodrome works. Also office and teaching work on hydraulic designs and investigations, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

CIVIL ENGINEER, B.SC. '25, A.M.E.I.C., P.E.Q., single, experienced in pulp and paper mill construction and hydro-electric developments; also experienced in highway construction and topographical surveying. Available at once, location immaterial. Apply to Box No. 473-W.

MECHANICAL ENGINEER, B.SC. Age 31. Married. Last ten years includes:—Mechanical structural and reinforced concrete design in pulp and paper mills, industrial plants, hydro-electric, mine, sewers and sewage disposal plant construction. My experience also includes shop production, steam plant combustion, fuel analysing, inspecting, supervising and instrument work on industrial construction. Permanent position preferred. Apply to Box No. 521-W.

CONSTRUCTION ENGINEER, age 26, unmarried, graduate C.E. Experience includes hydro-electric, railroad, highway, and industrial plant construction, both field and office, including cost accounting, estimating, stores, layout, general engineering and supervision, as well as practical work in mechanical trades. Apply to Box No. 567-W.

Situations Wanted

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aerophotographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

ELECTRICAL ENGINEER, McGill '31, desires permanent position in engineering field. Experience includes draughting, designing and testing of induction motors, radio supervision and test, and some construction. Available immediately. Apply to Box No. 626-W.

ELECTRICAL ENGINEER, B.SC., 1926. One year maintenance, one year operating, large hydro-electric plant. Five years hydro-electric construction, as wireman and foreman, on relay, metal, and remote control installations. Also conduit and switches. Three years maintenance electrician, in pulp and paper mill. Also small power system. Desires position of responsibility. Sober, reliable and not afraid of work. Available at once. Excellent references. Apply to Box No. 636-W.

Employment Service Bureau

This bureau is maintained by The Engineering Institute of Canada for the benefit of members and organizations employing technically trained men.

An enquiry addressed to 2050 Mansfield Street, Montreal, will bring full information concerning the services offered. Details can also be obtained from Branch secretaries who are located in the larger centres throughout Canada.

Brief announcements of men available and positions vacant will be published without charge in The Engineering Journal and the Bulletin. Replies addressed in care of the required box number will be forwarded to the advertiser without delay.

An additional service also offered those who are unemployed or wish to change their positions, is the opportuuity of placing their names and records on file at 2050 Mansfield Street for consideration by employers wishing to employ engineers. This is of great assistance as many employers will not advertise or wish to locate a suitable man on short notice. If desired the information contained in these records can be kept confidential.

Forms for registration purposes may be obtained from The Institute Headquarters or Branch secretaries.

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office experience including general design and plant layout. Also two years general shop work including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer, estimator. Available on short notice. Apply to Box No. 676-W.

ELECTRICAL AND RADIO ENGINEER, B.SC. '30. Variously engaged on receiver development work, testing, and transformer development, under direction. More recent experience includes transmitter test room procedure and short wave beam transmission engineering. For further information apply to Box No. 680-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.SC. Elec. '29, B.SC. Civil '33. JR.E.I.C. Age 29. Experience includes four months with Can. Gen. Elec. Co., approximately three years in engineering office of large electrical manufacturing company in Montreal, the last six months of which was spent as commercial engineer. For the last year and a half employed in electrical repair shop. Best of references. Apply to Box No. 693-W.

Situations Wanted

MECHANICAL ENGINEER, B.SC., '27, JR.E.I.C. Four years maintenance of high speed Diesel engine units, 200 to 1,300 h.p. Also maintenance of d.c. and a.c. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.SC., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

CIVIL ENGINEER, B.SC. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.SC. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.SC., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER, M.SC., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering. Read, write and talk French. Married. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

RADIO AND ELECTRICAL ENGINEER, B.SC. '31, S.E.I.C. Age 27. Experience in installation of power and lighting equipment. Temporary operator in radio station; studio experience with part time announcing. Two summers in switchboard and installation department of telephone company, eight months on extensive survey layouts. Interested in sales work of electrical or radio equipment. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, B.SC. '29, A.M.E.I.C. Married. One year building construction. One year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

MANAFACTURERS' REPRESENTATIVE, at present doing business with leading industrial organizations in Canada, wishes to represent manufacturers of mechanical equipment. Such work as would involve technical data, and the preparation of plans where necessary, would be handled by an engineer whose experience with outstanding firms and projects, would be valuable to those seeking representation. Apply to Box No. 764-W.

CIVIL ENGINEER, S.E.I.C., B.SC. Queen's Univ. '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.SC., '25, JR.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

PLANT ENGINEER or SUPERINTENDENT, capable of supervising all phases of industrial plant operation, graduate electrical, eleven years diversified industrial experience including test course, four years on large Quebec industrial development, on construction and operation, also six years with prominent consulting firm supervising electrical and mechanical engineering projects. Age 31, single. Apply to Box No. 795-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

Situations Wanted

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.A.SC., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, S.E.I.C., B.SC. '32 (Univ. of N.B.). Age 25. Married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.SC. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

STRUCTURAL ENGINEER, B.A.SC., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.SC. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

SALES ENGINEER, A.M.E.I.C., graduate engineer, age 34, practical experience in the manufacture of power plant equipment, thoroughly conversant with Canadian power plant practice and equipment for the metal working industries. Available on short notice. Apply to Box No. 860-W.

CHEMICAL ENGINEER, B.SC. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

AGENCIES WANTED. Young engineer, B.A.SC. in C.E., with business and sales experiences, speaking fluent French, would consider representing a firm as agent for Montreal or the province of Quebec. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.SC., JR.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

CIVIL ENGINEER, B.SC., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

CIVIL ENGINEER, B.SC. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

Situations Wanted

ELECTRICAL ENGINEER, S.E.I.C., B.SC., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No. 1010-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.SC. (Queen's, '14), A.M.E.I.C., Dominion Land Surveyor, 5 months special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply to Box No. 1035-W.

ENGINEER, JR.E.I.C., E.E. '29, is very interested in applying electrical methods to cement testing and research work. Apply to Box No. 1062-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.SC. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

ELECTRICAL ENGINEER, B.SC.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

MECHANICAL ENGINEER, B.A.SC. (Univ. of B.C. '29); M.S. Age 27. Single. Four years experience in research work in applied mechanics and materials testing. Desires position involving analytical work in design, development or testing. Available on short notice. Apply to Box No. 1023-W.

PETROLEUM CHEMIST, B.SC. in Chem. Eng. Age 25. Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

CIVIL ENGINEER, B.A.SC., S.E.I.C., age 26, single. Experience includes one year in bridge construction, plain and reinforced concrete, pneumatic caissons and surveying. Available at once. Any location. Apply to Box No. 1204-W.

PHYSICIST ENGINEER, B.Sc.Mech. (Queen's 1913), M.Sc., Ph.D.Physics (McGill 1929, '30). Experience in municipal engineering, producer gas installation and operation, university plant maintenance. Experienced teacher of college physics. Industrial and pure physical research experience. Age 42. Married. Apply to Box No. 1207-W.

MECHANICAL ENGINEER, B.SC. (Queen's Univ. '28), age 36, married, desires position of trust and responsibility. Experience includes fitting and assembly of machine tools, production, draughting, and maintenance. Five years teaching draughting and mathematics. Available on reasonable notice. Location immaterial. Apply to Box No. 1210-W.

Situations Wanted

CIVIL ENGINEER, B.A., B.A.SC., S.E.I.C., Canadian, age 27, single. Experience includes eighteen months in general building construction. Writes and speaks both French and English fluently. Available at once for any suitable position in general engineering. Apply to Box No. 1211-W.

CIVIL ENGINEER, B.SC. '34 (Univ. of N.B.), age 24. Experience includes construction and highway engineering. Desires position with contracting or manufacturing firm. Interested in design. References. Wil consider any location. Apply to Box No. 1214-W.

ENGINEER, with twenty years experience in industrial pulp and paper mill, and general engineering and design Age 41. Last five years chief engineer of paper mill making newsprint specialties and toilet tissues. Apply t Box No. 1246-W.

ELECTRICAL ENGINEER, B.SC. '34 (Univ. of N.B.), S.E.I.C. Age 21, single. Desires any kind of electrics work. Will consider any location. Apply to Box No 1262-W.

CIVIL ENGINEER, B.A.SC. (Toronto '33), S.E.I.C., ag 25. Married. One year as instrumentman with provincial highways dept. Experience in concrete and retre construction, draughting, estimating and accounting One year with department of National Défence or grading and reinforced concrete construction. Apply to Box No. 1265-W.

ELECTRICAL GRADUATE, S.E.I.C., B.SC. '32, M.SC. '34 Experience includes four years as part time operator and announcer for a radio broadcast station. At presen employed in radio repair dept. of a large wholesale firm Apply to Box No. 1283-W.

ELECTRICAL ENGINEER, B.SC., E.E., A.M.E.I.C. University of Manitoba '28. Age 32. Married. Experience one year power line construction, five years resident and assistant district engineer on highway construction; two years highway traffic regulation in charge of distric office. Good connections in Manitoba and Saskatchewan. Excellent references. Available at once and wil go anywhere. Located in Winnipeg. Apply to Box No. 1316-W.

ENGINEER AND DRAUGHTSMAN, JR.E.I.C., age 33 married. Diplomas from Mtl Tech. Inst. in R.C. and Structural Design. 11½ years experience in civil engineering, draughting and instrument work. This include 7 years with M.L.H. & P. Cons. as field engineer on construction and maintenance of gas mains. Presen location Montreal. Available at once. Apply to Box No. 1326-W.

GRADUATE ENGINEER, (McGill), in responsibl charge of design, construction and operation of hydro electric plants. Also power design and mechanica maintenance of industrial plants. Apply to Box No 1328-W.

MECHANICAL ENGINEER, recent grad. University o Toronto, B.A.SC. in mech. engrg, 24 years old, S.E.I.C. now managing a chain store, desires engineering work Present location So. Ontario. Location immaterial Best of references. Apply to Box No. 1348-W.

CIVIL ENGINEER, A.M.E.I.C. Married. Age 38 Twenty years experience in organization, design and estimating, and cost accounting. Active service in France. Apply to Box No. 1367-W.

ENGINEERING PHYSICIST, B.SC., M.SC. (McGill) S.E.I.C. Age 26. Single. Summer experience powe house maintenance, draughting and general work in small shop. Interested in development and research in radio or electrical work requiring more advanced theoretical training than usual electrical degree. Apply to Box. No. 1387-W.

FIRE PROTECTION AND SAFETY ENGINEER A.M.E.I.C., B.SC. '24 (Mech. Engrg.). Age 33. Bilingual Ten years experience with insurance underwriter inspection bureau covering phases of field work. Thoroughly familiar with insurance requirements. Position desired industrial or other concern maintaining sel insurance or relative departments. Location Montrea or vicinity preferred. Apply to Box No. 1395-W.

ENGINEER SUPERINTENDENT, A.M.E.I.C., R.P.E. Que. and Alta. Age 47. Married. Twenty years experience as engineer and superintendent in charge o hydro-electric, industrial, railroad, and irrigation construction. Specialized in rock excavation and suctio dredging. Intimate knowledge of costs, estimating and organizing. Available immediately. Apply to Box No 1411-W.

1935 GRADUATE IN CIVIL ENGINEERING, B.SC (Queen's Univ.), S.E.I.C. Experience includes eleven months summer work as county engineer's assistant in charge of the surveying party, and two months s surveyor's assistant during construction of concret formwork and installation of machinery. Keenly interested in graphical analysis, draughting, design organization and report writing. Now available fo any location. Apply to Box No. 1415-W.

THE ENGINEERING JOURNAL

THE JOURNAL OF THE ENGINEERING INSTITUTE OF CANADA

Published monthly at 2050 Mansfield Street, Montreal, by The Engineering Institute of Canada, Incorporated in 1887 as The Canadian Society of Civil Engineers.

ENTERED AT THE POST OFFICE, MONTREAL, AS SECOND CLASS MATTER.

"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."

May, 1936 — Volume XIX, No. 5

CONTENTS

Price 50 cents a copy, $3.00 a year, in Canada, British Possessions, United States and Mexico. $4.50 a year in Foreign Countries.
To Members and Affiliates, 25 cents a copy, $2.00 a year.

Published Monthly at 2050 Mansfield St., Montreal

THE ENGINEERING INSTITUTE OF CANADA

Incorporated in 1887 as The Canadian Society of Civil Engineers

BRANCHES:

Halifax Branch, Halifax, N.S.
Cape Breton Branch, Sydney, Cape Breton.
Moncton, Branch, Moncton, N.B.
Saint John Branch, Saint John, N.B.
Saguenay Branch, Kenogami, Que.
Quebec Branch, Quebec, Que.
St. Maurice Valley Branch, Three Rivers, Que.
Montreal Branch, Montreal, Que.
Ottawa Branch, Ottawa, Ont.
Kingston Branch, Kingston, Ont.
Peterborough Branch, Peterborough, Ont.
Toronto Branch, Toronto, Ont.
Hamilton Branch, Hamilton, Ont.
Niagara Peninsula Branch, Niagara Falls, Ont.
London Branch, London, Ont.
Border Cities Branch, Windsor, Ont.
Sault Ste. Marie Branch, Sault Ste. Marie, Ont.
Lakehead Branch, Port Arthur, Ont.
Winnipeg Branch, Winnipeg, Man.
Saskatchewan Branch, Regina, Sask.
Lethbridge Branch, Lethbridge, Alta.
Edmonton Branch, Edmonton, Alta.
Calgary Branch, Calgary, Alta.
Vancouver Branch, Vancouver, B.C.
Victoria Branch, Victoria, B.C.

Members of Council 1936

PRESIDENT
E. A. CLEVELAND, Vancouver, B.C.

VICE-PRESIDENTS

*E. V. CATON, Winnipeg, Man.
†R. L. DOBBIN, Peterborough, Ont.
†H. W. McKIEL, Sackville, N.B.
†A. B. NORMANDIN, Quebec, Que.
*P. L. PRATLEY, Montreal, Que.

PAST-PRESIDENTS

F. A. GABY, Toronto, Ont.
O. O. LEFEBVRE, Montreal, Que.
F. P. SHEARWOOD, Montreal, Que.

COUNCILLORS

*C. G. R. ARMSTRONG, Windsor, Ont.
†Y. C. BARRINGTON, Sydney Mines, N.S.
*C. B. BROWN, Montreal, Que.
†G. S. BROWN, Lethbridge, Alta.
*G. H. BURBIDGE, Port Arthur, Ont.
†H. CIMON, Quebec, Que.
*A. COUSINEAU, Montreal, Que.
†A. B. CREALOCK, Toronto, Ont.
†T. H. DICKSON, Moncton, N.B.
†A. FRIGON, Montreal, Que.
†A. B. GATES, Peterborough, Ont.
*L. F. GOODWIN, Kingston, Ont.
*B. GRANDMONT, Three Rivers, Que.
†A. K. HAY, Ottawa, Ont.
‡F. S. B. HEWARD, Montreal, Que.
*G. H. KIRBY, Riverbend, Que.
*H. S. JOHNSTON, Halifax, N.S.
†T. C. MAIN, Winnipeg, Man.
†E. P. MUNTZ, Hamilton, Ont.
†E. P. MURPHY, Port Colborne, Ont.
†H. J. McLEAN, Calgary, Alta.
‡F. NEWELL, Montreal, Que.
†E. A. RYAN, Montreal, Que.
†F. SMALLWOOD, Sault Ste Marie, Ont.
*R. E. SMYTHE, Toronto, Ont.
*E. W. STEDMAN, Ottawa, Ont.
†H. L. SWAN, Victoria, B.C.
*J. A. VANCE, Woodstock, Ont.
*G. A. VANDERVOORT, Saint John, N.B.
*H. R. WEBB, Edmonton, Alta.
*A. S. WOOTTON, Vancouver, B.C.
*S. YOUNG, Regina, Sask.

*For 1936 †For 1936-37 ‡For 1936-37-38

TREASURER
J. B. CHALLIES, Montreal, Que.

SECRETARY
R. J. DURLEY, Montreal, Que.

OFFICERS OF BRANCHES

HALIFAX
Chairman, C. S. BENNETT
Vice-Chair., C. SCRYMGEOUR
Sec.-Treas., R. R. MURRAY, 87 Cambridge St., Halifax, N.S.
Executive, J. R. KAYE, I. P. MACNAB, J. D. FRASER, J. F. F. MACKENZIE, W. H. NOONAN, J. W. McLEOD, J. B. HAYES
(Ex-Officio) H. FELLOWS, H. S. JOHNSTON

CAPE BRETON
Chairman, W. E. BOWN
Sec.-Treas., SYDNEY C. MIFFLEN, 60 Whitney Ave., Sydney, N.S.
Executive, M. R. CHAPPELL, W. S. WILSON, C. M. ANSON, W. E. CLARKE
(Ex-Officio) Y. C. BARRINGTON

SAINT JOHN
Chairman, V. S. CHESNUT
Vice-Chair., J. R. FREEMAN
Sec.-Treas., F. A. PATRIQUEN, 19 Horsfield St., Saint John, N.B.
Executive, S. HOGG, C. S. MACLEAN, G. H. THURBER
(Ex-Officio) E. J. OWENS, G. A. VANDERVOORT

MONCTON
Chairman, H. B. TITUS
Vice-Chair., G. L. DICKSON
Sec.-Treas., V. C. BLACKETT, Engrg. Dept., C.N.R., Moncton, N.B.
Executive, F. O. CONDON, JAS. PULLAR, T. H. DICKSON, C. S. G. ROGERS, A. S. GUNN, G. C. TORRENS
(Ex-Officio) H. W. McKIEL, J. G. MACKINNON

SAGUENAY
Chairman, J. SHANLY
Vice-Chair., S. J. FISHER
Sec.-Treas., L. R. BEATH, P.O. Box 211, Kenogami, Que.
Executive, W. L. YACK, E. LAVOIE, H. B. PELLETIER, M. G. SAUNDERS
(Ex-Officio) G. E. LAMOTHE, J. W. WARD, G. H. KIRBY

QUEBEC
Hon. Chair., A. R. DECARY
Chairman, ALEX. LARIVIERE
Vice-Chair., J. T. F. KING
Sec.-Treas., J. JOYAL, Quebec Public Service Comm., Court House, Quebec, Que.
Executive, R. B. McDUNNOUGH, L. P. METHE, L. BEAUDRY, A. G. SABOURIN, J. G. O'DONNELL, A. ROBERGE
(Ex-Officio) A. B. NORMANDIN, HECTOR CIMON

ST. MAURICE VALLEY
Chairman, B. GRANDMONT
Vice-Chair., J. E. FLEURY
Sec.-Treas., J. A. HAMEL, 642 Notre Dame St., Three Rivers, Que.
Executive, F. W. BRADSHAW, C. L. ARCAND, H. J. WARD

MONTREAL
Chairman, J. B. D'AETH
Vice-Chair., H. MASSUE
Sec.-Treas., C. K. McLEOD, 1440 St. Catherine St. W., Montreal, Que.
Executive, R. H. FINDLAY, C. C. LINDSAY, B. R. PERRY, T. C. THOMPSON, J. A. LALONDE, J. A. E. GOHIER
(Ex-Officio) F. S. B. HEWARD, A. COUSINEAU, C. B. BROWN, P. L. PRATLEY, O. O. LEFEBVRE, E. A. RYAN, F. NEWELL, A. FRIGON, F. P. SHEARWOOD

OTTAWA
Chairman, E. VIENS
Sec.-Treas., F. C. C. LYNCH, Dept. of Mines, Victoria Memorial Museum, Ottawa, Ont.
Executive, E. M. DENNIS, T. A. McELHANNEY, N. B. MACROSTIE, G. R. TURNER, B. F. HAANEL
(Ex-Officio) E. W. STEDMAN, R. W. BOYLE, A. K. HAY

PETERBOROUGH
Chairman, A. L. DICKIESON
Sec.-Treas., W. T. FANJOY, 223 Crescent St., Peterborough, Ont.
Executive, V. R. CURRIE, A. L. KILLALY, E. J. DAVIES, E. R. SHIRLEY
(Ex-Officio) J. W. PIERCE, H. R. SILLS, R. L. DOBBIN, A. B. GATES

KINGSTON
Chairman, R. A. LOW
Vice-Chair., Lt.-Col. N. C. SHERMAN
Sec.-Treas., Major L. F. GRANT, Royal Military College, Kingston, Ont.
Executive, G. G. CARR-HARRIS, S. STEPHENSON, J. E. GOODMAN
(Ex-Officio) W. CASEY, L. F. GOODWIN

TORONTO
Chairman, O. HOLDEN
Vice-Chair., A. U. SANDERSON
Sec.-Treas., W. S. WILSON, Mining Bldg., University of Toronto, Toronto, Ont.
Executive, W. P. DOBSON, N. MACNICOL, W. E. P. DUNCAN, A. M. REID, D. D. WHITSON, C. E. SISSON
(Ex-Officio) W. E. BONN, A. B. CREALOCK, R. E. SMYTHE, F. A. GABY

HAMILTON
Chairman, W. HOLLINGWORTH
Vice-Chair., E. G. MACKAY
Sec.-Treas., A. LOVE, 40 Paisley Ave. S., Hamilton, Ont.
Executive, W. J. W. REID, A. R. HANNAFORD, V. S. THOMPSON, D. W. CALLANDER
(Ex-Officio) E. P. MUNTZ

LONDON
Chairman, JAS. FERGUSON
Vice-Chair., A. O. WOLFF
Sec.-Treas., D. S. SCRYMGEOUR, London Structural Steel Co. Ltd., London, Ont.
Executive, E. V. BUCHANAN, W. C. MILLER, H. A. BRAZIER, H. A. McKAY
(Ex-Officio) S. W. ARCHIBALD, S. G. JOHRE, J. A. VANCE

NIAGARA PENINSULA
Chairman, P. E. BUSS
Vice-Chair., G. H. WOOD
Sec.-Treas., P. A. DEWEY, 1224 Ontario Ave., Niagara Falls, Ont.
Executive, C. G. MOON, E. P. MURPHY, C. W. WEST, C. S. BOYD, S. HAIRSINE, J. H. JACKSON, J. C. STREET, L. C. McMURTRY, H. WELLWOOD
(Ex-Officio) W. R. MANOCK

BORDER CITIES
Chairman, T. H. JENKINS
Vice-Chair., C. F. DAVISON,
Sec.-Treas., BOYD CANDLISH, 170 Rankin Blvd., Sandwich, Ont.
Executive, E. M. KREBSER, D. T. ALEXANDER, C. G. WALTON
(Ex-Officio) C. G. R. ARMSTRONG, H. J. COULTER

SAULT STE. MARIE
Chairman, J. L. LANG
Vice-Chair., W. SEYMOUR
Sec.-Treas., N. C. COWIE, 15 Hearst St., Sault Ste. Marie, Ont.
Executive, H. O. BROWN, C. W. HOLMAN, T. FOULKES, H. W. SUTCLIFFE
(Ex-Officio) F. SMALLWOOD, A. E. PICKERING

LAKEHEAD
Chairman, F. C. GRAHAM
Vice-Chair., G. R. DUNCAN
Sec.-Treas., G. R. McLENNAN, 80 North High St., Port Arthur, Ont.
Executive: H. G. O'LEARY, J. M. FLEMING, K. A. DUNPHY, E. A. KELLY, E. L. GOODALL, W. J. BISHOP
(Ex-Officio) G. H. BURBIDGE, R. J. ASKIN

WINNIPEG
Chairman, G. E. COLE
Vice-Chair., A. E. MACDONALD
Sec.-Treas., J. F. CUNNINGHAM, 918 Somerset Ave., Fort Garry, Man.
Executive, F. W. ALEXANDER, H. L. BRIGGS, W. D. HURST, R. W. McKINNON, W. F. RIDDELL
(Ex-Officio) E. V. CATON, F. V. SEIBERT, T. C. MAIN

SASKATCHEWAN
Chairman, W. E. LOVELL
Vice-Chair., STEWART YOUNG
Sec.-Treas., R. J. FYFE, 618 Broder Bldg., Regina, Sask.
Executive, A. R. GREIG, J. W. D. FARRELL, J. McD. PATTON, H. S. CARPENTER, H. J. BYRD, S. R. MUIRHEAD
(Ex-Officio) A. P. LINTON

LETHBRIDGE
Chairman, W. L. McKENZIE
Vice-Chair., J. M. CAMPBELL
Sec.-Treas., E. A. LAWRENCE, 207-7th St. S., Lethbridge, Alta.
Executive, G. S. BROWN, R. F. P. BOWMAN, J. HAIMES
(Ex-Officio) C. S. DONALDSON, J. B. DEHART

EDMONTON
Chairman, E. STANSFIELD
Vice-Chair., A. RITCHIE
Sec.-Treas., M. L. GALE, 9914-111 St., Edmonton Alta
Executive, J. D. BAKER, W. E. CORNISH, C. E. GARNETT, A. J. GAYFER, E. NELSON
(Ex-Officio) F. K. BEACH, H. R. WEBB

CALGARY
Chairman, JOHN DOW
Vice-Chair., H. W. TOOKER
Sec.-Treas., JAS. McMILLAN, 506 Insurance Exchange Bldg., Calgary, Alta.
Executive, J. J. HANNA, W. T. McFARLANE, H. J. McEWEN
(Ex-Officio) J. HADDIN, F. M. STEEL, H. J. McLEAN

VANCOUVER
Chairman, JAS. ROBERTSON
Vice-Chair., H. N. MACPHERSON
Sec.-Treas., T. V. BERRY, 3007-36th Ave. W., Vancouver, B.C.
Executive, E. C. THRUPP, P. SANDWELL, G. L. BOOKER, J. P. MACKENZIE, P. H. BUCHAN, C. P. HAMILTON, F. O. MILLS
(Ex-Officio) G. M. GILBERT, E. A. CLEVELAND, A. S. WOOTTON

VICTORIA
Chairman, I. C. BARLTROP
Vice-Chair., J. C. MACDONALD
Sec.-Treas., KENNETH REID, 1336 Carnsew St., Victoria, B.C.
Executive, G. M. DUNCAN, G. M. IRWIN, G. M. TRIPP, C. D. SCHULTZ
(Ex-Officio) D. MACBRIDE, H. L. SWAN

THE

ENGINEERING JOURNAL

The Institute as a body is not responsible either for the statements made or for the opinions expressed in the following pages.

Volume XIX | Montreal, May, 1936 | Number 5

The Scope and Progress of Work under the Prairie Farm Rehabilitation Act

Dr. E. S. Archibald,
Director of Experimental Farms, Ottawa, Ont.

Paper presented before the Ottawa Branch of The Engineering Institute of Canada, March 12th, 1936.

SUMMARY—The author presents a general picture of the efforts which are being made to ameliorate the conditions of farming in the semi-arid regions of the prairies. The work described includes the development of strip farming, improved methods of cultivation, the planting of shelter belts, the introduction of improved varieties of soil-maintaining plants and grasses, and the conservation and improvement of available water resources. Cooperative activities along these lines on the part of farming communities are being encouraged, while skilled advice and financial aid are being made available.

The Prairie Farm Rehabilitation Act was passed by the Dominion Parliament during the 1935 session, to provide for the amelioration of agricultural conditions in the drought and soil drifting areas in southwestern Manitoba, southern Saskatchewan, and southern Alberta. The Act provides for an appropriation of $750,000 for the fiscal year 1935-36, and an amount not to exceed $1,000,000 for each of the four succeeding fiscal years. Administration of the Act is vested in the Federal Minister of Agriculture.

During recent years, especially from 1931 to 1934, inclusive, conditions of extreme drought accompanied by widespread soil drifting, have been experienced over an extensive area in the prairie provinces. The area includes part of southwestern Manitoba, southern Saskatchewan and southern and southeastern Alberta. The eastern and northern parts of this area are devoted to the production of grain, principally wheat, while the western and south central portion is largely used for ranching.

Continued drought and soil drifting has resulted in very serious losses due to reductions in crop yields in the grain growing sections, and in shortage of grass, feed, and water in the grazing sections of this area. The economic loss caused by drought has been further increased by the low prices for agricultural produce which have prevailed during the dry years. Destitution has been widespread among farmers, and very large Federal and provincial expenditures for relief have been necessary. It is the object of the Prairie Farm Rehabilitation Act to remedy these conditions, and to provide whatever safeguards may be possible against their recurrence.

Under the provisions of the Prairie Farm Rehabilitation Act a comprehensive programme is in progress to encourage and assist farmers and ranchers in combating drought and soil drifting problems. Measures are being introduced to minimize the adverse effect of drought on crop yields, to prevent drifting, and to reclaim farm land, which has been abandoned due to severe drifting, for crop production or grazing. Assistance is being given to individual farmers and to communities in planting shelter belts of trees and hedges as a measure of soil drifting control. Drought resistant grasses are being used for soil binding purposes on some areas of drifting land for hay production, and to provide grazing on land which is too dry for economic grain growing. In connection with all phases of this programme a considerable amount of investigational work is in progress.

An important part of the rehabilitation programme is the development of water resources for stock watering purposes, and for growing reserve supplies of feed under irrigation on small community projects.

The various methods of rehabilitation in use, and the agencies through which the foregoing programme is being effected, are described below, with some reference to the progress already made.

District Experimental Sub-stations

The purpose of the District Experiment Sub-stations is to extend the drought and soil drifting experimental and demonstrational work of the Dominion Experimental Farms to strategic points throughout the drought area. These sub-stations are private grain growing farms each of approximately one section in area, which are operated by the owners under the direction and supervision of officials of the Dominion Experimental Farms. During 1935 thirty-nine sub-stations were established, three in Manitoba, twenty-seven in Saskatchewan, and nine in Alberta.

Inasmuch as the best measures so far known of drought and soil drifting control are being used on the District Experimental Sub-stations, these measures are described below in some detail.

Rotations

Certain uniform cropping practices have been adopted on all District Experiment Sub-stations. In the production of grain, a two-year rotation of summerfallow and grain is followed. On some sub-stations a three-year rotation of summerfallow and grain is also followed in comparison with the two-year rotation. The object of frequent summerfallows is partly to control drought-resistant weeds which compete at an advantage with the grain crops, but principally to ensure maximum yields by the most economical utilization and conservation of soil moisture. Another reason for short rotations is that they enable the practice of strip farming, described below, to be followed.

Strip Farming

The most severe soil drifting occurs on summerfallow land which is kept bare of vegetation during the year, and is therefore much more subject to the erosive effects of

Fig. 1—Drifted Soil.

high winds than land under crops or other vegetation. With this fact in mind, the preventative cropping practice known as "strip farming" is being widely introduced.

Part of the grain produced on all sub-stations is grown in long strips in alternation with fallow strips. These strips are usually from 10 to 20 rods wide, the width depending on local conditions, and of much greater length, depending on the size of the field. The purpose of these strips, which are run at right angles to prevailing strong winds, is to reduce to a minimum the area of summerfallow land which is exposed to wind action. Where drifting does occur on the fallow strips, the adjacent strips of grain tend to trap drifting soil, thereby localizing the damage and checking the cumulative effect.

Strip farming has proved very effective in controlling soil drifting in some localities, particularly in southern Alberta. The introduction of strip farming on District Experiment Sub-stations throughout the drought area is intended partly to familiarize farmers with this practice, and partly to learn its value in localities where it has not previously been tried.

Cover Crops

Cover crops of fall-seeded spring grain, the roots of which have a binding effect on soil, are being used on all sub-stations to prevent fall and spring drifting on part of the summerfallow land. This practice may be followed independently of or in conjunction with strip farming as local conditions may warrant. As cover crops are seeded in the early fall about August 1st, they do not usually make sufficient growth before freeze-up to greatly reduce the amount of soil moisture conserved by the summerfallow for crops grown in the following year. Where surface moisture has been sufficient for germination and grasshopper attack has not been serious or kept under control by the use of poison bait, cover crops have proved satisfactory in preventing drifting on several sub-stations during 1935.

Cultural Practices

In order to determine the best cultural practices for soil drifting control, various methods of working land are compared in conjunction with the different cropping practices followed on the sub-stations. The main objective of these cultural practices is to keep down weed growth on fallow land, with as little pulverization of the soil as possible. Any method which will produce a cloddy condition of cultivated soil is desirable. Where this condition is not obtainable, due to loose-textured soil or tendency to deflocculation, drifting may be checked by shallow surface cultivation, which leaves as much stubble or other "trash" on the surface as possible. The production of this "trash cover" on fallow land is effected by shallow cultivation. In this connection, the "ploughless fallow" in which the land is cultivated without ploughing, has proved very satisfactory. Incidentally, the "ploughless fallow" is more economical of labour than the standard ploughed fallow. These methods of cultivation have already proved very effective in reducing the tendency of soil to drift on several of the sub-stations.

Agricultural Improvement Associations

In order to stimulate interest in the rehabilitation programme, and to secure community co-operation in the solution of drought and soil drifting problems, agricultural improvement associations have been organized among farmers in a number of districts. Through these associations the systematic adoption throughout various districts of control measures is being effected with greater probability of success than could be expected from the individual efforts of isolated farmers. For this reason special assistance is being given to members of associations to enable them to introduce certain rehabilitation measures on their farms, such as tree planting and seeding grasses for soil drifting control as well as the development of surface water resources.

Considerable progress has been made in the organization of agricultural improvement associations. The total number formed at the end of January 1936, was twenty-

Fig. 2—Eroded Soil as a result of the Removal of the Fertile Surface Layer of Soil.

nine, of which five are in Manitoba, twenty-three in Saskatchewan, and one in Alberta. These associations have already proved of great educational value.

Reclamation Projects

With the object of determining the best methods of preventing soil drifting, and of reclaiming severely drifted land for grain and grass production, reclamation projects have been established at several representative points throughout the drought area. The work on these projects is an extension of the investigational work of the Dominion Experimental Farms, and while not expressly designed for demonstration purposes, will eventually prove useful in this respect. Reclamation of land for farming purposes has been started at Melita, Manitoba, and Mortlach, Saskatchewan. Regrassing reclamation is under way on five areas lying north of Medicine Hat in Alberta, and at Kerrobert, in Saskatchewan.

The reclamation project at Melita consists of an extensive group of experiments, conducted on two sections of abandoned land. These experiments include comparisons of different rotations, of different widths and directions of strips in strip farming, and of different methods of seeding cover crops. Investigations are being started into methods of reclaiming badly drifted land for grain and grass production with tractor-powered equipment. The relative effects of different cultural methods in reducing the tendency of soil to drifting are being compared. Experiments are also being planned on the use of fertilizers on drifted soil, and on methods of establishing grasses and clovers on land which has been abandoned for grain production.

Another reclamation project similar in purpose and scope to the Melita project has been established at Mortlach, Saskatchewan.

Regrassing reclamation projects have been started in that part in Alberta lying between Ranges 1 to 14 west of the Fourth Meridian, and extending north from Medicine Hat to Sullivan Lake and Sounding Lake. Within this area a very large percentage of land, which had formerly been brought under wheat production, has been abandoned because of inadequate precipitation. Much of this land is covered with weeds, such as Russian thistle, sage, and poverty weed, while soil drifting is widespread. The object of the regrassing projects is to determine the best methods of establishing a grass cover which will displace weed growth, hold the light soils against drifting, and furnish grazing for livestock.

During the fall of 1935 regrassing work was started at the following five points in the above mentioned area: Naco, Sounding Creek area; Stanmore, North Berry Creek; Cessford, South Berry Creek; Hutton; and Bowell, Tilley East area. Some seeding of crested wheat grass has been done on these projects, and extensive seeding is planned for the spring of 1936. Where difficulty is likely to be experienced in securing a stand of grass due to drifting, a suitable fall-sown cover crop is used to hold the soil until the growth of grass is well started. The information which will be secured on these projects will afford guidance for more extensive work throughout this area.

At Kerrobert, Saskatchewan, a total of 87 acres of crested wheat grass has been seeded on eleven farms, with the object of establishing grass for hay or pasture on farm land subject to drifting.

Grass seed for the above projects, as well as for other branches of rehabilitation work, is being secured through the Dominion Forage Crop Laboratory at Saskatoon, assisted by the Dominion Seed Branch. Special attention is given by these agencies to propagation and distribution of drought resistant species, especially crested wheat grass. Brome grass and western rye grass are also being used for regrassing, while sweet clover and alfalfa are seeded where conditions are suitable.

Tree Planting

Tree planting as a measure of soil drifting control is being undertaken under the rehabilitation programme. Shelter belts of trees planted on the margins of farms or large fields, together with intervening hedges, tend to check soil drifting by reducing surface wind velocity. Where such shelter belts and hedges can be successfully established and maintained, the soil drifting problem may be greatly simplified.

Under the provision of the Prairie Farm Rehabilitation Act, certain assistance is given farmers in establishing shelter belts and hedges. For many years there has been a free distribution of tree seedlings to farmers throughout the prairie provinces from the Forest Nursery Stations at Indian Head, Saskatchewan, and Sutherland, Saskatchewan. In addition to continuing this service, the rehabilitation

Fig. 3—Strip Farming.

programme provides free seedlings plus supervising and financial assistance for operators of District Experiment Sub-stations, members of agricultural improvement associations, and for selected community tree planting projects. The outstanding community projects in this programme are located in Saskatchewan, one in the rural municipality of Kindersley, and the other near the village of Conquest. In the Kindersley project assistance is being given to the municipality in planting shelter tree belts and hedges on an area of light drifting soil about 10 miles northwest of the town of Kindersley. During 1935, 27,500 seedlings were planted on five quarter sections in this area, and provision has been made for about 150,000 seedlings to be planted during 1936.

The Conquest Field Shelter Belt Association, comprising a group of farmers located in the vicinity of the village of Conquest, received assistance during 1935 in planting approximately 85,000 seedlings in some 20 miles of field shelter belts. During 1936 it is proposed to plant about 350,000 seedlings on thirty-four quarter sections.

The object of the Kindersley and Conquest projects is to determine the value of large scale shelter belt plantations in controlling soil drifting. Owing to the extensive nature of this work, the degree of success obtained will profoundly affect the future status of afforestation in the prairie provinces.

Supplies of seedlings for the foregoing tree planting programme have been produced on the Dominion Forest Nursery Stations at Indian Head and Sutherland in Saskatchewan. For the work during 1936 and subsequent years the nursery facilities at these stations have been increased, and extended to include nursery plantings on the Dominion Experimental Stations throughout the prairie provinces. During 1935 preparations were made to supply nine million seedlings for various rehabilitation projects.

Water Development

Under the terms of the Prairie Farm Rehabilitation Act engineering and financial assistance has been made available to farmers and ranchers throughout the drought area for the development of livestock and domestic water facilities, as well as for small irrigation schemes. Under the Supplementary Public Works Construction Act, 1935, the sum of $500,000 has been set aside for western conservation works. This sum is being expended by the Department of Agriculture to augment the water development work of the Prairie Farm Rehabilitation Act, through the development of large community irrigation and water storage projects.

The object of the water development programme is to effect the optimum utilization of natural water resources, with a view to securing an improved relationship between livestock and crop production.

Fig. 4—Field Crop Shelter Belts.

The climate of the semi-arid parts of the prairie provinces is characterized by hot summers, cold winters, and low average precipitation which varies considerably in amount in different years. One result of these conditions is to render surface water supplies inadequate for the optimum utilization of crop and grazing land. Rivers and lakes are separated by quite extensive areas of land on which surface water is unobtainable, especially during the summer months. Well water is difficult to obtain in some districts, and frequently of unsatisfactory quality. For these reasons, many farmers and ranchers are dependent on the storage of spring run-off water for their summer supply. One of the main objects of the water development programme is to secure greater utilization of run-off waters for agricultural purposes.

Another result of the above-mentioned climatic conditions is that a condition of uncertainty exists as regards the success of farming operations. Variations downward from the low average precipitation result in correspondingly low crop yields, and sometimes in complete failures. In order to reduce as much as possible the economic insecurity arising from this condition, steps are being taken under the rehabilitation programme to utilize surface water resources for growing subsistence supplies of forage and garden produce on small irrigation schemes. This type of water development will enable many farmers and ranchers to survive severe periods of drought. Engineering difficulties are the chief obstacles in the way of water development by farmers themselves, while short term land tenure conditions act as an additional deterrent to ranchers. Furthermore, the utilization of surface water supplies for agricultural purposes is very strictly controlled by provincial governments, which apportion available water to applicants after careful investigation. These governments require that the services of qualified engineers be secured in connection with initial surveys and actual construction of water storage projects. In many cases farmers and ranchers are unable to meet these requirements owing to the cost involved. By providing free engineering services for prospective water users and by enabling farmers and ranchers to comply with provincial water rights legislation, the rehabilitation programme is effecting desirable utilization of natural water resources which would not be otherwise accomplished.

During 1935 a considerable amount of preliminary survey work was done in connection with various water development projects, and construction work was undertaken on a number of projects. A large number of projects are under consideration for construction during 1936 and subsequent years. The progress already made in this work is described below under the headings of "small" and "community" projects.

Small Water Development Projects

Small water development projects, which come under the Prairie Farm Rehabilitation Act, include dugouts for storing water, stock watering dams, and small irrigation projects. By January 31st, 1936, the engineering staff of the Water Development Committee had received applications for assistance covering a total of 1,832 projects, comprising 508 dugouts, 1,066 stock watering dams, and 258 small irrigation projects. Of the total number of applications, 637 were received from Alberta, 1,109 from Saskatchewan, and 86 from Manitoba. Actual construction work on a large percentage of these projects has been started, and several hundred have been completed. The exact number of projects completed during 1935 is not known, since final inspection has not been possible in many cases due to winter conditions.

In connection with the development of small water storage projects on land overlying a deep sandy or gravelly subsoil, difficulty is sometimes encountered in preventing erosion and seepage losses. Some experimental work to find remedial measures for this condition is proposed including trials with clay and asphalt for waterproofing purposes.

Community Water Development Projects

The construction of community irrigation and water storage projects at suitable points in the drought area is provided for under the terms of the Supplementary Public Works Construction Act, 1935, as previously noted. Under the classification of community projects are included municipal storage dams, works in incorporated irrigation districts, and other large water development projects of a public nature.

The purpose of these community projects is to provide desirable water storage facilities which, while too costly for private enterprise, may be economically constructed on the basis of per capita cost to individual water users. To this end, projects are located on sites where local conditions of topography, stream flow, and relation to surrounding farm or ranch land are particularly advantageous. This point may be illustrated by the following description of typical community projects under the rehabilitation programme.

Community Irrigation Projects

The Val Marie Irrigation Project is located on the Frenchman river near the village of Val Marie in southwestern Saskatchewan. This project is designed to provide dependable supplies of supplementary feed for the large adjacent ranching district, by the irrigation of over 5,000 acres of river bottom land suitable for the production of alfalfa and other forage crops. For this purpose it is proposed to construct a dam across the Frenchman river, about 6 miles northwest of Val Marie, to create a storage reservoir of some 6,000 acre feet capacity. From this reservoir water will be conveyed by a canal running for about 6 miles along the left bank of the river to a point near Val Marie. This portion of the canal will be used for stock-watering purposes, and for irrigating over 2,000 acres on the left bank of the river. At Val Marie the canal will cross the Frenchman river through an inverted siphon, from which point the water will be distributed through ditches to over 3,000 acres of river bottom land just south of Val Marie. Excess irrigation water is to be conveyed back to the Frenchman river by means of drainage ditches.

On completion of construction work, this project will be operated by Val Marie Irrigation District, incorporated under the irrigation laws of Saskatchewan.

Irrigable land in this project will be divided into parcels of about 80 acres by the Val Marie Irrigation District for the production of forage crops by local farmers and ranchers.

Similar irrigation schemes to the Val Marie project described above are under construction at Wildhorse, Alberta, and at Eastend, Saskatchewan. The Wildhorse project is a new venture, while at Eastend an earlier irrigation scheme, rendered inoperative some years ago through the destruction by ice of the reservoir dam, is being reconstructed.

A noteworthy feature of the foregoing projects is the relatively short distance which exists between the storage reservoirs and the irrigable land, being not more than six miles in any case. In this manner the high construction expense and water wastage due to long canals is avoided.

Community Water Storage Projects

Storage of river water for community use is being effected at a number of points by the construction of dams across water courses. Municipal storage dams have been built at the town of Souris and near the village of Crystal City in Manitoba. In the municipality of Edward in Manitoba, four large stock watering dams have been constructed on creeks tributary to the Souris river, for the storage of spring run-off water. A similar series of dams is planned for the use of farmers and ranchers along the Wood river in Saskatchewan.

For the improvement and extension of existing river bottom irrigation on the neighbouring water courses of

Fig. 5—Stock-Watering Dam.

Middle Creek and Battle Creek in southwestern Saskatchewan, a storage dam is being constructed on the upper ranches of Middle Creek. Part of the water stored by means of this dam will be used for summer irrigation along Middle Creek, and part will be diverted to Battle Creek for similar use. Additional storage facilities are planned for Battle Creek by means of a reservoir at Adam's Lake in the Cypress Hills.

On Waskana Creek, southeast of Regina, a combination drainage and storage scheme is under construction. The object of this project is to prevent destructive flooding of farm land by excessive run-off in the spring, partly by means of drainage ditches, and partly by creating reservoirs at the heads of creeks tributary to Waskana Creek. Water stored in these reservoirs will be released during the dry summer months to maintain stream flow in Waskana Creek.

Rehabilitation of Existing Irrigation Systems

Several large irrigation projects in Alberta which were constructed by private enterprise during the past, have fallen into financial difficulties due to excessive investment charges and low revenue. In some cases where the discontinuance of water supply services to farmers and ranchers located on these projects would entail severe hardship, provision is made under the rehabilitation programme for assistance to ensure continued operation.

Such assistance is not intended to rehabilitate potentially insolvent irrigation companies, but to prevent the economic ruin of settlers who are entirely dependent on irrigation for water supplies. Under this arrangement, financial assistance has been advanced to the Eastern Irrigation District in Alberta, to enable certain necessary repairs and extensions to be made. This project, formerly part of the irrigated land of the Canadian Pacific Railway, is controlled and operated by local farmers and ranchers who are dependent upon its continued operation for their water supplies. Assistance for several other projects of a similar nature is under consideration.

Ground Water Supplies

As part of the water development programme the Geological Survey of Canada is investigating the possibility of securing ground water supplies in areas where surface water conservation is impossible or impractical. The object of this investigation is to determine the depth to which wells must be sunk in different parts of the drought area in order to obtain water. Particular attention is given to the quality of water for domestic and stock watering purposes. The results of these investigations will be made available to farmers and ranchers for their guidance in ground water development.

Red Deer River Gas Well

An exploratory boring for natural gas, to furnish power for pumping irrigation schemes, is contemplated on the Red Deer river near Atlee, Alberta. Natural gas is used to supply power for pumping engines at various points in the prairie provinces, and if it can be found at a reasonable depth in the Red Deer valley, between Empress and Steveville, the irrigation of several thousand acres of river flats will be possible. The topography of the land in question is such that irrigation by storage water is not feasible, but pumping schemes would be practicable if power from natural gas can be obtained. Successful irrigation in this instance would ensure dependable supplies of supplementary feed for a large local ranching area.

Research

In addition to the information relative to drought and soil drifting control which is being secured on the Dominion Experimental Farms, and through the various rehabilitation activities described above, a considerable amount of research work is in progress.

Investigations into the fundamental causes of soil drifting are in progress on the Dominion Experimental Station at Swift Current, Saskatchewan. This is designed to secure data relative to the causes and control of drifting on different soil types, under various climatic, cultural, and cropping conditions. During 1935 a large amount of work was done in co-operation with the Meteorological Services of Canada on the influence of shelter belts on soil drifting control and soil moisture conservation.

The object of the soil survey work is to determine the location, extent, and possible utilization of different types of soil throughout the agricultural area of the prairie provinces. Owing to the great value of such information in rehabilitation work, the Dominion Department of Agriculture is co-operating with the Soils Departments of the three provincial universities in accelerating the work of soil survey in the prairie provinces.

Under the direction of the Economics Branch of the Dominion Department of Agriculture, a comprehensive study of land utilization in Saskatchewan and Alberta is in progress. During 1935 detailed information on the economic status of 1,384 farmers, located in the drought area, was secured. This information will serve as the basis of studies to determine what adjustment may be necessary in land utilization and farm management, in order to improve farm economic conditions in the affected areas.

Conclusion

The programme of work conducted under the Prairie Farm Rehabilitation Act, as described above, is designed to improve the agricultural conditions of the prairie provinces which have been most severely affected by extreme drought and soil drifting. This improvement is being accomplished by means of the demonstrational and research activities of the Dominion Experimental Farms with the co-operation of the provincial Departments of Agriculture. The main objects of this work are to introduce the best methods of soil moisture conservation and soil drifting control on farm land, to effect the regrassing of certain submarginal land for grazing purposes, and to develop surface water resources for domestic and stock watering purposes. A further object is to secure the best utilization of the land for various agricultural purposes.

Prairie Farm Rehabilitation Water Development

B. Russell, M.E.I.C.,

Senior Engineer, Prairie Farm Rehabilitation Act Water Development Committee, Swift Current, Sask.

Paper presented before the Lethbridge Branch of The Engineering Institute of Canada, November 23rd, 1935.

SUMMARY—The paper outlines the activities of the Water Development Committee, working under the Prairie Farms Rehabilitation Act passed in 1935. These include mainly the smaller water conservation works for individual farmers and irrigation schemes for small groups or municipalities. Reference is made to some of the larger projects involving expenditures in excess of $15,000.

The drought area problem as it affects Saskatchewan and Manitoba has been the cause of much concern to the provincial authorities during the past five or six years. Probably the two best authorities on the question in the province of Saskatchewan are the Hon. J. G. Taggart, Minister of Agriculture, and Dean A. M. Shaw of the University of Saskatchewan. Articles by these men published in the "North West Farmer" of July 1935 and in the "Western Producer" of December 13th, 1934, give a very clear picture of the problem, particularly as it affects the province of Saskatchewan.

The drought area proper, however, is mostly in the province of Alberta, and a study of the report by the Survey Board appointed by the province in 1921 is necessary for a full understanding of the drought problem.

After careful consideration and consultation the Board outlined on a map of the province the general boundaries subject from time to time to drought. These boundaries have been reproduced on the map (see Fig. 1) and extended into Saskatchewan to include that area which would probably have been considered in 1921 as subject to drought. The area does not show a large portion of Saskatchewan including the Regina plains where drought conditions are the exception rather than the rule, but those areas where the reverse is the case, and where ranching rather than farming must predominate. The total area thus outlined includes some 11,681,000 acres in Saskatchewan and 16,197,000 acres in Alberta. It is for this area that water supplies are most essential.

Rehabilitation Programme

The rehabilitation programme provides for demonstration townships where experiments are carried on in strip farming, regrassing, soil drifting, tree planting for shelter belts, etc. This paper, however, deals only with water development which is an important part of the programme.

Necessity of Action

The possibilities of conserving surface water supplies in the drought area were brought prominently to the attention of governments in 1924 as a result of an investigation made of the Tilley East area consisting of some 1,684,000 acres of land between the Red Deer and South Saskatchewan rivers to the east of range 11 in Alberta. These lands were largely settled by farmers in the years 1911-12 and 13, but later abandoned as unfit for farming purposes. A Commission was appointed in 1924 to ascertain eventually what use might be made of this area in providing summer range for stock farmers on adjacent irrigation projects while crops are grown on the irrigable lands for winter feed.

For this purpose the improvement of water supplies is essential and a survey of the area demonstrated the possibility of creating stock water and feed supplies by dugouts and small dams. An experimental station was later established by the Dominion Department of Agriculture in the Manyberries district, where by actually constructing a number of small dams in coulees and conserving the spring run-off, it was demonstrated beyond doubt that the range land in that area could be greatly improved that way. Gilchrist Brothers, ranchers in the Cypress Hills district, also demonstrated the value of small dams to create stock water and feed supplies on their range.

Rehabilitation Act

The continued drought of the past six years made it necessary for governments to look for some measures to combat it. This led to the Rehabilitation Act which was passed by the last session of parliament. The Act provides for the appointment of a committee representative of the many interests affected by drought, to advise the Minister of Agriculture for the Dominion as to the best means of providing against drought conditions. Suitable appropriations were made to carry on this work for the year 1935-36.

Water Development Committee

One of the committees set up under the Advisory Committee is the Water Development Committee, which consists of representative engineers and agriculturists from the three prairie provinces headed by a chairman, who is also superintendent of the Swift Current Experimental Station.

Under this committee an engineering staff has been set up to handle the applications for water development projects and make recommendations to the committee. In addition to engineering assistance the committee have drawn up a programme of financial assistance available to individual applicants desiring to construct small stock water and irrigation supplies. In the case of dugouts which consist merely of a rectangular excavation which can be filled up every spring with flood water, financial assistance at the rate of three cents per cubic yard up to a maximum of $50 is available. In the case of a small stock water dam three cents per yard up to a maximum of $150 is available, and in the case of an irrigation scheme three cents up to a maximum of $350 is available, except that where a special structure is required, involving costs for material, further assistance is considered by the committee.

Payment is contingent upon the works being carried out in accordance with plans and specifications approved by the engineers of the committee. Larger projects are dealt with on their merits by the committee. Up to $15,000 projects can be authorized by the minister. Financial assistance in excess of $15,000 must be approved by order-in-council. In connection with all projects authorization is required under the provisions of the Water Resources acts of the respective provinces.

Progress to November 15th, 1935

The Water Development Committee met for the first time on May 4th, 1935, but it was not till July 1st that engineers were appointed. By that time a great many applications of all descriptions for assistance had been received by the secretary. To deal with these the drought area was divided into ten districts and an engineer placed in charge of each district. One additional engineer was appointed to look after the larger projects. Draughtsmen, clerks, junior engineers, instrumentmen and rodmen were eventually appointed and the staff completed by the appointment of agriculturists and a construction superintendent. Up to November 15th, 1935, some two thousand applications had been referred to the engineering staff for assistance; eight hundred and sixty-seven have been inspected and of these one hundred and fifty have so far been built. The above are all small projects, such as dugouts, stock water ponds and small irrigation schemes.

Larger Projects Authorized

Application has been made by municipalities, boards of trade and other organizations for assistance in the construction of many larger or community projects. With regard to these the conditions required before any consideration is given to applications are that they must be agriculturally sound and that a responsible organization must be set up to construct, operate and maintain them.

Southern Manitoba

In the southwest corner of Manitoba there is a considerable area where drought conditions during the past five years have been exceptionally bad. For the purpose of creating stock water supplies along a number of streams such as Gainsboro, Antler and Graham Creeks a sum of money was authorized for the construction of a number of dams. These are all of timber crib rock filled type, capable of being topped by floods, and are now under construction. These will be maintained and operated by the municipalities in which they are located. These dams are being wholly financed from moneys voted under the Act, and their construction supervised by the committee's engineer in this district. This type of dam is necessary on account of poor foundation.

Waskana Creek

In connection with Waskana Creek which flows through the city of Regina, a very ambitious scheme of flood control by reservoirs and dredging has been advocated for some years. The ultimate aim of the scheme is to build a sufficient number of reservoirs to completely regulate the flow, thereby not only preventing flood conditions, but providing a good flow of fresh water during the summer months. The committee has so far authorized an expenditure of $15,000 to straighten a portion of the creek channel. This work has started in the fall of 1935 and is now about 50 per cent complete.

With regard to this expenditure, the purpose is to reclaim certain lands in the vicinity of Lajord. These lands are all settled and are protected by dykes. These dykes, however, have never been authorized by the provincial government, and because they back up water on adjacent lands there was a demand by those who were not fortunate enough to have such protection from floods to have them removed. Since the settlers affected have everything they own in these lands the destruction of these dykes would be a disaster for them. By increasing the capacity of Waskana Creek here it will be possible to drain off water which would otherwise lie too long on the lands, thus at least partly solving a very difficult situation. While this is essentially drainage it should be pointed out that drainage is essential to irrigation, and that in this case irrigation is accomplished naturally while the drainage must be provided artificially.

Frenchman River

Along the Frenchman river in southern Saskatchewan are a number of fine flats which can be irrigated. Irrigation possibilities here have been recognized for a great many years and the Dominion Reclamation Service in connection with the International Waterways treaty made extensive surveys of the whole river valley. This is not only an international stream, which requires that 50 per cent of the flow must be allowed to pass into the United States, but as the run-off occurs during a few weeks in the early spring and then the stream goes dry or nearly so, storage is absolutely necessary in order to irrigate any of the lands. This was recognized by the reclamation service and years ago a number of possible storage sites including Cypress Lake were surveyed. Applications have been received from residents both at Val Marie and at Eastend for assistance in the construction of projects to irrigate valley lands at these points. The irrigable lands at Val Marie consist of about 6,000 acres of what has been known for years as the Seventy Mile flats, while the irrigable lands at Eastend are those which were originally owned and irrigated by Enwright and Strong in the early days. In both cases the schemes are too small to justify the construction of the large reservoirs surveyed by the reclamation service, but smaller reservoirs are available just above the irrigable lands to store the comparatively small quantity of water required. For the Val Marie scheme $125,000 has been authorized and the scheme is now under construction. In the case of Eastend $73,000 has been authorized for that purpose. In both cases construction and engineering costs are wholly provided for by the committee.

Wood River

In southern Saskatchewan the Wood river which rises in the Moose mountains flows through a very dried out district to Johnson Lake where it is lost by evaporation. By the construction of a number of dams along the river it is possible to conserve water which would otherwise run to waste in the spring and make it available for stock watering purposes during the summer. A number of possible storage sites along this stream have been located by survey, but so far only one has been authorized and is now ready for construction.

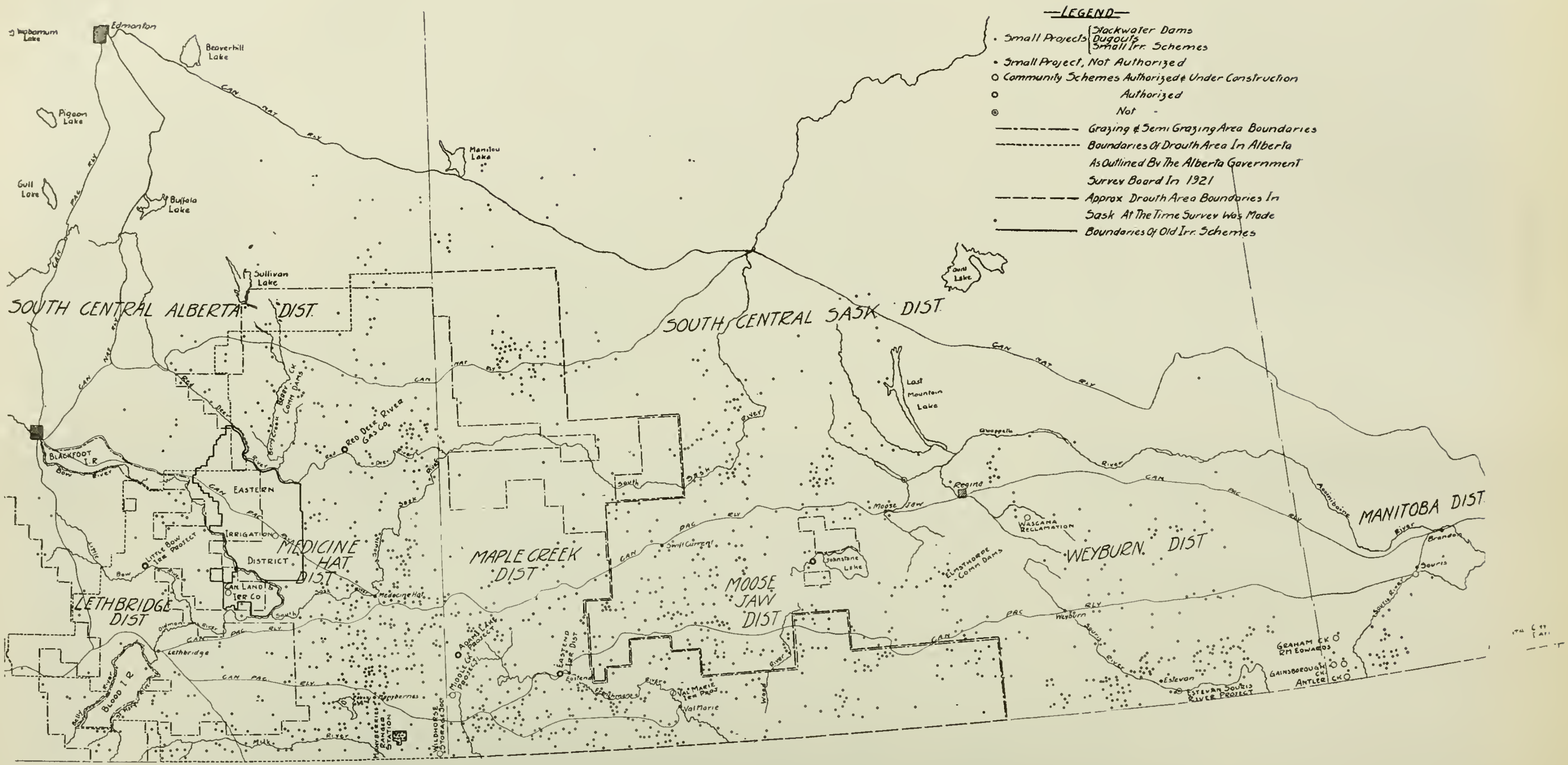


Fig. 1—Map showing Water Development Projects and Districts subject to Drought.

Surveys have been completed of the whole of the Wood river, of which further studies are required before any definite scheme of development can be outlined.

Canada Land and Irrigation Company

The Canada Land and Irrigation Company, which is at present operating an irrigation project in Alberta and providing water for some 35,000 acres of land in the Vauxhall district, has now insufficient funds to make necessary repairs to its system and has requested the assistance of this committee to finance the necessary repairs. An expenditure of some $80,000 has been authorized and construction will be proceeded with at once. One of the main flumes of this project is in a very critical condition and requires immediate replacement. Other structures are also in bad repair and require attention as soon as possible. It is proposed to carry out the necessary repair work and extensions during the next year to make water available for 40,000 acres.

Eastern Irrigation District

The Eastern Irrigation District which was originally the eastern section of the Canadian Pacific Railway project has applied for assistance to construct a storage scheme on One Tree Creek. Because of insufficient capacity in the Brooks aqueduct a large area of land to the east of this structure which it was originally intended to irrigate cannot now be provided for. By diverting some of the water at the west end of the aqueduct into One Tree Creek and creating storage there it is possible to bring about 10,000 acres under water at a cost of about $6 per acre. An amount of $15,000 has been authorized by the committee for such a development and the work is now under construction.

Cypress Hills District

This is one of the districts on the prairie to practise irrigation. Many small schemes are now in operation mainly for the purpose of growing feed supplies for stock which are ranged in the area which depend on their water supply from twenty streams which run off from the Cypress Hills. Storage reservoirs are essential because most of the run off takes place in the early spring and then the streams go practically dry later in the season. It has been estimated that the area drained by the above streams is 7,281 square miles, and the average annual run-off about 337,000 acre feet.

While it is not possible to conserve all of this flow there are from thirty-five to forty reservoir sites where much of the spring flow could be stored for use later on.

Provision has been made for the construction of three reservoirs in this district, one on Sage Creek and the others at the head of Battle Creek. The water stored in these reservoirs will be used to irrigate lands along the respective streams for which licenses under the Provincial Irrigation Acts are now held.

Little Bow Irrigation District

Along the Little Bow river in Alberta are a number of flats which might be irrigated. A district was organized some years ago to provide water to these lands by a diversion from the Highwood river. On account of financial difficulties the district is now unable to maintain the diversion works, with the result that farmers throughout the whole length of the Little Bow river are in danger of being deprived of their water supply. It is proposed to assist the district to retire certain debentures and thus put the district on a sound basis financially.

In addition to these larger projects some ten smaller community projects have been authorized and have either been constructed or are under construction.

Larger Projects under consideration

About thirty larger projects which have not yet been authorized are under consideration by the committee, and already engineering investigations have been made of many of them. Included in these are the Buffalo Pound Lake on the Qu'Appelle river and the Estevan project on the Souris river. Both of these require special consideration.

Both of these valleys are very flat, the slope in the case of the Souris river being about five-tenths of a foot per mile. Generally the banks of the river are the high points in the cross section of the valley, and it is therefore difficult and expensive to build canals to irrigate in the usual way, but quite simple by raising the water level to flood water over the valley lands. It is proposed by a system of dykes and headgates to simply flood large areas of the valleys' lands during the spring to insure a hay crop. There are a number of such projects proposed along the Souris river in the United States which have been estimated at from $6 to $8 per acre. Tentative estimates would indicate that it can be done at Estevan and Moose Jaw for from $10 to $15 per acre.

Purpose of Irrigation Projects

None of the irrigation schemes so far investigated by the Water Development Committee are such schemes as have been built in Alberta, but comparatively small and cheap schemes located in the centre of range country simply to insure hay and water for stock.

Provincial Authorization

Since the respective provinces now administer their water resources it is necessary that all schemes be authorized by their administration authorities. This sometimes is responsible for some duplication of work. However, considering all of the difficulties which might arise there has so far been little duplication. It is conceivable, however, with a large number of these smaller projects constructed along the various streams throughout the drought area, that many administration complications could arise, and it is necessary for the provinces to take every precaution to see that prior rights are protected in order to avoid disputes and conflict between water users in the future.

Notes on the Design, Characteristics and Applications of Synchronous Motors

J. Leech-Porter,
Canadian Westinghouse Company Limited, Hamilton, Ont.

Paper presented before the Montreal Branch of The Engineering Institute of Canada, March 9th, 1936.

SUMMARY—The synchronous motor is discussed as regards its performance, limitations and suitability for various types of duty. Notes are given on torque, methods of starting, use for power-factor correction, flywheel effect and excitation.

A brief review of the history of the synchronous motor shows that Wilde, in 1869, discovered that alternators could be used as motors and this was confirmed by Hopkinson in 1883. These motors were of course single-phase as the discovery by Tesla of the rotating field was not made until 1887. The latter discovery accelerated the development of the synchronous motor, as well as that of all other a.c. motors.

There were no damper windings on early synchronous motors and consequently the starting torque was very low. What starting torque there was, was due to eddy currents induced in the solid pole tips. As a result it was necessary in most cases to use an induction motor to supply the necessary starting torque and to bring the motor up to synchronous speed. The damper winding, as its name implies, was originally developed to reduce oscillations on alternators. It was then applied for a similar reason to synchronous motors and finally it was developed as a starting winding, but the original name "stuck." The latter development gave great impetus to the use of synchronous motors and now they are used for nearly every application where electrical motors of any kind can be used.

Mechanical Construction

Early synchronous motors were of cast iron and cast steel construction and were very heavy compared to those of modern design. Their windings were of the push-through type. These gave way to chain windings and finally to those of the modern diamond type. The motors gradually became lighter as more efficient use was made of the materials of which they were constructed. Fabricated construction, introduced in the 20's, gave a great impetus to this lightening process.

The main component parts of a modern synchronous motor are the pedestals, the bearings, the shaft, the spider, the poles and the field windings, the stator winding and the stator frame. Pedestals are either made of cast steel or fabricated. Bearings are either sleeve or anti-friction, the latter being again subdivided into roller or ballbearing. Shafts are made of a variety of steels depending on the application for which the motor is intended. Spiders are of four kinds: plate, laminated, cast steel and fabricated. All poles are laminated and they differ chiefly in the method of attachment to the spider, being either held on by bolts or by dovetails. Field windings are of two types: wire or strap wound. The type in each of the last three cases is decided chiefly by the speed of the motor. Stator windings do not vary much except in the matter of bracing. Stator frames are either cast iron or fabricated.

The following table shows the above in tabular form:—

Table I

Varying Definitely with Motor Speed

Motor Speed	Spider	Poles	Field Windings
High Low	Laminated plate Cast steel fabricated	Dovetailed Bolted on	Strap Wire

Not Varying Definitely with Motor Speed

Pedestals	Bearings	Shaft	Stator Windings	Stator Frame
Cast steel Fabricated	Sleeve Anti-friction	Steel	Diamond type	Cast iron Fabricated

Torque

The torques of a synchronous motor generally considered are the starting, the pull-in, the running, and the pull-out. The starting torque is defined as the torque the motor will develop when the rotor is locked, that is at zero speed; the pull-in torque as the torque it will develop when d.c. is applied to the field; the running torque as the torque corresponding to full load; and the pull-out torque the maximum torque the motor will develop without decidedly slowing down.

The starting torque must of course be large enough to start the given load. It varies as the square of the voltage applied to the motor terminals and therefore allowance must be made if any method of reduced voltage starting is used. D.c. is generally applied to the field when the motor has reached approximately 94 per cent of synchronous speed. The resulting pull-in torque must be large enough to suddenly accelerate the load to synchronous speed. It varies with the value of field current applied and with the square of the voltage. It is relatively difficult to obtain really high pull-in torques with a synchronous motor and consequently motors are usually not synchronized until after full voltage has been applied. The pull-out torque varies directly with the voltage and not with the square of the voltage as in an induction motor. As a result variations in voltage are not so serious as in the case of an induction motor. It can also be controlled with the field current. To obtain higher pull-out torque, the field current can be increased, provided it is not increased to the point where excessive field heating occurs. For fluctuating loads, provision is often made to temporarily increase the field current during the peaks.

A good example is that of the motor of a motor generator set supplying d.c. to the hoist motor in a mine. The heaviest load is naturally during the period of acceleration upwards. During this period the field current is temporarily increased to carry the increased load. The current is reduced after the peak to allow the field to cool off again. If this procedure were not followed a larger motor would be required.

The pull-out torques of synchronous motors vary from 140 to 400 per cent, the former being used for compressors and the latter on sheet mills.

Synchronous motors are used to drive three more or less distinct types of loads:—

(1) Light starting and light accelerating, such as compressors and jordans.
(2) Light starting and heavy accelerating such as centrifugal pumps and centrifugal blowers.
(3) Heavy starting and heavy accelerating such as ball mills and rubber mills.

Compressors require starting torques of 40 per cent, pull-in torques of 20 per cent.
Jordans require starting torques of 50 per cent, pull-in torques of 50 per cent.
Centrifugal pumps require starting torques of 30 per cent, pull-in torques of 100 per cent.
Centrifugal blowers require starting torques of 30 per cent, pull-in torques of 100 per cent.

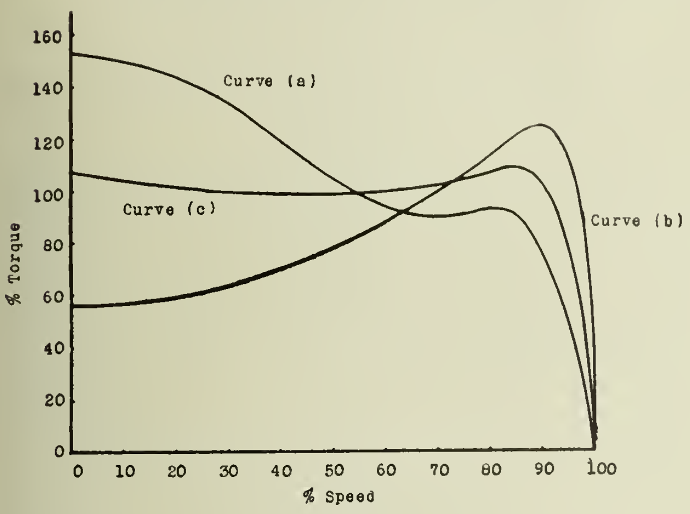


Fig. 1.

Ball mills require starting torques of 175 per cent, pull-in torques of 100 per cent.
Rubber mills require starting torques of 125 per cent, pull-in torques of 100 per cent.

This list could be expanded indefinitely but these six examples will give some idea of the variety of torques synchronous motors can develop. Briefly they can develop starting torques from 30 to 250 per cent, and pull-in torques from 20 to 150 per cent. It is not so difficult from a design point to obtain a high starting torque and a low pull-in torque, or a low starting torque and a high pull-in torque, as it is to have both high at the same time.

This is not hard to understand when one considers that a synchronous motor starts as an induction motor. It has in fact a double rotor winding, the damper and the field winding. They are not so effective though as in the case of the induction motor on account of the non-continuity of them both. But as the damper winding is not required to any extent when the motor is running at synchronous speed, it can be made of much higher resistance than in the case of the induction motor. This increases the starting torque considerably and also decreases the starting inrush.

A motor may have sufficient starting torque to start its load and yet not come up to speed. This is due to a cusp in the speed torque curve, the speed torque curve of a motor being a curve showing the torque the motor can develop at all speeds up to synchronous speed. As suggested before, the speed torque curve of a synchronous motor is the result of two windings. Their effects can be best investigated by varying each separately. The effect of varying the resistance of the damper winding is similar to varying the resistance of the squirrel cage in an induction motor. Curve (*c*) Fig. 1, shows the effect of a medium resistance damper winding. Curves (*a*) and (*b*) show the effect of high and low resistance respectively. In each case the field has a resistance of four times its own resistance connected in series with it.

The effect of varying the field resistance is shown in Fig. 2. Actually the resistance of the field itself is not varied but rather the resistance of the resistor in series with it. Curve (*a*) shows the speed torque curve with the field short circuited, that is, it has no resistance in series; curve (*b*) when it has twice its resistance in series; (*c*) four times; (*d*) seven times, and (*e*) an infinite resistance, that is, the field is open circuited.

It will be seen the effect of short circuiting the field through a resistance is to decrease the torque at lower speed and to increase it at higher speeds.

The possibility of a cusp in the speed torque curve preventing the motor coming up to 94 per cent of synchronous speed has been mentioned previously. If this does occur, it is usually around 90 per cent speed. Figure 2 suggests a means of overcoming such an occurrence, namely by changing the resistance in series with the field. There are, however, two limiting factors. Too low a resistance reduces the starting torque appreciably and too high causes too high a voltage to be induced in the field winding during starting. Two to seven times are good limiting values of external resistance.

In designing a synchronous motor to obtain high starting torque or high pull-in torque, or both, there is often a very definite difficulty, that of also obtaining a low starting inrush and a small line disturbance at pull-in. The latter in general is unimportant so will not be considered further. Low inrush is obtained by using a high resistance damper winding or by reduced voltage starting. The former is used when a high starting torque and a low pull-in torque is required, and the latter when a low starting torque and a high pull-in torque is required. More difficulty is experienced if both torques must be high and in exceptional cases specially shaped bars must be used. This is of course also true of an induction motor.

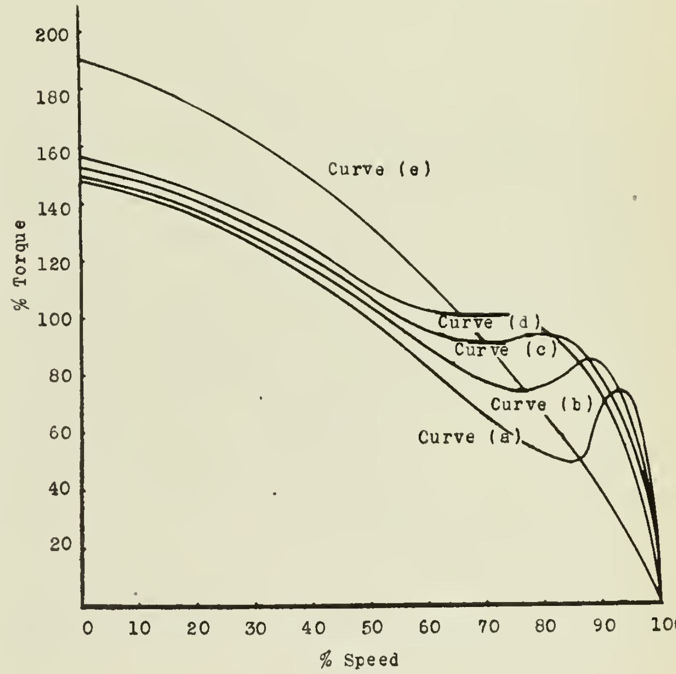


Fig. 2.

Power Factor

The power factor of an a.c. system is an indication of the ratio of the useful current flowing to the total current. The non-useful part is referred to as the wattless component. It may cause the total current to be either leading or lagging. Most industrial systems have lagging currents and since it so happens that the addition of a leading current to a lagging current tends to reduce the lag, or in other words to raise the power factor, ideal opportunities for the use of synchronous motors are presented, for these motors draw leading currents when over-excited.

This leads to a discussion of the two kinds of synchronous motors, namely 100 and 80 per cent p.f. 100 per cent p.f. motors draw neither a leading nor a lagging current, that is their armature current is a minimum for the given power required. 80 per cent p.f. motors on the other hand draw a leading current,

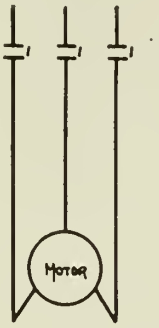


Fig. 3.

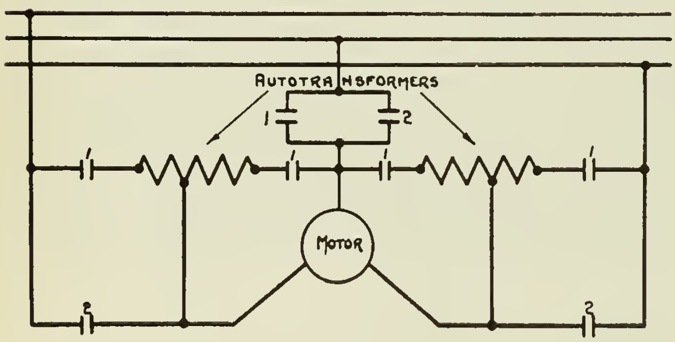


Fig. 4.

25 per cent larger due to being over-excited. Consequently they are 30 to 40 per cent larger and so about 25 per cent more expensive than 100 per cent p.f. motors. 100 per cent p.f. motors are used where no power factor correction is required and where first cost is a prime consideration. 80 per cent p.f. motors are desirable in all other cases.

From a performance viewpoint 100 per cent p.f. motors are more efficient than those of 80 per cent. On the other hand, their inrush is higher when given in the usual way, namely on a percentage basis. Again, they have lower pull-out torques. That they require smaller exciters follows more or less naturally. The pull-out torque of 100 per cent p.f. motors varies from 140 per cent upwards while that of 80 per cent p.f. motors varies from 200 per cent upwards. The required exciter capacity for 100 per cent p.f. motors is about 75 per cent of that required for 80 per cent p.f. motors.

The following table gives a typical comparison of a 100 per cent p.f. and an 80 per cent p.f. motor. The actual figures are for a 250-h.p., 2,200-volt, 3-phase, 300-r.p.m., 60-cycle engine type motor.

Table II

	100 per cent p.f.	80 per cent p.f.
Kv.a. input	201	256
Full load efficiency	92.8 per cent	91.5 per cent
Pull-out torque	150 per cent	200 per cent
Starting torque	70 per cent	80 per cent
Pull-in torque	40 per cent	45 per cent
Starting kv.a.	300 per cent	270 per cent
Exciter capacity	4.5 kw.	6.0 kw.
Corrective capacity, full load	0 kv.a.	154 kv.a.
Corrective capacity, no load	66 kv.a.	185 kv.a.

The last two lines of this comparative table may require some further explanation. As the mechanical load of a motor is reduced its corrective capacity is increased. The effect of the small field of a 100 per cent p.f. motor is well illustrated here. At no load it can only supply one-third of that of a corresponding 80 per cent p.f. under similar conditions.

If power factor improvement is required in any given system it can be achieved in the following ways:—

(1) By eliminating under-loaded induction motors.
(2) By adding synchronous or static condensers.
(3) By adding synchronous motors, preferably 80 per cent p.f.

Unloaded induction motors are a common cause of low power factor, as the power factor of an induction motor drops off quickly with a reduction in mechanical load. Low speed induction motors are also a cause of low power factor. Synchronous condensers are synchronous motors operating with no mechanical load. They are generally preferable to static condensers except in small sizes. The addition of either 100 per cent or 80 per cent p.f. motors will improve the power factor: the former by adding pure power load, and the latter by adding leading current as well. This effect is still more increased if the synchronous motors are replacing underloaded or slow speed induction motors.

Starting Synchronous Motors

There are two main ways of starting synchronous motors, namely full voltage starting and reduced voltage starting. The latter is again subdivided into six methods: three by means of external apparatus, namely auto-

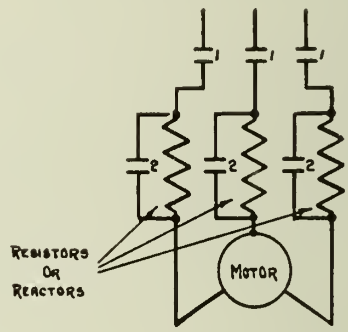


Fig. 5.

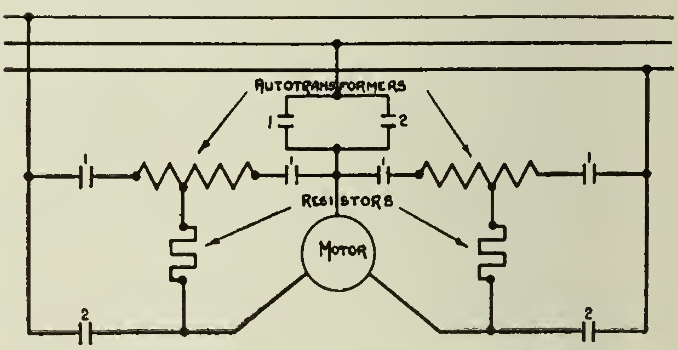


Fig. 6.

transformer, reactor and resistor, and three by means of changes in the motor armature winding—star-delta, series-parallel and partial winding.

Full voltage starting is of course the cheapest and is used where a high starting torque is required and where a high starting current is not objectionable. (See Fig. 3.)

The auto-transformer method is the most common one for reduced voltage starting. Two auto-transformers in open delta are used except for large motors, when three are necessary. (See Fig. 4.)

In the reactor method a reactance is connected in series with the motor. The reactors are generally of the air type, although those with iron cores are also used. (See Fig. 5.)

The resistor method is similar to the reactor method except a resistance is substituted for the reactance. It is usually of the grid or ribbon type. (See Fig. 5.)

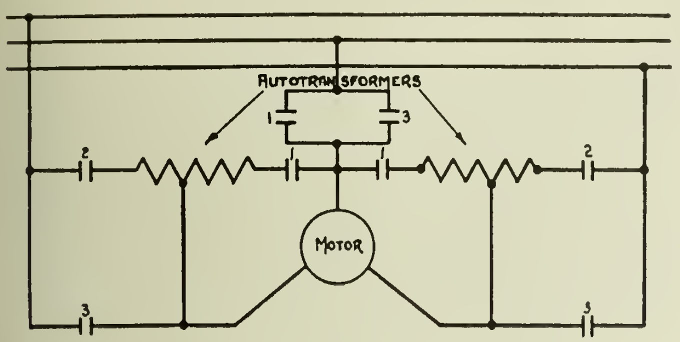


Fig. 7.

The power factor of the starting current of a synchronous motor is quite low, around 50 per cent, and the magnetizing current required by either auto-transformers or reactors lowers the power factor still further. This is of course undesirable. On the other hand resistors raise the power factor of the starting current but they require much more space and produce a large amount of heat.

From a cost basis the resistor method is the cheapest. The other two cost about the same amount.

The auto-transformer method however has a big advantage from the viewpoint of line disturbance. This is perhaps most easily explained by using actual figures. Suppose the motor has a starting torque of 100 per cent and an inrush of 400 per cent; also that the load requires a starting torque of 50 per cent. Using auto-transformers the motor will be started on the 70 per cent tap giving a line inrush of 200 per cent. But using either resistors or reactors, the inrush will be 280 per cent.

The resistor and the reactor methods, however, have one offsetting advantage over the ordinary auto-transformer method, namely that of closed transition. Closed transition meaning that the motor voltage is changed from the reduced to the full value without opening the circuit. When the circuit is opened, the procedure is called open transition and considerably more line disturbance is caused. It can be avoided, however, when the auto-transformer method is used by the use of preventative resistors or by the Korndorfer method of connection. Either of the latter of course increase the cost considerably but where line disturbance must be minimized, are well worth while. (See Figs. 6 and 7.)

Good rules for the use of the above three methods are as follows:—

(1) Use resistors below 100 per cent h.p.
(2) Use auto-transformers with open transition, above 100 h.p.
(3) Use reactors or auto-transformers with closed transition, above 1,000 h.p.

With the star-delta method the motor is started with the windings connected in star, and for normal running the windings are connected in delta. The latter is not desirable as circulating currents may be setup. Another disadvantage is that the only reduction obtainable is to one-third of full voltage torque. (See Fig. 8.)

The series-parallel method is similar, the windings being connected in series for starting and in parallel for running. Its main disadvantage is that the only reduction obtainable is to one-quarter full voltage torque. (See Fig. 9.) The other method, namely the partial winding, is very satisfactory except the motor must be specially designed and it cannot be used in every case. In it the armature winding is divided into two parallels and only one is used during the starting period. It is a closed transition method and gives a starting torque of approximately 65 per cent of full voltage torque, which is quite satisfactory for many applications. (See Fig. 10.)

All of the above methods can be used with the three types of control, namely automatic, semi-automatic and manual. In the automatic type all the breakers are electrically operated and d.c. is applied to the field, either by a definite time relay or by a relay operated by the current induced in the field winding during acceleration. In the semi-automatic type the breakers are operated manually and the d.c. is applied automatically. In the manual type all operations are done manually.

The opposite operation to that of starting is that of stopping. It is done in three ways: (1) a gradual coasting to rest, (2) plugging, and (3) dynamic braking. The first is satisfactory for most applications, the latter two only being used where sudden stopping may be necessary to protect the operator in case of accident. There is some discussion regarding which of the latter is the better, however the author has found dynamic braking the more satisfactory. The procedure is to suddenly disconnect the

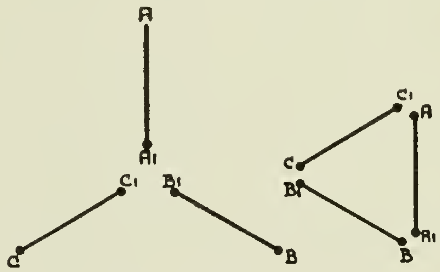


Fig. 8.

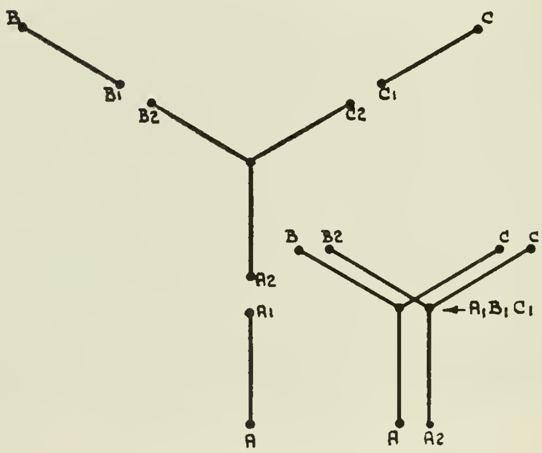


Fig. 9.

motor from the line and to connect it to a resistance. It then operates as a generator and this quickly brings it to a stop. Plugging is of course more common and merely consists of reversing the motor connections until the motor stops.

Flywheel Effect

Another important point to consider in the design of a synchronous motor is the flywheel effect. A certain amount of flywheel effect is necessary for any given motor driving a given load. The amount is determined by the maximum fluctuation allowable in the line current of the motor.

These fluctuations have of necessity received most study in the case of compressor applications. The fluctuations are generally limited to 40 per cent or 66 per cent. The N.E.M.A. in the United States has classified all common compressors manufactured in the United States under application numbers. For each application number there is a definite constant "*C*" which determines the necessary flywheel effect. Where sufficient flywheel effect cannot be incorporated in the rotor of the motor, a separate flywheel is necessary. These "*C*" constants are, of course, determined from the characteristics of the compressors under consideration.

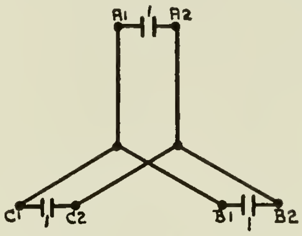


Fig. 10.

For every compressor there is a definite *X-Y* curve. This *X-Y* curve gives the relationship between the motor current fluctuation and the total flywheel effect; that is the combined flywheel effect of the motor and of the compressor. Roughly they can be divided into two types. With type 1, the current fluctuation decreases steadily with an increase in flywheel effect, but with type 2 the current fluctuation decreases to a minimum, then increases to a maximum, and then decreases steadily with an increase in flywheel effect. Suppose the current fluctuation must be limited to 66 per cent. Then with type 1, *X* must be 7.5 or greater; but with type 2 it can vary between 2.0 and 6.3, or be greater than 12.2. *X* is synonymous with "*C*" and is proportional to the flywheel effect. Thus with type 1 only a heavy flywheel can be used but with type 2 either a heavy, or light flywheel can be used. (See Fig. 11.) *X-Y* curves are computed from the crank-effort diagram of the compressor.

Excitation

The last important point to be considered is the methods of exciting synchronous motors. The common methods are (1) bus excitation, (2) M.G. set excitation, (3) direct connected exciters, (4) belted exciters. Bus excitation is used where d.c. power is already available but it has the disadvantage of requiring a large rheostat. M.G. set excitation is used where there are several similar motors, or where dynamic braking is required. Direct connected exciters are used on high speed motors and belted exciters on low speed motors.

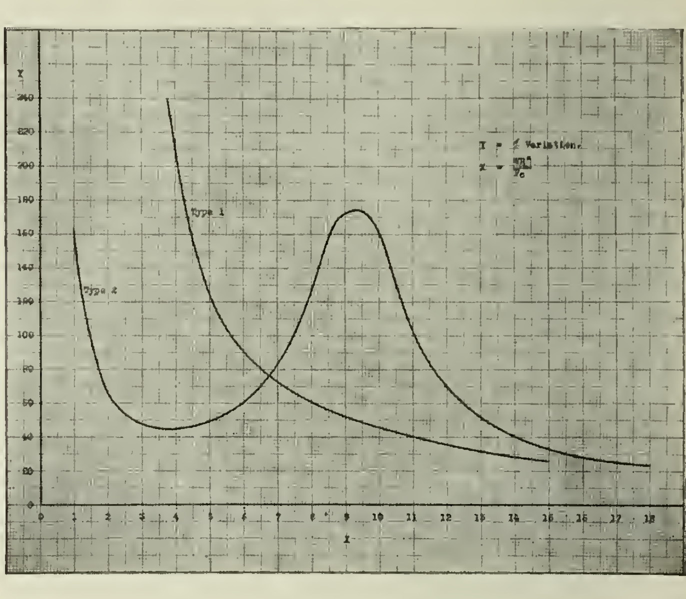


Fig. 11.

THE PAST-PRESIDENTS' PRIZE 1935-1936

Members are reminded that essays in competition for this prize must be in the General Secretary's hands not later than June 30th, 1936

The subject prescribed by Council is

"The Engineer's Contribution to Transportation."

The prize has a value of One Hundred Dollars.

Kilns and Cement Burning

At Plant No. 1, Canada Cement Company Limited

T. R. Durley, A.M.E.I.C.,
Canada Cement Company Limited, Belleville, Ontario.

Paper presented before the Junior Section of the Montreal Branch of The Engineering Institute of Canada, October 28th, 1935

SUMMARY.—This paper contains a short history and description of the manufacture of Portland cement, followed by a discussion of the chemical changes taking place inside the rotary kiln, a description of the kiln itself and operating data respecting the burning process.

Portland cement was first patented in 1824 by an Englishman, Joseph Aspdin, who called it 'Portland' since it resembled the stone taken from the Portland quarries. In 1859, John Grant published, in the Transactions of the Institution of Civil Engineers, his reasons for using it in the construction of the London Drainage Canal. Since then its use has become universal. The first German plant was established in 1852 and to the Germans must go the credit of introducing scientific methods from the very outset of the industry.

On the western hemisphere, the industry dates from 1866 when the first mill was built in the United States. Since then the consumption of cement has increased rapidly and in 1900 had passed 50,000,000 barrels a year.

In Canada, a large number of small plants were in existence before the formation of the Canada Cement Company and it is interesting to note that the first plants on the Island of Montreal were at Longue Pointe where the Canada Cement Company's plant No. 2 once stood and at Pointe Claire where the old quarry is still visible.

Most of these small plants operated on the dry process although some did grind their raw materials wet. Due to the nature of the material, powdered rock and clay, it was not easily sampled with the result that the plant chemist had difficulty in trying to decide in what proportions he should mix his limestone and clay. If he did not have enough clay and obtained a sample high in lime, by the time he had corrected it with more clay, the material from which the original sample was taken was already clinker. With the wet process the rock and clay are ground wet and the resulting mud called slurry is stored in tanks and agitated until a representative sample has been analyzed. The various tanks are then blended in the correct proportions and the mixture stored in a large basin until required. A more uniform and better cement is the natural result.

Plant No. 1 of the Canada Cement Company, due to the nature of the limestone deposit in the quarry, was more fortunate than some of the other plants taken over in 1909 The cement rock deposit at Montreal East is almost a natural mixture. It was, therefore, not until 1930 that a reconstruction programme was carried out and the plant changed from dry to wet process.

Manufacture

The rock is drilled and shot so that it can be handled by 1¾ and 2¼ cubic yard shovels. The three existing shovels are electric drive and load the stone into twelve yard cars. They are drawn across the quarry floor by gasoline locomotives to the crushing plant. Here the rock is dumped into a large gyratory crusher and then passes through swing hammer mills. The resulting product is no larger than one inch and contains a considerable quantity of quite finely divided rock. It is then stored in a covered building equipped with a crane and drawn out as required. The raw mill building adjoins the storage and here the water is added to the rock as it enters the large ball mills that pulverize it. These mills are driven by 800 h.p. 720 r.p.m. motors and produce about 100 barrels of slurry per hour each. (See Fig. 2.) The slurry is then pumped to the correcting tanks, blended in the mixing basin and stored ready to be made into clinker in the cement kiln. (See Fig. 3.) It is the changes taking place in the kiln and its operation that will be dealt with later. When discharged from the kiln the clinker is conveyed by a shaking conveyor to storage. It is in turn ground and pulverized in tube mills with about 4 per cent of gypsum added to retard the time of set. The tube mill product is cement.

Chemical

The chemical changes taking place in the cement kiln are briefly as follows. Cement slurry containing 32 per cent water and ground to 90 per cent fineness through a 200-mesh sieve is fed into the kiln where it is at first exposed to a temperature of 500 degrees F. The first change is, of course, the removal of the water from the slurry. As the then dry material progresses through to the discharge end it is being gradually heated and prepared for the final clinkering or sintering process. The calcium carbonate in the limestone is split up by the heat of the kiln into lime and carbon dioxide according to the chemical equation $CaCO_3 = CaO + CO_2$. The CO_2 goes off up the stack and the CaO continues on down the kiln with the other constituents of the raw material. As the charge approaches the clinkering or burning zone, it is being prepared by the increasing heat for clinkering. The CO_2 has, by this time, all been driven off and now the silica and alumina of the cement rock combine with the lime present to form the tricalcium silicates and tricalcium aluminates present in a

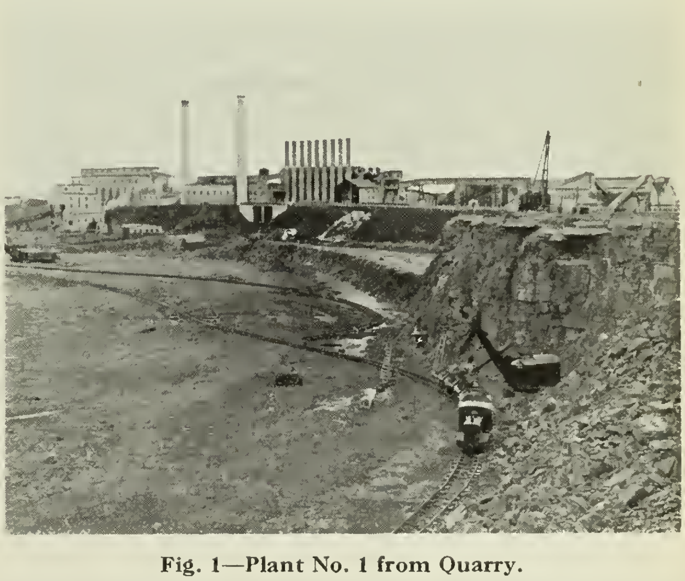


Fig. 1—Plant No. 1 from Quarry.

well burnt clinker. The temperature required to sinter the charge depends on the amount of lime and silica present in it but it is generally about 2,600 degrees F. The clinker is then cooled and discharged from the kiln at about 300 degrees F. and conveyed to storage.

With the wet process installation complete, four new kilns were operated for the first time. Their great weight and length makes them one of the largest pieces of moving machinery in existence and a brief description of the equipment is desirable. Each kiln is 361 feet long with an outside diameter of 11 feet 5 inches at each end and a diameter of 10 feet 2 inches in the centre. They are supported on six tires each and revolve on rollers equipped with roller bearings. The total weight thus supported, is in the neighbourhood of 3,000,000 pounds. The maximum weight on each roller is about 117 tons, this includes coolers, firebrick lining, charge and interior equipment. (See Fig. 4.)

Fig. 2—Unikon Mills in which Limestone is Pulverized Wet.

The heaviest loaded rollers are at each end of the kiln shell. At the discharge end, where the cement clinker pours from the kiln, ten coolers are overhung from the first supporting tire. They are cylindrical drums supported about the circumference of the kiln in cradles. (See Fig. 5.) Their function is to preheat the air required for combustion by means of chains. The clinker passing over the chains heats them and as the kiln revolves the chains become uncovered and they in turn heat the air passing through the cooler into the kiln proper. At the feed end of the kiln, where the raw material or slurry is fed in, for some 150 feet chains again transfer heat from the hot gases passing through the kiln to the charge, thus effecting a large saving in fuel.

The feed end of the kiln is enclosed in a dust housing from which the exit gases are drawn by an induced draught fan capable of handling about 160,000 cubic feet per minute at 550 degrees F. The fan is driven by a 75 h.p. 900 r.p.m. induction motor through a silent chain drive. The gases are then delivered through a steel duct to a 200-foot concrete stack. A louvre damper placed before the fan allows control of the amount of gas delivered to it. The kiln shell is completely covered inside with firebrick of various types ranging from an insulating brick at the feed end to an 8-inch high-alumina brick in the burning zone.

The whole kiln is inclined at ½ inch to the foot, sloping downward from the feed end to the discharge end, and is driven by a 120-h.p. 900/1,100-r.p.m. d.c. variable speed motor through a Falk reducer and a helical pinion and girth gear located above No. 3 tire—approximately 138 feet from the discharge end. (See Fig. 6.)

The downhill thrust is resisted by a thrust roller located at No. 3 tire and the reaction at this point is about 4 per cent of the total weight or 120,000 pounds. It is interesting to note that all tires except No. 3 are floating, that is, they creep around the kiln shell as the kiln revolves; the amount of creep is about 2 inches an hour but this varies depending on the fit of the tire. When hot the total length of the kiln expands about 7⅛ inch and this must be taken into consideration when locating the rollers at the extreme ends, No. 3 tire being the fixed point due to the girth gear located near it.

Bituminous coal pulverized at the plant is blown into the kiln through an 8-inch pipe and is discharged into the air stream from the blower by means of a coal injector equipped with a slide for cutting the amount of air being blown in. The coal is drawn from the tanks by screw conveyors driven by a variable speed d.c. motor.

The company has at the river, a large coal dock equipped with a Mead Morrison bridge for unloading boats, storing the coal and rehandling, for the use of the plant. Due to limited space, the coal is piled quite high (about 35 feet) and has, as a result, considerable fire in the pile at all times. Consequently, by spring a fair percentage of coke is mixed with the coal delivered to the mill. An analysis of the coal which comes from Sydney, Cape Breton, follows:

B.t.u. per pound.....	13,500
F.C.	57.28 per cent
Volatile............	33.95 per cent
Ash................	7.49 per cent
Sulphur	2.50 per cent

With some of the coal coked, the volatile goes down to say 24 per cent and the burner will have difficulty in obtaining a well-burnt clinker, for the flame will not travel far back enough in the kiln to prepare the raw material.

Control Equipment

Kiln speed, amount of coal required, the draught fan, louvre damper opening and slurry feed are all controlled by the burner from a central control board located on the burners platform. The problem of having a constant feed delivered to the kiln, regardless of speed, has been arranged for by having a small 7½ kv.-a. alternator coupled directly to the motor driving the kiln. It in turn drives through a suitable control a 5 h.p. synchronous motor coupled to the slurry feeder. As the kiln speed varies so does the frequency of the power supply to the feeder motor, so that a reduction in speed of the kiln results in a proportional reduction in feed. The feeder itself is a double scoop rotated in a constant level tank and discharging through the centre of its hollow shaft to the kiln feed pipe. It is driven through a Cleveland reducer and a Stevens Adamson variable speed transmission.

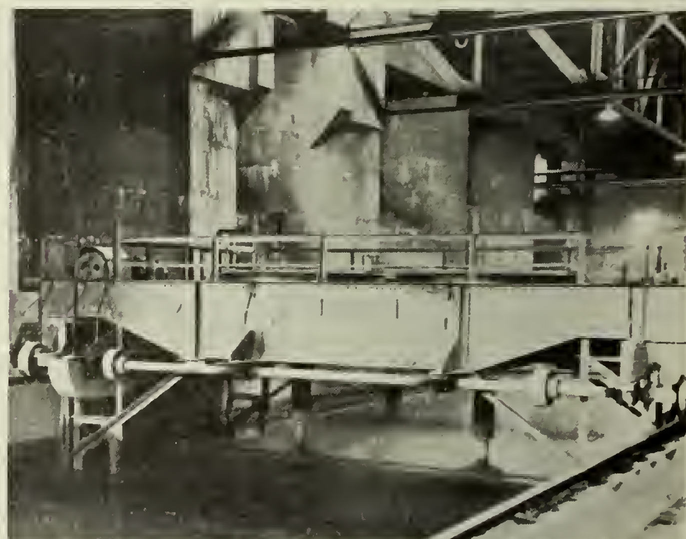


Fig. 3—Mixing Basin with Agitator. Correcting Tanks in Background.

Draught gauges are mounted on the control board and report the reading at the feed and discharge ends of the kiln. A Selsyn driven gauge tells the burner the number of degrees opening on the louvre damper. A continuous chart of the heat at the feed end is given by a Leeds and Northrup multiple point recorder on the burner's platform and an indicating pyrometer is mounted on each control board. Both instruments operate from the same iron and iron-constantan thermocouples.

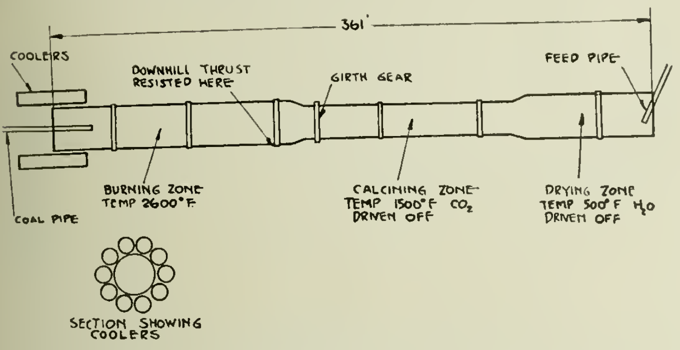


Fig. 4—Outline Drawing of Cement Kiln.

A Siemens and Halske CO_2 analyzer was installed at a later date with indicating meters for CO_2 and $CO + H_2$ on the control board and a recording meter giving a continuous chart in the foreman's office. The operation of the CO_2 meter depends on the ability of the gas to transfer heat. If a platinum wire surrounded by a gas sample to be analyzed is heated, the temperature of the wire rises until the continuous dissipation of heat is equal to the heat in the form of electrical energy supplied to it. The action of the $CO + H_2$ analyzer is based on the catalytic action occurring when a sample of flue gas is passed through a tube and comes in contact with a platinum wire electrically heated. If combustibles are present, catalytic action will cause them to be ignited, a sufficient amount of air being admitted through a small orifice to assure complete combustion. This will cause an increase in the temperature of the wire in proportion to the percentage of combustible present.

The percentage of CO_2 in the stack gases runs as high as 31 or 32 per cent due to the amount of CO_2 driven off during the progress of the material through the kiln and the CO_2 from the combustion of the coal. The $CO + H_2$ is kept at zero reading by the burner but a chart showing an occasional trace indicates that no free oxygen is present in the flue gases.

The amount of coal required to convert a barrel of raw material into a barrel of cement clinker is obtainable in various ways. It can be calculated from the gas analysis and this gives the actual amount of coal being used. The coal may also be weighed as delivered to the plant but this only gives a weekly or monthly figure. The amount of coal required in an ideal kiln in which there is no radiation and no heat loss up the stack is given as 22 pounds per barrel using 12,600 B.t.u. coal.*

Burning

The actual burning of cement clinker is probably the most expensive part in the manufacture of Portland cement, the large quantities of coal consumed and the high cost of the rotary kiln being probably the two main factors. Before the development of the modern long kiln as used in this country and the United States and the more complicated modern control, the burner was given a piece of blue glass and told to burn clinker as best he could. He had no control over kiln speed, it either ran at constant speed or not at all, and his only means of controlling his kiln was to take off or put on more coal. It should also be pointed out that in the old short kiln of 125 to 150 feet in length, the temperature of the exit gases was usually in the neighbourhood of 1,500 to 1,800 degrees F.

With the long modern kiln an intelligent and a rather more highly trained burner and kiln room foreman are essential. There are so many changes that can take place that the burner must now be able to interpret properly what has to be done in order to correct faults as they occur. He must know the chemical analysis of the material he is trying to burn, know what effect more coal will have, whether he should make a change in his damper opening and many other variables. He must also be told whether there is any coke coming over to his coal tanks for the reasons mentioned above and, if so, make allowance for it.

Generally speaking the slurry delivered to the kilns at plant No. 1 has the following chemical analysis.

SiO_2	13.20 per cent
R_2O_3	5.57 per cent
CaO	41.88 per cent
MgO	2.30 per cent
Loss on ignition	35.72 per cent

The symbol R_2O_3 is used to denote the oxides of iron and alumina in the raw material. Both oxides are determined as one by the chemist. The silica ratio is found by dividing the SiO_2 by R_2O_3 and is in the neighbourhood of 2.37. It determines the amount of lime that the cement can carry, or to express the same thought differently, the silica combines with more lime than do the oxides of iron and alumina. If the silica ratio is too low the mix or charge will burn too easily. The higher the lime in the mix the better will be the finished cement, for this gives higher early strength.

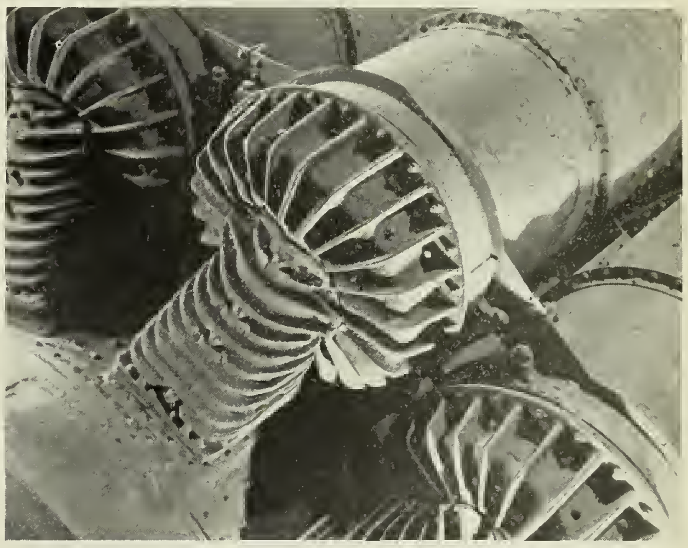


Fig. 5—Discharge End of Kiln showing Spouts Through Which the Clinker Falls into the Coolers.

The lime ratio is determined by dividing the lime by the sum of SiO_2 and R_2O_3. A low lime ratio has the same effect as a low silica ratio. A high lime ratio, however, not only makes the clinker hard to burn but will cause unsound cement due to free lime, since there will not be enough silica and alumina to combine with all the lime present. With high silica the kiln will become very dusty. The burner then should also know something of the chemistry of cement.

At plant No. 1 the arrangement of the kilns is such that two kilns discharge their gases into one stack. The damper

*"Chemical Engineering and Thermodynamics as Applied to the Cement Rotary Kiln," by G. Martin, D.Sc. Published by Crosby, Lockwood and Son, London, Eng.

is generally carried about 15 degrees open giving a temperature of 500 degrees F. at the feed end. The kiln itself when producing 2,500 barrels or 437½ tons a day revolves at the rate of one revolution per minute. The draught at the feed end is about one inch of water and at the discharge end ¼ inch, the net draught on the kiln being ¾ inch or a little higher. Approximately 3¾ tons of coal per hour are required for complete burning of the clinker at the rate of 2,500 barrels a day. The proper opening for the louvre damper was (until the installation of the recording CO_2 meter) largely a good guess. Opening the damper will lessen the heat at the discharge end of the kiln and increase the heat at the feed end. This in turn will drive off the water sooner and also the CO_2 from the mix. Closing the damper has the opposite effect but has a great disadvantage, for as the draught is decreased the heat and flame from the coal pipe spread radially, eating away the high alumina firebrick in the burning zone.

Fig. 6—Kiln near Feed End.

With low heat at the feed end and consequent saving of fuel it has been found that rings of dried raw material will form if the slurry leaves the chain section with moisture still present. These rings are also caused by a low silica ratio and will break away from time to time, either due to an increase in heat at the feed end, or from mechanical reasons due to the material becoming dammed up behind them and then breaking the ring down. A heavy load then progresses through the kiln necessitating the slowing down of the kiln and increasing the supply of coal in order to burn the charge properly. The kiln is then upset and the temperatures throughout the kiln are not normal; the material progressing after the heavy load becomes heated too soon due to the extra coal required and before the burner knows it he must take off more coal than he put on. Thus care must be exercised in burning a heavy load such as described. Sudden changes of magnitude in the amount of coal, kiln speed, and damper opening should be avoided. With the kiln functioning as designed and the proper changes in the charge taking place only slight changes in the amount of coal and damper opening should take care of any slight inequality of load or variation in the chemical analysis. In theory any change in coal consumption should be accompanied with a change in damper opening. In practice with a slight change in coal no damper adjustment is made.

The problem of devising some means whereby the amount of coal delivered by the screws may be measured has not yet been solved. At the end of each month the total amount of coal used is determined from the number and weights of the cars unloaded at the mill, plus or minus any difference in amount of coal that is stored in the various tanks. The back pressure caused by a nozzle in the end of the coal pipe has the effect of changing the amount of coal delivered by the screws so that from day to day only an approximate figure can be obtained. The back pressure has, however, some value in that it tends to eliminate sliding and flushing of the coal through the screws delivering it to the blower.

The number of pounds of coal required per barrel of clinker will vary in any one plant due to various reasons. First—the mix—whether it is high or low in lime and silica. Second—the condition of the coal—whether there is much coke in it, the B.t.u.'s per pound and the volatile. Thirdly—the amount of water in the slurry and the temperature of the exit gases. It is true that the less water in the slurry the less heat will be required to drive it off—practically, however, a state is possible when a further reduction in percentage of water does not further reduce the number of pounds of coal burnt. This is best described by Dr. Martin when he says that the correct way to abolish inefficiency is to concentrate on making the hot end of the kiln more efficient and not to worry unduly about the moisture—the main effect of reducing the slurry moisture is to increase the exit temperature. As this takes place coal must be taken off with the result that under-burnt clinker will be discharged from the kiln. The other alternative is to close the damper and the effect this has on the kiln lining has already been noted.

The transfer of heat from the flame to the charge depends more on the length of time that the charge is covering the hot brick than on the radiation from the flame direct. The brick should be exposed to the flame long enough to let it soak in enough heat so that it may be later transferred to the charge. Thus the speed of the kiln is dependent on the amount of material to be produced more than any other factor. The more rapid the transfer of heat to the charge the more efficient will the kiln be and it is possible that a kiln rotating at higher speed with a lighter load might use less pounds of coal per barrel. The large diameter of the modern kiln required to carry off the large volume of gases discharged by the load and the products of combustion make this hard to try out at the present time. The critical temperature at which all the CO_2 has been

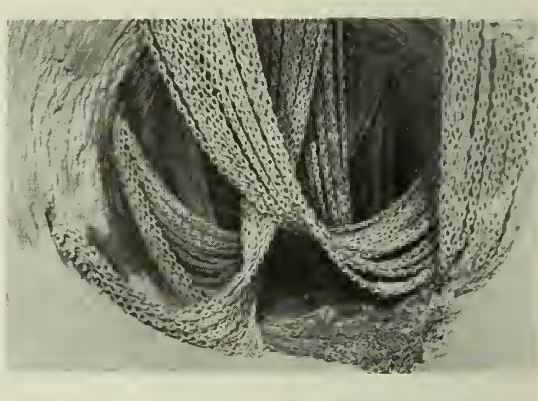


Fig. 7—Chains inside Kiln at Feed End.

driven off is given as 1,481 degrees F. and all the heat present in the kiln above this temperature should be used to sinter the clinker. It is here that the greatest inefficiency of the present cement kiln exists, for most of this so called high grade heat will pass through the kiln without doing useful work in the burning zone—it then becomes low grade heat further up the kiln and its effectiveness is lost.

The life of any kiln lining depends entirely on the burner, provided he has been supplied with good brick. When a kiln is lighted up a thick scale forms on the brick in the clinkering zone. If this can be kept there the lining should last for at least six months. Should, however, the burner get the kiln too hot for any cause whatever he will destroy this scale. If a kiln is overheated the raw material instead of sintering, melts and fuses together in hard round balls. In the molten state they will attack the scale and lining. As the scale comes off portions of the brick come with it so that two or three treatments such as this remove almost all of the brick lining. Stopping the kiln for repairs to coolers or the coal pipe will tend to loosen the scale and shorten the life of the lining.

At plant No. 1 it has been found that the minimum temperature required at the feed end is 470 to 480 degrees F. with 32 per cent moisture in the slurry. This ensures the proper sequence of events taking place throughout the kiln. This is due primarily to the length of the kiln, for it should be possible to design one in which the temperature at the feed end would be no higher than 212 degrees F. The length of a kiln is limited practically by the internal resistance to the flow of the gases through the kiln, from the kiln shell, the chain section and the internal friction of the gases themselves.

The thermal efficiency of the modern kiln is somewhere in the neighbourhood of 30 per cent, based on actual coal consumption and the theoretical value of 22 pounds per barrel of clinker.

The Superstructure of the Reconstructed Second Narrows Bridge, Vancouver

P. L. Pratley, M.E.I.C.[1]

DISCUSSION

M. B. Atkinson, M.E.I.C.[2]

The Institute is to be congratulated, and the author commended for his interesting and valuable paper. Credit is also due to the Dominion Bridge Company, Limited, and their subcontractors for the efficient manner in which the construction work was handled.

It would be useful to record the relative pound prices for rolled material, F.O.B. Montreal, for standard structural carbon steel; special structural carbon steel; silicon structural steel; and the chromador structural steel for bridges.

The author states that the method used in creosoting the timbers rendered the timber fire-resistant. The writer has always understood that creosoted timber was at least as inflammable as ordinary timber, and if this is not the case, would appreciate further information.

It is recognized that air buffers on movable bridges have always given trouble. This may be due to the finish of the cylinder walls, materials used in the piston rings, lubricants, adjustment of valves, or lack of means for forcing out the plungers when the span is rising. In the case under discussion what were the piston rings made of, in order to ensure that they would retain their elasticity, and what lubricants were intended to be used in maintenance. In some cases compression springs have been used outside of the cylinders to start the plungers down when the span is opened.

It can be inferred from the paper that prestressing of the ropes was confined to the counterweight ropes, and not to the operating ropes, but this is not definitely stated. What was the approximate cost for the prestressing of these ropes? Information with respect to the firmness of construction of the hemp centres, the lubricant used to impregnate these and the lubricants used when the strands and ropes were woven, would be of interest. What lubricant is to be used for maintaining the counterweight ropes at the bridge, as this presents an important feature in the life of the ropes? On the counterweight ropes of the Welland Ship canal vertical lift bridges, No. 5 Tramway lubricant is used for maintenance purposes.

The author has taken the modulus of elasticity E at 18,000,000, instead of 28,500,000, as called for in the C.E.S.A. Standard Specifications for Movable Bridges, for computing the bending stress in the wires going round the sheaves. It is questionable if the modulus for the wires when bending round the sheave can be considered so reduced as compared to the modulus for the rope as a whole.

Where the counterweight ropes are connected to the lifting girder of the lift span a horizontal moment couple is generated at one corner by the flare of the ropes which would tend to rotate the span horizontally. Are the ropes arranged at the four corners so that these couples offset one another?

The author states that the use of prestressed ropes makes it possible to dispense with equalizers, but it should be emphasized that the use of rope clamps on the counterweight ropes, both on the counterweight side and the span side, plays an important part in reducing inequality of stress among the ropes. If the rope clamps were omitted there would be considerable shifting of stress between the ropes as the bridge moves up and down, due to the fact that the flare of the ropes necessary for their connection alters the relative lengths of the ropes between the connections and the points of tangency to the sheave, depending upon the distance of the points of connection away from the point of tangency. In other words, the use of rope clamps on counterweight ropes is more important than the use of equalizers, or prestressing. What means would be used to operate the bridge locks in case of failure in the bridge lock motor?

Standard practice has been followed with respect to the guides for the span and counterweights and the use of steel on steel. From experience gained in the operation of the eleven vertical lift bridges over the Welland Ship canal, it has been found advisable to alter the guide castings so as to provide them with replaceable bronze liners, which will take up the wear and reduce the wear on the long vertical structural steel guide angles. When the wear in the

[1] Paper presented before the General Professional Meeting of The Engineering Institute of Canada, at Hamilton, Ontario, on February 7th, 1936, and published in the January, 1936 issue of The Journal.

[2] Welland Ship Canal, Department of Railways and Canals, St. Catharines, Ont.

bronze liners becomes too great, they can be replaced. It is desirable to protect as much as possible the edges of the long vertical steel guide angles from wear.

Standard practice for properly aligning the lift span as it seats has also been followed, and this no doubt will continue to function properly, due to the equable climate at Vancouver. In eastern Canada, due to the extremes of heat and cold, it is advisable to provide a centring device on the centre line of bridge, so that more clearance can be allowed between the side guide castings and the column guides.

What means has been provided to equalize the loads on the operating ropes and the travel at each corner?

The counterweight sheaves were shrink fitted on their shafts by being heated to 400 degrees F. and presumably this was performed by means of oven heating.

With respect to the bearings for the counterweight sheaves, it would appear from Fig. 12 that no grooves are provided in the journals. Therefore, grooves would be provided in the bushings. What means are provided to ensure that the grooves are kept clear?

No doubt the author gave consideration to the use of roller bearings for these counterweight sheave bearings. What would have been the extra cost for the provision of roller bearings, in lieu of the type of bearings used?

The author describes a new feature which provides a cover plate, welded to the inner flanges of the counterweight sheave rim, to prevent water or debris entering and lodging in the chambers of the rim girder. In Fig. 12 it might be inferred that drainage is provided at the hub, so that water will not remain in the chambers. The author also states that with this welded plate, hoods over the counterweight sheaves were unnecessary. So far as the writer is aware, it is usual practice to provide hoods, as it protects the ropes lying on top of the sheave from the weather.

The writer was unable to note from the paper whether any intermediate supports were provided for the operating ropes between the drums and deflector sheaves, in order to take care of the sag. On the Welland Ship canal this feature is taken care of by the provision on the top chords of wooden platforms for the ropes to slide on. In this particular bridge, however, either sheaves or rollers may have been provided and it would be interesting to hear how they have functioned.

It is noted in the description of the concrete counterweights that the unit weight of the concrete was greater than that figured in the design. It is advisable to use in the design a unit weight of concrete that will be heavier than the actual, and to provide pocket space in the counterweights that will give a leeway 5 per cent below and 5 per cent above the theoretical weight. No matter what care is used in an effort to control the unit weight of the concrete, variations occur and these become more apparent as the bridge is operated over a period of years.

The front post column guides for the lift span are situated on the forward, outside corner of the column and although the cross sectional area of these guides has not been counted into the section of the column, yet this material will act as a whole with the rest of the material of the column. Therefore the action of the vertical load to the entire area of the column will be eccentric. However, the effect of this eccentricity will occur mainly in the top sections of the front tower posts and will gradually disappear on the way down due to the effect of the stresses induced into the bracing. Moreover the top sections appear to have excess section, and no doubt will be able to properly take care of this eccentric loading.

The horizontal twisting moment exerted on the column from the reaction of the lift span in various positions is taken care of by horizontal diaphragms which are placed at intervals of approximately 4 feet. No detail is shown for these diaphragms, but it can be inferred that they are only connected to the central web of the column and the outside flange angles. It would seem to be desirable to provide the diaphragm with angles connected to the outside webs of the columns. This would relieve the pulling on the heads of the rivets and would stiffen the outside webs of the column, so that the cross section of the column would act together in a better manner to take the tortional moment.

Have separate integrating meters been provided on the bridge to record the power used for actually moving the bridge and the power used for other appliances? These meters are not costly and serve a useful purpose in that logs can be kept of the average consumption of power for an operation. More important however is that these meters will show if excessive power is required, thus indicating the necessity for immediate investigation.

The protection of a movable bridge against collision with vessels is always a source of worry and it would be interesting to have a description of the rules, regulations, signals and equipment used for the protection of this bridge.

W. Chase Thomson, m.e.i.c.[3]

The author has made a contribution to the literature of lift bridges, in that he has explained in detail methods of design and construction not readily found in text books. His treatment of the balance chains will be found particularly useful by the designing engineer who only occasionally has to deal with the type of structure described.

In the section dealing with ropes, the writer is unable to understand why the very low value of E (18,000,000 pounds per square inch) has been used in applying the C.E.S.A. formula for bending, viz.:

$$f = \frac{E\,d}{D}$$

in which f = unit fibre stress, in lbs. per square inch.
d = diameter of individual wires, in inches.
D = diameter of sheave, in inches.
E = modulus of elasticity of the *wires* (28,500,000 lbs. per sq. in.)

It is difficult to see how this modulus for the wires could be greatly modified by pre-stressing the cable, especially as the maximum unit stress was only 42,500 pounds per square inch, or considerably less than one-half the yield point of the wires.

The modulus of elasticity of the rope, after prestressing, may be determined roughly from the figures given in connection with the pre-stressing of rope No. 3. Here the total stretch, with a pull of 52,000 pounds, was about 81 inches; the permanent stretch, when released, 38 inches; thus the elastic stretch was 81 − 38 = 43 inches. Then

$$E = \frac{S\,l}{A\Delta} = \frac{52{,}000 \times 28{,}800}{1.225 \times 43} = 28{,}500{,}000 \text{ lbs. per sq. in.}$$

which, by coincidence, is the same as the value of E for the wires, as given in the C.E.S.A. specification for movable bridges.

In this formula, S = stress in rope = 52,000 lbs.
l = length of rope before pulling = 2.400 ft. = 28,800 ins.
A = sectional area of wire in rope = 1.225 sq. ins.
Δ = elastic stretch of rope = 43 inches.

Now the specified ultimate strength of the rope is 259,000 pounds; its area is 1.225 square inches, and thus its required strength per square inch is 259,000/1.225 = 212,000 pounds. The C.E.S.A. specification states that the total

[3] Consulting engineer, Montreal.

unit stress in the rope shall not exceed 1/5 of the specified ultimate unit stress; and that the unit stress from direct load only shall not exceed 1/10 of the specified ultimate unit stress. Thus:

Allowable unit stress
(including bending) = 212,000/5 = 42,400 lbs. per sq. in.
(direct load only) = 212,000/10 = 21,200 lbs. per sq. in.

Using the value for E, as given in the C.E.S.A. specification, the maximum stress per square inch on the outer wires would be:

$$\text{(from bending)} \quad \frac{Ed}{D} = \frac{28{,}500{,}000 \times 0.116}{144} = 23{,}000$$

$$\text{(from direct load)} \quad S/A = 26{,}100/1.225 = 21{,}300$$

$$\text{Total} = 44{,}300 \text{ lbs.}$$

which is about 2,000 pounds per square inch greater than allowable.

With the value of E, adopted by the author of the paper, the maximum stress per square inch is:

$$\text{(from bending)} \quad \frac{Ed}{D} = \frac{18{,}000{,}000 \times 0.116}{144} = 14{,}500$$

$$\text{(from direct load)} \quad S/A = 26{,}100/1.225 = 21{,}300$$

$$\text{Total} = 35{,}800 \text{ lbs.}$$

as given in the paper, but which seems to be too little.

John Portas, M.E.I.C.[4]

The wide range of bridge steels which, for reasons technical, economical and political, find a place in the reconstructed Second Narrows Bridge, must surely constitute an all time record. Six different grades of structural steel are used: structural carbon, special carbon, high carbon, rivet steel, 'silicon' and Chromador. The last named merits special attention.

Unlike the silicon in so called 'silicon' steel, chrome is an alloying element which combines with steel to give a wide range of useful alloys.

'Chromador' is a chrome-copper steel of low carbon content, with high physical properties produced without heat treatment, which is usually considered necessary to develop the strength of chromium alloys. The manufacturer claims that Chromador provides at least 50 per cent greater strength than mild steel at an increase in cost of only 15 to 25 per cent; that it is as easy to work as ordinary mild steel and definitely superior in this respect to silicon steel; further that it has a resistance to corrosion nearly double that of mild steel. If this is so the advantages of this new steel are obvious. It would be interesting to hear from Dominion Bridge Company of their experience in fabricating Chromador.

Except in the case of carbon—manganese structural steel, it has been the practice to use ordinary carbon steel rivets to connect alloy steel bridge members, with a considerable loss in efficiency. Dorman Long have developed a 'high tensile steel' rivet for use with chromador which, they state, has excellent rivetting properties and in which the permissible stresses may be increased in the same proportion as those in the main material. Was any consideration given to the use of these rivets in this case? The experience gained in their use would have been of value on larger projects.

The author is to be congratulated on his thoroughness in computing the secondary stresses in the truss of the lifting span. It is unfortunate that present day specifications make this a precautionary measure only. For many years a wordy warfare has been waged over the degree of deference due secondary stresses.

[4] Chief engineer, J. W. Cumming Mfg. Co. Ltd., New Glasgow, N.S.

The writer must confess to unconventional ideas on this subject. He believes that—considering the consistently excellent quality of modern steel, the high order of workmanship in fabrication, and the liberal loading assumed—a high factor of safety is unnecessary. It is possible that the day is not far distant when methods of design based on a complete stress analysis, supported and modified by strain readings, will lead to an exact knowledge of stress distribution and justify working stresses approaching the elastic limit.

With a view to finding the effect of the moments due to rigidity of joints on the deflection of the long top chord compression members, the writer computed the secondary stresses throughout the lift span truss. Taking Dead Load, highway live load, an equivalent uniform railway load with impact, and wind load—a condition of loading which gives secondary stresses approaching maximum in the chords—the highest secondary stress amounted to 13 per cent of the primary. It was assumed for these calculations that the truss was assembled and reamed to cambered shape in the shop, and was free from secondary stress in this condition except for the effect of the hangers which were cambered for full live load.

The author has computed the bending moments due to weight of member in the top chord by the conventional method which neglects the resistance by web members to rotation at panel points. The writer suggests that these moments can be easily and accurately determined by a method which has recently been applied to the solution of secondary stresses. This consists of distributing, balancing and 'carrying over' unbalanced moments until the desired degree of accuracy has been obtained. The system is balanced throughout, and the end moments so found include the influence due to the weight of every member. The solution of the top chord stresses by this method checked Mr. Pratley's figures closely and showed the restraining influence of the web members to be negligible except at point U1.

In conclusion it should be pointed out that the dangerous conditions of wind and tide, which have caused so much trouble in the past, were again emphasized by the mishap to the lifting span during erection. It seems unfortunate that the cost of fenders was found to be prohibitive.

J. R. Grant, M.E.I.C.[5]

There has already been considerable criticism of this bridge from the aesthetic side. In the discussion of a previous paper by the author on the substructure,* he replied to this criticism as follows:—"As a matter of fact, viewed from the ferry boats or from Brockton Point, the new work has quite appropriate lines, and a satisfying appearance."

Unfortunately, in the long distance view, one must see the new work in conjunction with the old and an observer might readily imagine that he was seeing one of Heath Robinson's drawings "come to life." The appearance of the machinery cabin is one of several good reasons why the operating machinery should not be placed on the movable span of a lift bridge, but on the towers. This arrangement has been chosen for several lift bridges during the last ten years, and recently for the railroad lift bridge over the Cape Cod canal, which has a 544-foot movable span.

The design of the floor system is shown with considerable detail in Fig. 3. For the railway stringers and floor beams carbon steel web plates, marked (Ca), are stressed to 22,000 pounds per square inch, or 22 per cent more than the 18,000 pounds "laid down" for this material on page 5. The use of carbon steel web plates in conjunction with silicon steel flange angles for plate girders is not uncommon,

[5] Consulting engineer, Vancouver, B.C.
*The Engineering Journal, November 1934.

but is there justification for over-stressing the web plates which is usually the result of such a combination?

The description of the pre-stressing of the main lifting ropes, and the difficulty of obtaining ropes of equal length is most interesting. It would appear that some provision should be made for the difference in the length of various ropes, for although with the assumption made by the author in the last paragraph, i.e. "that fifteen ropes were all one length and the other rope was ⅝ inch longer," the overload on the fifteen ropes is not excessive, but if the one rope was ⅝ inch shorter than the other ropes, that rope would be seriously overstressed.

The "locking device" shown in Fig. 6, appears simple and should be effective. Good locks are essential for lifting spans with cantilever roadways, as there is no positive reaction from dead load to resist the negative reaction from a live load on one roadway. During recent visits to the bridge the writer found that the locks were not being used, either to hold down the span, or to force the span down tight on to its shoes and he was told that they had given considerable trouble. There was a bad "hammer" when a heavy truck came on, or passed off the span. When standing on the top chord at the south end of the span, when it was being lowered, one felt considerable side-sway just before the span came to rest on its shoes or bearing pins. This may have been due to the down-haul ropes or the bearing pins not being in correct adjustment.

Metal idler rollers, to support the operating ropes, were mounted in bearings adjoining panel point U3. These rollers have not functioned as apparently intended, the uphaul and downhaul ropes moving in opposite directions did not turn the rollers but wore grooves in them, and the lubricating grease was rubbed off the ropes, exposing them in places to corrosion. The rollers have been removed and wooden rubbing strips placed at the machinery cabin, on the top chord between U3 and U5, and at each side of the bearings for the original rollers. These rubbing strips are not satisfactory as the grease is rubbed off the ropes and grooves are soon worn in the wooden strips, with a tendency, when the grooves become deep, to prevent the free lateral movement of the operating ropes. Similar idler rollers, on Bridge No. 17 over the Welland canal, gave very unsatisfactory service; so they have since been replaced by wooden platforms running along the top chord.* Separate rollers or sheaves for the up-haul and down-haul ropes would appear to be a better solution of this problem.

Frederick W. Caldwell[6]

The Troy-Menands bridge which crosses the Hudson river between Albany and Troy was opened about two years ago and is a recent design. Also there is the Albany-Rensselaer bridge erected a few years before the Troy-Menands bridge. These appear to be simple rugged designs of lift span bridges. The interesting features as compared with the Second Narrows bridge are in the tower and truss composite and in the counterbalance for the hoisting ropes by a bowstring cable and a small auxiliary counterweight attached to the bowstring cable.

C. D. Meals, m.e.i.c.[7]

The author has been generous with the details of the wire ropes in his excellent article as, usually, little is noted regarding these important tension members in vertical lift bridges.

The rope wire specifications are essentially those given in C.E.S.A. Specification A20-1927, for Movable Bridges, with an increase noted in the unit wire strengths for the 1¾-inch diameter counterweight ropes.

[6] 353 Broadway, Albany, N.Y.
[7] Wire rope engineer, B. Greening Wire Co. Ltd., Hamilton, Ont.
*The Engineering Journal, February 1928, page 93.

An elongation of 2.4 per cent in 12 inches for best plough and improved plough steel rope wire is difficult to procure; in fact, with air-tempered wire, it is hardly practical and consequently requires a lead-tempered wire. As early as 1925 the writer urged the adoption of an elongation, varying from 1½ to 2 per cent in 10 inches, and in 1927 the Lackawanna Railroad specifications for the vertical lift bridge over the Hackensack river specified 2 per cent elongation in 10 inches and for the various Pennsylvania and Lehigh Valley Railroad bridges in and around Newark and Jersey City, N.J., the elongations specified were 1½ to 2 per cent in 10 inches, the minimum value being for the smaller diameters of wires.

Ductility in a rope wire is not as essential as in other structural members, as the structure of the finished rope is such that there is ample elasticity to resist shock loads and stresses.

Shaft hoist ropes in the mines are subject to high acceleration stresses, high speeds and abuse in winding multiple layers of rope on the drums; these ropes are made of rope wire in accordance with the lower elongation values noted above and give satisfactory service; vertical lift bridge rope service requirements are not as exacting, hence, why the necessity of a special quality of wire.

The diameter tolerances of the wires as given are rather liberal; the B.E.S.A. requirements and a "suggested tolerance" are as follows:—

Diam. Wires	B.E.S.A. Tolerances	Suggested Tolerances
.018 to .039 inch	± .0005 inch	± .001 inch
.040 to .079 inch	± .001 inch	± .0015 inch
.080 to .143 inch	± .0015 inch	± .002 inch

The "suggested tolerances" are liberal enough and are representative of good rope designing practice.

The usage of the prestressed rope modulus of elasticity instead of the wire modulus is to be commended.

Many variables are involved in such a complex product as wire rope and the accurate calculation of bending stresses is hardly practical mathematically. Any one of the many bending stress formulae may be used if its limitations are appreciated and the results used as a standard for bending stress calculations for the different constructions of wire rope, and experience will indicate a suitable factor of safety on the sum of the load, acceleration and so-called bending stresses in the rope. For high speed shaft hoist ropes, the factor is generally 4 as a minimum on the sum of the stresses based upon using the rope modulus in the bending stress calculations.

The efficiencies given of the strands and ropes were interesting and a check was made with the formulae given by the writer in an article "Main Cables and Suspenders for Suspension Bridges"* with the following results:—

Rope	Strand Efficiency, Per cent Actual	Strand Efficiency, Per cent Calculated	Rope Efficiency, Per cent Actual	Rope Efficiency, Per cent Calculated
1¾-inch Counterweight	94.8	93.4	86.54	88.7
1⅜-inch Operating......	....	....	86.4	88.9

The behaviour of the 1¾-inch counterweight ropes under repeated loadings as noted in the prestressing of these ropes indicates quite clearly that the stretch of a wire rope under load consists of two factors—(1) the constructional stretch and (2) the elastic stretch; the former is caused by the compression of the manila centre, an adjustment of the wires in the strands and a lengthening of the rope lay and it is largely permanent after the rope has been stressed repeatedly.

*The Engineering Journal, August 1934.

It is difficult to calculate the constructional stretch on account of the manufacturing variables involved; ordinarily, for a 6 by 19 rope, stressed to 20 per cent of its breaking strength, the constructional stretch is approximately 1/5 per cent of the rope length, this for a rope running over sheaves. For the 1¾-inch rope, 2,400 feet long, loaded to 52,000 pounds, on the basis of 1/5 per cent, the constructional stretch of the rope would be 4.8 feet (57⅝ inches) which is excessive compared to the result charted in Fig. 5, though the latter is not quite comparable as the base is a 5,000-pound load instead of zero; this in itself would make a possible 7 inches more stretch in the ropes tested.

The modulus of elasticity of these 1¾-inch ropes, for the first loading, was approximately 16,000,000 pounds per square inch and the calculated stretch for a 52,000-pound load, for the 2,400-foot length, is 74⅞ inches; the modulus of the wire was probably 26,500,000 pounds per square inch, consequently, the elastic stretch will be 53½ inches and the difference between 74⅞ and 53½ or 21⅜ inches is the constructional or permanent stretch in the rope but the actual permanent stretch was nearly twice this amount, showing that the calculation of the constructional stretch is hardly practical. A repetition of the loading on the rope will gradually eliminate the constructional stretch; that is, the curves of the progressive and retrogressive loadings will coincide and not show the hysteresis loops typical of the tests as recorded.

A wire rope wound on a reel will open out somewhat due to the curvature on the reel and this disturbance, with other slight factors, will explain the variation in length noted of the prestressed and measured 1¾-inch ropes in rehandling.

The decision adverse to the using of "Tru-lay" rope for the 1⅜-inch operating ropes was interesting, considering the fact that these ropes are in service on vertical lift bridges in New Jersey, though it must be admitted that these bridges are more frequently operated than the Second Narrows bridge.

In the analysis of a wire rope installation, the unit radial pressure of the rope on the sheave or drum should be given more consideration, as experience has shown it is of more importance than the bending stresses in the rope. The unit radial pressure of a wire rope in the groove of a sheave or drum may be expressed by $T/R\,d$ in which T is the load on the rope, R is the radius of the sheave to the bottom of the groove and d is the diameter of the rope. It will be seen that it is independent of the arc of contact over the sheave.

For the 24-inch pitch diameter deflector sheaves shown in Fig. 8, for the 1⅜-inch operating rope under 23,333-pound load, the unit radial pressure, pounds per square inch of the projected area of rope is 1,500 pounds; for the 67-inch pitch diameter sheaves and drums, it is 517 pounds and for the 1¾-inch ropes with 26,100 pounds load on each, over the 12-foot pitch diameter sheaves, it is only 210 pounds.

Representative good shop crane practice for 6 by 19 ropes, over equalizing or compensating sheaves, show unit radial pressure values of 1,600 pounds per square inch of projected area of the rope. Accordingly, these deflector sheaves are representative of good crane practice but the unit pressure is high and considering that the rope "creeps" over these sheaves, though the movement may be but 1/25 inch in a 90-degree arc of contact of the 24-inch sheaves, it will result in wear of the rope and sheaves over the course of years.

The specifications for the wire and wire ropes for vertical lift bridges have gone through an evolution in the past decade, all tending towards commercial practice and a more common-sense consideration of the requirements. Movable Bridges C.E.S.A.-A20-1927 is in need of revision insofar as the wire rope data is concerned.

P. B. Motley, M.E.I.C.[8]

A serious problem is raised whenever a bridge is put across a navigable tideway and in this case subsequent events have made it questionable whether a bridge should have been built. The relatively low first cost of a bridge against that of a tunnel no doubt appealed to the promoters of the scheme, but in view of the hazards to be run both during and after construction, it is not certain that in the long run a tunnel would not have been the better scheme.

The writer would refer to the character of the bridge and the fact that the counterweight of the original bascule span has been left in place. Apart from the possibility that the span upon which it is attached and dependent might be struck by a ship, in which case it is probable that more than one span will suffer, it may be contended that it was desired to avoid the cost of its removal and the reinforcement of its dependent span. In the writer's opinion this is a species of mentality in connection with public works that he is not prepared to endorse. People today do not buy cheap eggs—but good eggs, at the most economical price. The argument may be advanced that with the regulations for navigation now in effect regarding movements of vessels through the bridge, there need be no apprehension for the safety of the bridge, but accidents may happen for one reason or another, and it is a question whether glance booms or other effective guiding fenders should not yet be erected on either side of the bridge. Also an audible signal for use in fog or hazy weather should have been installed in addition to the visible signals provided.

Has any impact allowance been made for earthquake shocks and whether the structure was protected from lightning—the latter especially being a feature often overlooked?

The writer would like to emphasize the desirability of some government authority who would give general consideration to large public works, both as to suitability for location, and as regards aesthetics, so that at least important works shall not take away from the natural beauty of the landscape.

R. K. Palmer, M.E.I.C.[9]

The chairman commented that limitations of available money have always been apparent throughout the history of the Second Narrows bridge. In the discussion of the earlier paper by the author on the substructure of the bridge*, attention had been drawn to the potential dangers from a ship colliding with the bascule under the new construction. A wreck of the bascule span would crash the structure.

The importance of further observation of the physical properties of silicon steel should be emphasized. Certain silicon steel, in the past, had been found in the Hamilton shops to be hard and brittle in spots and lacked uniformity. The Western Bridge Company, who fabricated some of the floor material for the Second Narrows bridge, reported they had no difficulty in this respect.

W. W. Cushing[10]

What type of brakes were used, and what was their capacity? Has the machine design been governed by the motors or the effect of the brakes and was there any tendency to wind sway of the electric cables?

---

[8] Engineer of bridges, Canadian Pacific Railway Company, Montreal.

[9] Chief engineer and vice-president i/c operations, Hamilton Bridge Co., Hamilton, Ont.

[10] Hamilton Bridge Co., Ltd., Hamilton, Ont.

*The Engineering Journal, November 1934.

V. S. Thompson, A.M.E.I.C.[11]

Attention should be drawn to the unequal loadings at the corners of the span, 1,100 pounds per rope, or a total for all ropes of 17,200 pounds difference between the light and heavy corners. Has consideration been given to moving the centre of gravity of the counterweight ropes off the centre line of the sheave and lifting girders, to equalize this pull?

The appearance of the operator's cabin for the Second Narrows bridge is an improvement on the customary rather ugly design.

Fred Newell, M.E.I.C.[12]

The fixed structure already erected limited the design clearances of the new structure, and though the unbalanced condition due to a sidewalk on one side only had been recognized it was considered that the only reasonable way to overcome this was by throwing the counterweight out of balance by the same amount transverse to the centreline of the bridge.

Roller type bearings have proved satisfactory on smaller bridges but on larger structures standard bearings were safer and more reliable over a long period. Roller bearings cost considerably more but it is important to determine the possible savings in electric power as an offset to the additional cost of roller bearings.

Counter weight ropes should not be prestressed to excessively high figures (no more than slightly above the operating tension). Prestressing increases the modulus of the rope and consequently raises the bending stresses in the rope when passing around the counterweight sheave. All that is required of prestressing is to make the rope uniform and take out any permanent stretch which would be likely to occur up to the maximum working load.

W. T. Fanjoy, A.M.E.I.C.[13]

Is lowering the span a positive operation requiring machine power?

F. P. Shearwood, M.E.I.C.[14]

Congratulations should be offered to the author for his valuable contribution to the literature of lift bridges, also Mr. Motley should be complimented for his pertinent observations concerning the serious problem of spanning navigable waterways, and the desirability of providing sufficient funds to carry out the projects properly.

P. L. Pratley, M.E.I.C.[15]

Mr. Atkinson inquires the per pound prices for rolled material, f.o.b. Montreal, but these can not be completely determined since they fluctuated widely depending on market conditions. A rough estimate shows silicon steel to be about one cent per pound more costly then the carbon steels. Silicon steels were selected for certain members of the Second Narrows bridge because of previous knowledge and favourable experiences with this quality of steel.

A pamphlet published by the American Wood Preserver's Association, which describes the new empty cell method of creosoting, should be referred to regarding the fire resistant qualities of creosoted timbers. By this means all excess creosote is drawn out under vacuum leaving practically no oil to burn and therefore considerable heat is necessary to set the timber afire.

The piston rings of the air buffers are of cast iron. The selection of lubricants was left to the contractor and given to the operators with strong recommendations as to use. Selection of lubricants is largely a matter of experience and the information offered by the manufacturers is always most dependable. A chart for the Second Narrows bridge recommends different lubricants for almost every moving part (at least sixteen types of greases and oils).

The small cost of prestressing the counterweight ropes was considered well worth while.

The value of E (modulus of elasticity) 18,000,000 pounds per square inch, used in the design calculations was an arbitrary value and it would have been better if the paper had stated that the value selected was 60 per cent of the recommended C.E.S.A. Standard Specification for Movable Bridges.

The horizontal turning moment by the flare of the ropes, where the counterweight ropes are connected to the lifting girder, has been recognized and taken care of.

Hand operation for operating the bridge locks is not provided and the auxiliary power source is a gasoline engine.

The wear of the steel guides has been provided for by an arrangement for adjustment from time to time to take up this wear.

The author agrees with Mr. Atkinson that the use of a centring device was not considered necessary because of the equable climate at Vancouver. In the operating equipment flexible couplings are not used as the considered opinion was that an equalizing gear would aggravate the tendency to side swing.

The counterweight sheaves are a shrink fit on their shafts after oven heating to 400 degrees F. Also grooves are provided in the bushings of the counterweight sheaves, these being cleared by use of rods or wires from the outside end and charged frequently by gun lubrication.

The installation of roller bearings was carefully considered but the expense was not justified, as the old operating machinery of the original span was utilized and it was impossible to take full advantage of the appreciable saving in friction. The additional expense for roller bearings was estimated roughly as $22,000.

The special cover plate welded to the inner flanges of the counterweight sheave rim, effectively prevents water or debris from being emptied on to the bridge floor below. The use of a hood over the counterweight sheave was not regarded as necessary as the greater part of all wire ropes are exposed to the weather.

Intermediate supports are provided for the operating ropes between the drums and the deflector sheaves, but experimentation with regard to type is still under way.

The author also agrees with Mr. Atkinson regarding the design of the concrete counterweights. However, since ample pocket space and plenty of blocks have been provided no ultimate balance problems should arise.

The excess cross-section of the top compressive members of the lift span is sufficient to take care of eccentric loading causing secondary stresses. The horizontal diaphragms to take care of the horizontal twisting moment in the tower posts are connected only to the central web of the column and the outside flange angles. These were simpler to fabricate than diaphragms with angles connected to the outside webs of the columns, which type was not deemed necessary.

Integrating meters have not been employed to record the power used for actually moving the span, but these would no doubt constitute a desirable accessory, under certain circumstances.

With reference to Mr. Motley's question relating to the protection of the bridge against collision, this protection is inherent in the stringent regulations now enforced by the harbour commission. Conditions of navigation are vastly improved compared to what they were; the bridge has an excellent system of visual signals, large semaphores and

---

[11] Designer, Hamilton Bridge Co. Ltd., Hamilton, Ont.

[12] Assistant chief engineer, Dominion Bridge Co. Ltd., Montreal.

[13] Industrial control engineer, Canadian General Electric Co. Ltd., Peterborough, Ont.

[14] Chief engineer, Dominion Bridge Co., Montreal.

[15] Monsarrat and Pratley, consulting engineers, Montreal.

coloured lights, all of which are under the autocratic control of a competent harbour master; the spans are well lighted and a flood light effect has been attained on the main piers thus affording ample protection. During foggy weather all traffic must cease so that no unnecessary risks are taken.

An allowance of five tons was made in balancing the bridge so that the lift-span would be heavier than the counterweight. This was slightly more than the two or three tons which Mr. Atkinson mentions as having been used in the case of the Welland Ship canal bridges.

In commenting on Mr. Portas' questions, the careful selection of steels for the new superstructure should be emphasized. The properties of the silicon steel specified for certain span members were already favourably known. The Dorman Long product Chromador had been submitted by the contractor for acceptance and had been readily approved. Consideration was given to the use of special steel rivets but little information of their practicability was available when this was considered, two or three years ago.

Attention was given to the possible magnitude of secondary stresses in truss members of the lifting span at the stiff end. In contrast with the highest stress computed by Mr. Portas, (13 per cent of primary), the author had computed stresses as high as 50 per cent of the primary. The excess cross-section of certain members was considered sufficient to take care of these secondary stresses. Further, the vertical hangers of the span were given special adjustment to assist in the reduction of these stresses. The method suggested to compute the bending moments due to the weight of members in the top chord, was unnecessarily complicated for the purpose in view.

The similarity of the Troy-Menands bridge and the Albany Rensselaer bridge was mentioned by Mr. F. W. Caldwell and there was also the Cape Cod Canal bridge. All three spans were designed by Waddell & Hardisty. The use of an auxiliary counterweight to take the place of balance chains was not the ultimate satisfactory method, as the use of balance chains gave a much simpler scheme. All three bridges utilize duplicate machinery synchronously connected at either end of their span. The continuous operation of these spans was essential and the reliability of this method of operation was not thoroughly tested. The brakes were those used on the original structure, which were rated strictly in accordance with C.E.S.A. specifications. The prevailing winds are easterly from the sea and of little consequence, therefore it was not considered necessary to allow for wind sway.

The earthquake allowance was effective as an additional horizontal force at the base of the structure and amounted to approximately seven per cent, though in Japan this figure is at least ten per cent. No such allowance was deemed necessary for the Second Narrows bridge as the earthquake record in the locality is of unimportant consequence.

Lightning protection was not regarded as essential and therefore not allowed for.

Referring to Major Grant's comments, the present paper and its predecessor both refer to the fact that the contribution made by the existing bascule to the aesthetic ensemble was entirely beyond the control of the author. The machinery cabin is quite differently viewed by other contributors to the discussion, for example Mr. V. S. Thompson, and as a matter of fact the choice was made after considerable sketching and concentration. As mentioned elsewhere in the discussion, the removal of the operating machinery to the towers, while admittedly accomplished on two or three spans recently, cannot yet be considered as entirely successful, and was out of the question because of the necessity of using the existing machinery. The Cape Cod canal span was illustrated and referred to during the discussion in Hamilton. Major Grant refers to visits to the bridge when the locks were not being used and to considerable trouble and to hammer. This condition was due to improper operation and has been corrected. There is no structural weakness or inefficiency in the locks, but if they are not used as directed they do not perform the functions expected. Side sway, just before the span comes to rest, is of course possible as the result of winds, which reduce the clearance on the windward side and enlarge it on the leeward side during the greater part of the travel, whereas as the span reaches the lower few feet it has to centre itself and therefore moves laterally in space.

The idler rollers supporting the operating ropes are always a matter of considerable concern to designing engineers, and in this instance were apparently erected slightly too high. Temporary wooden rubbing strips have replaced them, and these are now being removed in favour of a type which is the result of much study. Separate rollers or sheaves for the up-haul and down-haul ropes have often been used or suggested, but these also have not given satisfaction, and the whole matter is one which is subject to experimentation. Regarding counterweight ropes and the differences in length after prestressing, there are various ways of providing for such differences if they become of consequence, such as untwisting, shimming, etc. To untwist one of the counterweight ropes on the Second Narrows bascule, one circumference would lengthen it almost an inch. The detail adopted for locking the ropes in position would then either have to be modified or its manufacture delayed if such unwinding were permissible. As a matter of fact, all ropes can be readily checked before trans-shipment, and no differences that would involve over-stress need arise. Actually the hypothetical condition referred to by Major Grant where one rope is assumed to be ⅝ inch shorter than the other fifteen, results in a direct load on this rope of 35,200 pounds, or a total fibre stress of 43,200 pounds per square inch, which reduces the factor of safety given on page 6 of the paper as 6.82 to 5.65 which reduction, although substantial, is not alarming.

The formula $f = \frac{Ed}{D}$ produces too high a unit for bending in hemp centred ropes passing over large sheaves, but is quite satisfactory. It appears to be the practice in mining operations in certain places to cut this to about 40 per cent, but approximately 60 per cent or an equivalent E of 18,000,000 was used. The introduction of an empirical coefficient of .6 would be the logical way of expressing what is, after all, a matter of experimentation and judgment. Reference in this connection is also made in the discussion by C. D. Meals.

THE
ENGINEERING JOURNAL
THE JOURNAL OF
THE ENGINEERING INSTITUTE
OF CANADA

VOLUME XIX MAY 1936 No. 5

Prairie Farm Rehabilitation

The conditions under which the western farmer produces his grain crops ought to be a matter of deep interest to all Canadians, and not least to engineers, the demand for whose services, whether in connection with industrial production, construction or transportation depends so largely upon the agricultural prosperity of the country. The success or failure of prairie farming decides the position of Canada among the wheat-growing nations of the world; affects directly the livelihood of at least a quarter of our population; enlarges or limits the potential market for other Canadian industries, and profoundly influences the activities of our transportation systems.

For these reasons the programme of The Institute's annual meeting in February, 1935, was largely devoted to the consideration of the western drought problem. The subject was being widely discussed in the press; general interest in this vital question was evident, and The Institute's Council received appreciative comment on the part taken by The Institute in connection therewith. It was gratifying also to note the governmental action which resulted in the passage of the Prairie Farms Rehabilitation Act by the then Dominion government early in the session of 1935. The passage of the Act was followed by the prompt commencement of a programme of government-aided work, intended to repair, as far as possible, the damage done by the drought, and to put remedial measures in force as a protection against its recurrence, while providing the western farmer with all the assistance which technical and engineering knowledge could give him. It will be recalled that in April 1935 all this remedial work was placed in the hands of a strong Advisory Committee, who obtained the co-operation of such bodies as the provincial government departments, the agricultural colleges, the Geological Survey of Canada, the Dominion Experimental Farms, the Water Power and Hydrometric Bureau of the Department of the Interior, and the two railways. The detailed development of the programme has been largely the task of the Dominion Experimental Farms with the assistance of a specially selected technical staff. The bulk of the work naturally has to do with distinctively agricultural questions. Some of its main divisions, however, are of interest from an engineering point of view, particularly those allotted to three special sub-committees dealing respectively with soil surveys, soil drifting and water development.

The work which has already been accomplished is described in two papers which are printed elsewhere in this issue of The Journal. The accounts given us by Dr. Archibald and Mr. Russell make it evident that the Federal and provincial governmental authorities concerned are to be congratulated upon the soundness of the programme laid down and upon the results which have already been achieved. It will be noted, as Dr. Archibald points out, that the problems dealt with are predominantly agricultural. In many cases, however, problems of water conservation or supply arise in which engineering advice and assistance are essential, and this aspect was not lost sight of when the Water Development Committee was organized and commenced its work.

Mr. Russell's address deals more especially with projects of this kind, among which schemes for dugouts and stock-watering ponds are, of course, most numerous, although a number of larger and more comprehensive undertakings are also being planned and constructed.

Dr. Archibald, as chairman of the Advisory Committee and director of the Dominion Experimental Farms, can speak with authority on these matters and his paper is noteworthy as presenting a general picture of the efforts which are being made to develop improved methods of cultivation; effective means of controlling soil drifting; the planting of trees and shelter belts; the introduction of improved varieties of plants and grasses, as well as the conservation and improvement of the water resources which are available. An essential feature of the programme is the manner in which farmers and farming communities are being encouraged to help themselves by the formation of agricultural improvement associations, shelter belt associations, and the like, such co-operative bodies being aided by skilled technical advice and financial support. The resources of the scientific departments of the Dominion and provincial governments are thus made available, and are badly needed in connection with many problems where experimental data are still lacking. There are, for example, districts in which the real nature of the water supply available is not fully known, owing to the lack of hydrometric observations in past years. Progress has still to be made in the development of drought-resisting grasses; the effect of certain novel cultural practices for soil drifting control requires further investigation; the efficacy of tree planting as a measure of soil drifting control, and the conditions under which shelter belts can be grown and made effective still have to be determined. These are tasks which are beyond the capacity of individual farmers or even farmers' associations. Such questions can only be effectively dealt with by government action extending over a term of years.

Since the passage of the Act the drought conditions in the west have fortunately shown some improvement. Human nature being what it is, it is natural in such a case that there should be a tendency to relax the efforts made to deal with the problem, and in view of the financial situation at Ottawa and in the western provinces, that there should be an inclination to economize on the expenditure involved. Various changes in the administration of the Act have been made since the change of government at Ottawa. It has been stated that the funds available (which are apparently somewhat reduced) will be allocated for expenditure by the provincial governments rather than by the Advisory Committee, and that the technical staffs now employed under the working sub-committees of that body, particularly the Water Development Committee, are being reduced. This does not sound encouraging, but possibly such changes in organization indicate an effort for more effective utilization of the funds available, and do not involve any slackening of the rehabilitation movement. It is at any rate essential that the funds at the disposal of the technical departments of the Dominion and provincial governments shall provide for the effective continuation of all the basic investigational work. Interruption, for example, of the series of hydrometric studies, or the experiments on soil drifting or plant varieties, might evidently result in destroying the value of much of the work already accomplished, and leave us unprepared when lean years come again.

The objective of the movement is more than a mere improvement of the living conditions on a few isolated farms. It involves the much wider question of the future possibilities of settlement and growth in population of the prairie provinces, based on the knowledge of what areas are suitable and what areas are not suitable for agricultural development of various types. It is also necessary to find means of insuring that the average farm dweller on the prairies shall be more than a mere wheat miner, and shall be able to secure for himself a reasonable standard of living and a larger share of the amenities of civilized life. To obtain these results even for a part of the present population of the prairie provinces is a task which requires the maintenance and support, not the relaxation, of the activities which have already commenced to give such admirable results.

The International Commission on Large Dams

Canadian participation in the Second Congress of this body to be held in connection with the World Power Conference in Washington on September 7th to 12th, 1936, is now assured. The Canadian Management Committee of the World Power Conference has consulted with the Council of The Engineering Institute of Canada and has arranged for the preparation of a paper on the deterioration of concrete in these structures. Climatic and soil conditions in Canada are such as to make the problem of deterioration a very serious one. The paper will be prepared by Mr. E. Viens, M.E.I.C., Director, Laboratory for Testing Materials, Department of Public Works, Ottawa, in consultation with a committee comprising Dr. O. O. Lefebvre, M.E.I.C., member of the Quebec Electricity Commission, Montreal, Mr. J. A. McCrory, M.E.I.C., Vice-President and Chief Engineer, Shawinigan Engineering Company, Montreal, Mr. C. N. Simpson, Chief Engineer and Manager, Gatineau Power Company, Ottawa, and Mr. R. B. Young, M.E.I.C., Testing Engineer, i/c Chemical and Engineering Material Laboratories, Hydro-Electric Power Commission of Ontario, Toronto.

Mr. R. B. Young has also been appointed by the Council of The Engineering Institute of Canada as the chairman of a committee to study the general subject of deterioration of concrete in structures in Canada, its causes, and possible means of preventing such deterioration. The other members of the Committee will be appointed at the next meeting of the Council of The Institute.

Institute Members Appointed to Reorganized C.E.S.A. Executive Committee

In order to make the Main Committee of the Canadian Engineering Standards Association more truly representative of the industries of the country, a reorganization of that body has recently been made effective.

The Main Committee has been considerably reduced in numbers and has appointed an Executive Committee of some twenty members to deal with the current affairs of the Association.

At the thirty-first annual meeting of the Main Committee held in Ottawa recently, P. L. Pratley, M.E.I.C., a vice-president of The Engineering Institute of Canada, was elected to represent professional bodies on the Executive Committee. R. J. Durley, M.B.E., M.E.I.C., General Secretary of The Engineering Institute, and a former secretary of the Canadian Engineering Standards Association, was re-elected Honorary Secretary of this body.

It is interesting to note in reviewing the personnel of the Executive Committee of this technical body, that of some twenty members, only two are not members of The Engineering Institute of Canada.

OBITUARY

Karl H. Marsh, M.E.I.C.

We regret to have to record the death of Karl H. Marsh, M.E.I.C., which occurred on April 22nd, 1936, while he was travelling on the Ocean Limited from Sydney, N.S., to Montreal.

Mr. Marsh was born at Corydon, Pa., on August 25th, 1885, and graduated from the University of Pennsylvania in 1909 with the degree of B.A.

From 1909 until 1913, Mr. Marsh served as mechanical draughtsman with the following companies: A. G. McKee and Company, Cleveland, Ohio, the Republic Iron and Steel Company, Youngstown, Ohio, the Dominion Iron and Steel Company, Sydney, N.S., and the Garrett-Cromwell Company, Cleveland. In 1913 he was appointed superintendent of construction for A. G. McKee and Company, holding that position until 1918 when he went to Hamilton, as chief engineer of the Hamilton Furnace Company. In 1919 he returned to the Dominion Iron and Steel Company as chief engineer, and held the same position with the Dominion Steel Corporation at the time of his death.

Mr. Marsh was a member of the Association of Professional Engineers of Nova Scotia, the American Society of Mining and Metallurgical Engineers, and the Canadian Institute of Mining and Metallurgy.

He joined The Institute as a Member on September 20th, 1921.

PERSONALS

Frank P. Adams, A.M.E.I.C., city engineer and manager of waterworks, Brantford, Ontario, was elected chairman of the Canadian Section of the American Water Works Association, at the sixteenth annual meeting of the Section which was held in Hamilton on April 1st to 3rd, 1936.

George H. Midgley, A.M.E.I.C., has joined the staff of the Dominion Bridge Company, Limited, Lachine, Que., as sales engineer. Mr. Midgley graduated from the Nova Scotia Technical College with the degree of B.Sc., in 1924, and following graduation was for a time in the engineering departments of the Dominion Iron and Steel Company Ltd., at Sydney, N.S., and the Riordon Pulp Corporation, at Temiskaming, Que. In 1926 he became connected with the Dodge Manufacturing Company, and remained with that company until the present time, having been sales manager of their Montreal office for the past two years.

G. J. Desbarats, C.M.G., M.E.I.C., Elected Honorary Member

At the meeting of Council held on April 3rd, 1936, George Joseph Desbarats, C.M.G., M.E.I.C., was declared elected as an Honorary Member of The Institute.

Born in 1861, Mr. Desbarats was educated at the Terrebonne College and the Ecole Polytechnique, Montreal, graduating with honours at the age of eighteen. In 1879 he entered the service of the Dominion government

G. J. Desbarats, C.M.G., M.E.I.C.

as assistant engineer in the Department of Railways and Canals, and was engaged in the design and construction of various portions of our canal system, particularly in connection with the present Canadian locks at the Sault, the Welland canal and the Soulanges canal. Later he was occupied in railway construction in British Columbia, particularly on the Canadian Pacific Railway, and soon after coming east in 1896, he re-entered the government service, being in charge of a hydrographic survey on the St. Lawrence river in 1899. In 1901 he was appointed director of the Government Shipyard at Sorel. In 1909 he became Deputy Minister of Marine and Fisheries, and in 1910 Deputy Minister of Naval Service. When the control of the Naval, Military and Air Forces of the Dominion was placed under the Department of National Defence, Mr. Desbarats became Acting Deputy Minister of that Department, and he held that office with distinction from 1924 until his retirement in 1932.

During this period of public service, Mr. Desbarats held a number of important appointments, having been Plenipotentiary Delegate from Canada to the Wireless Conference, London 1912, and Canadian government representative to the Seamen's Conference, League of Nations, in 1920.

In 1915 he was made a Companion of the Order of St. Michael and St. George in recognition of the duties performed by him during the early part of the War.

During Mr. Desbarats' long connection with The Institute, he took an active part in its affairs. He joined as a Member on May 20th, 1897; served on Council in 1900, 1907, 1933 and 1934; he was a vice-president in 1909, and has rendered many important services in connection with Institute and branch committee work. His continued aid and interest has been most valuable to the Ottawa Branch of which he was chairman in 1931.

C. E. Hogarth, A.M.E.I.C., of the Toronto Iron Works Limited, has been transferred by that company to Montreal, where he will be in charge of the sales office. Mr. Hogarth graduated from the School of Practical Science, University of Toronto, in 1915, with the degree of B.A.Sc., and following graduation was overseas until 1919 as a lieutenant with the Canadian Engineers. From April until October 1919 he was field engineer on the Welland Ship canal, and later, until July 1920, was field engineer and general foreman with the Austin Company at Cleveland, Ohio. In 1920 Mr. Hogarth was engaged with the Foundation Company of New York as field engineer, and in 1921-1925 he was sales engineer with the Refinite Company of Canada, and the Canadian International Filter Company, at Toronto. In 1926 Mr. Hogarth was acting assistant superintendent on power house construction for the Detroit Edison Company at Detroit, Mich., and subsequently, until 1931, he was engineering assistant with the Michigan Bell Telephone Company, at Detroit. In 1931 Mr. Hogarth returned to this country as engineer with Christman-Burke Limited, Toronto. In 1934 he acquired an interest in the firm of J. D. Armstrong Construction Limited, Hamilton, and joined the staff as engineer, and in 1935 he became connected with the Toronto Iron Works Limited, Toronto, as sales engineer.

G. E. Cole, A.M.E.I.C., Director of Mines, Department of Mines and Natural Resources, Winnipeg, Man., was elected president of the Canadian Institute of Mining and Metallurgy for the year 1936-1937 at the annual meeting of that organization recently held at Ottawa, Ont. Mr. Cole was educated at McGill University, receiving the degree of B.A. in 1902 and that of B.Sc. in 1906. He spent his undergraduate summers in the mines at Phœnix, B.C., and after graduation was engaged as mine engineer in that camp by the Granby Consolidated M.S. and P. Company until 1909, when he moved to Ontario and for four years served with various mining companies in the Gowganda, Sudbury and Cobalt districts. From 1913 until 1915 he was instructor in mining at the Haileybury Mining School. In December 1915 Mr. Cole enlisted with the 15th Overseas Battalion; in 1917 he transferred to the Canadian Engineers and became Adjutant of the Tunnelling section at Shoreham and Seaford, England. Later he served in France and Belgium with the 3rd Tunnelling Company, Canadian Engineers. Returning to Canada, Mr. Cole

G. E. Cole, A.M.E.I.C.

carried on instructional work for the Department of Soldiers' Civil Re-establishment at the Haileybury Mining School, and in 1920, he joined the Ontario Department of Mines as Inspector in the Sudbury and Porcupine districts. In 1928 Mr. Cole was appointed Chief Inspector of Mines for Manitoba, with headquarters at Winnipeg, and when the administration of Natural Resources was transferred from the Dominion to the several provinces he received the appointment which he now holds.

Commitee on Consolidation

Report for April 1936

Though there has been no meeting of the Committee during the month of April, matters relative to Consolidation have made progress and a review of the circumstances upon which this progress is based may be of interest to the members of the profession.

The discussion of the Report of the Committee on Consolidation by the Annual Meeting at Hamilton on February 5th, has been ably summarized by Mr. Durley in the March issue of the "Journal," and gives a complete review of this very important meeting.

It will be recalled that this Annual Meeting of The Institute was made the occasion for the bringing together of the representatives of the various Provincial Professional Associations known as the "Dominion Council." This Council held meetings on February 6th, 7th and 8th, and opened its deliberations with a review of the activities of its predecessor, the "Committee of Eight," which met in February, 1933, issued a report recommending the formation of a "Dominion Council of the Professional Associations" and drew up a Constitution for the same for submission to and acceptance by the various Provincial Associations.

During the meetings of this Council held in Hamilton, its aims and objects were re-stated and its Constitution reviewed and this statement, and a record of the proceedings of these meetings, have been sent to the various Provincial Professional Associations for their consideration and approval.

At its meeting of February 6th, the Dominion Council considered the report of the Committee on Consolidation which had been presented and adopted at the Annual Meeting of The Institute, and it was the opinion of that Council "that neither The Institute nor the Dominion Council were tied by the nine recommendations of that Report," and that those recommendations which provided the opportunity for Consolidation to be carried out independently by each province and without the simultaneous action of every Professional Association across Canada, should be dropped. This was expressed in the agreement of the Dominion Council that recommendation No. 7 of the Report of the Committee on Consolidation should be revised to read,—

> "That The Institute agree to act as the national body in the event of Consolidation being consummated with all of the Provincial Professional Associations."

which recommendation originally read,—

> "consummated with any or all of the Provincial Professional Associations."

Further, "It was the consensus of opinion (of the Dominion Council) that all should work for the 'speedy' consummation in a Dominion sense of consolidation, coordination or confederation, *throughout the Dominion.*"

At the joint meeting of the Dominion Council and the Committee on Consolidation held on February 7th, the suggestion was made and received the general approval of the meeting, that in the event of Consolidation being achieved, the Dominion Council should be retained to function for the co-ordination of all the legal activities of the Provincial Associations and that its members should become members of the Council of The Institute.

In considering the status of the Class "C" or non-Institute members of the Professional Associations, there was considerable discussion of their privileges and fees in the national body. It was pointed out that, as the national body would maintain and develop the functions of the Dominion Council and in other ways materially advance the interests of this class of member in a legal and Dominion-wide sense, it was only right and proper that each Professional Association should make a per capita contribution to the national organization to defray the expenses of the Dominion Council and such other outlays as the national body would be required to make in the interests of the members of this particular class. This principle is now in effective operation through the per capita contribution by the Associations to maintain the meetings and activities of the Committee of Eight and the present Dominion Council.

This joint conference drew up a memorandum of suggestions which has been circulated to the Council of The Institute and to the Professional Associations. It had been hoped that this memorandum could have been published in the April issue of the "Journal."

In connection with the above, the Committee on Consolidation is advised that at the Annual Meeting of the Corporation of Professional Engineers of Quebec, held on March 25th, 1936, the following resolution was passed,—

> "That the meeting request the Council to continue its efforts towards Consolidation following the lines of the report adopted at the Annual Meeting of the Corporation in 1935, and that the Council do not agree to the setting up of any council or committee representing all the professional associations of the Dominion, other than as a temporary organization to facilitate consolidation of the engineering profession in Canada."

Under date of March 28th, Mr. C. C. Kirby, President of the Dominion Council of Professional Engineers, wrote the chairman of the Committee on Consolidation as follows,—

> "I am quite in accord with the idea that when a scheme of Consolidation with all of the provinces has been prepared by your Committee with the co-operation of the Dominion Council members upon it that any province can then put it into effect as soon as it cares to without waiting for similar simultaneous action by the other provinces. I would expect, of course, that each province would try to find out what action the others were willing to take about it and when, and would wait a decent time to try and get simultaneous action and I will naturally urge them to that end. I am unable to appreciate, on the other hand, why The Institute should wish any other course to be taken and am not suggesting that you think otherwise. The above is not what we considered to be piece-meal Consolidation which was action by the E.I.C. Committee to give effect to the suggestions of Nova Scotia, Manitoba or Saskatchewan without reference to the views of the Dominion Council and possibly against the wishes of the majority of its members. Should the achievement of a scheme satisfactory to the Dominion Council prove not to be feasible, the E.I.C. Committee should then feel free to take such action as it may deem fit in negotiating with any individual province."
>
> Yours very truly,
>
> (Sgd.) C. C. Kirby,
>
> *President.*

At a meeting of the Council of the Association of Professional Engineers of the Province of New Brunswick, held on April 9th, 1936, the following resolution was passed,—

> "Resolved that this Council adopts and expresses approval of the report of our representative on the Dominion Council, Mr. C. C. Kirby, with the reservation that the Dominion Council is an interim organization until some form of consolidation with The Engineering Institute of Canada has been achieved, and further, subject to the approval of the next Annual Meeting of the Association."

On April 7th, 1936, a meeting of the Manitoba Joint Committee on Consolidation was held under the chairmanship of Mr. A. J. Taunton, at which the proceedings of the Annual Meeting of The Institute relative to Consolidation were discussed together with a report on the same by Mr. T. C. Main, the Manitoba representative to the Annual Meeting. As a result of this meeting, its chairman communicated with the secretary of The Institute indicating the strong desire on the part of the engineers in Manitoba that as speedy action as possible should be taken to implement Manitoba's policy for early consolidation of the profession in that province.

In order that the membership may understand the present position of the Committee relative to immediate action on Consolidation, the following letter from Mr. Geoffrey Stead, under date of April 22nd, 1936, is quoted as a most comprehensive and appreciative statement,—

Saint John, N.B.,
22 April, 1936.

Dear Mr. Pitts,—

I am much obliged for your letter of the 20th April, and the enclosed copies of letters received from Mr. A. J. Taunton, Chairman of the Joint Consolidation Committee of Manitoba; and am pleased to see that a strong feeling for early consolidation in Manitoba is evident from Mr. Taunton's report.

Since they agree with the general resolution passed at the Annual Meeting following the adoption of your report in principle as a progress report, and providing the Manitoba Association will approve of the amended by-laws which you are preparing to enable the E.I.C. to act as the central organization for the engineering profession in Canada, I cannot see any real objection to the Manitoba Association initiating this movement.

It is a fact, reiterated in the resolution passed at our last meeting of Council, of which you have a copy, that each Association is an autonomous body, subject only to the requirements of the Provincial Acts, and within these requirements able to do as they wish, and not liable to outside control or dictation. While the Associations in the Dominion cannot lose their separate identity except by a Dominion Act, which is now out of the question, the members of each Association can by their own agreement join with the central body for such purposes and objects as the E.I.C. now supplies, as soon as provision is made by by-laws to cover the new situation.

It would be impracticable, except with considerable additional delay, to have members of all the Associations enter consolidation at the same time on account of the varying dates of the annual meetings of the Associations; and it would be a pity to have the Manitoba Association lose a favourable time for action by any delay; but whether they could provisionally accept amended by-laws and their members be received in consolidation under such by-laws before approval of these by the E.I.C. at Annual Meeting is doubtful, and is a question which might be decided by E.I.C. Council. Of course, as I say, no one can dictate to the Manitoba Association in such action as they may wish to take, and they may, if they wish, provisionally accept the E.I.C. as their central body under the present by-laws so far as these will allow. The Council of the E.I.C. may be able to accept the recommendation of the Annual Meeting, provisionally in the case of Manitoba applicants, that membership be restricted to registered professional engineers.

Very little was actually accomplished previous to the work of your committee, but with it and the co-operation and good feeling shown by the representatives of the Associations from the east to the west of Canada at the Hamilton Meeting, the concessions approved then by the E.I.C. in matters which had occasioned most difficulty and the results of the discussions at that meeting, the way has been so paved that with the completion and approval of the amended by-laws, and judging from the strong feeling throughout the profession in Canada for consolidation, practically only formalities will remain for its consummation.

I believe that the E.I.C. will then act as the central body to carry out the functions for which it is intended.

Yours sincerely,

(Sgd.) Geoffrey Stead,
President,
New Brunswick Association
Professional Engineers.

On April 18th, Mr. C. C. Kirby, President of the Dominion Council, met the chairman of the Committee on Consolidation, in an informal conference relative to the further steps to be taken in the carrying out of the programme for the early consummation of Consolidation. This conference was most constructive and was devoted to a review of progress to date and to a study of certain tentative revisions to the By-laws of The Engineering Institute prepared by Mr. Kirby, in accordance with the principles approved by the Annual Meeting and necessary in order that Consolidation may be put into effect.

The procedure proposed is that after the president of the Dominion Council and the chairman of the Committee on Consolidation have satisfied themselves that the proposed revisions to the By-laws of The Institute meet the requirements of the profession, the same shall be submitted to the Committee on Consolidation for their consideration and approval, after which they will be placed before the Council of The Institute and other interested organizations, and subject to the recommendations received thereon, will be finally submitted by the Committee to the Council, in accordance with the provisions of the By-laws, for presentation to the Annual Meeting of The Institute and subsequent ballot by the general membership.

Gordon McL. Pitts,
Chairman.

Elections and Transfers

At the meeting of Council held on April 3rd, 1936, the following elections and transfers were effected:—

Members

DEAN, Curtis Milford, B.A.Sc., (Univ. of B.C.), mgr., Shellburn Refinery, Shell Oil Co. of B.C. Ltd., Vancouver, B.C.

FRASER, William Thomas, mgr., Vancouver Machinery Depot Ltd., and the Vancouver Iron Works Ltd., Vancouver, B.C.

GREEN, John, (Manchester Coll. of Technology), consltg. engr., 1915 West 14th Ave., Vancouver, B.C.

HOUSTON, David Waters, B.Sc., (Queen's Univ.), supt., Street Railway Dept., City of Regina, Sask.

MACKENZIE, Daniel Campbell, (Hamilton Tech. School, Scotland), gen. mgr. and technical adviser, Cons. Gold Alluvials of B.C. Ltd., Wingdam, B.C.

MACKENZIE, John Alexander, Grad. S.P.S. (Univ. of Toronto), mgr., Minto Gold Mines, Vancouver, B.C.

McGUINNESS, Thomas, asst. supt., Regina Municipal Railway, Regina, Sask.

SMITH, William Chester, B.A.Sc., C.E., (Univ. of Toronto), mgr., Engrg. Divn., The Cooksville Co. Ltd., Toronto, Ont.

Associate Members

BALMFORTH, Harold, B.E., (Univ. of Sask.), Strasbourg, Sask.

DIXON, Keith, (Univ. of Sheffield), divnl. engr., Dept. of Northern Development, North Bay, Ont.

JOHNSEN, Hagbart, M.E., (Norges Teknishe Hiskole), designing engr., Montreal Locomotive Works, Montreal, Que.

LUKE, Edward Corbus, (Grad., R.M.C.), chief dftsman., Pacific Great Eastern Rly., Squamish, B.C.

McMILLAN, Hugh, B.Sc., (Univ. of Man.), res. engr., Dept. of Northern Development, White River, Ont.

O'NEILL, George William, pricer, Manitoba Bridge and Iron Works Ltd., Winnipeg, Man.

PATERSON, James Wilson, (Royal Technical College, Glasgow), asst. woods mgr., The E. B. Eddy Co. Ltd., Hull, Que.

SIMPSON, Frederick John, head of dfting dept., T. J. Trapp Technical High School, New Westminster, B.C.

VIBERG, Ernest Frederick, B.Sc., (McGill Univ.), foreman, steel casting divn., Canadian Car and Foundry Co. Ltd., Montreal, Que.

Juniors

MOLONEY, James Grant, B.Sc., (Tri-State College, Indiana), reinforced concrete designing, for S. W. Archibald, M.E.I.C., London, Ont.

McCUNE, Samuel, B.Sc., (Univ. of Illinois), dftsman., Dept. of Northern Development, Sudbury, Ont.

RICHARDS, Hilary John Brewerton, B.Sc., (Univ. of Man.), 515 Raglan Rd., Winnipeg, Man.

TOVEE, Edward Harold, B.A.Sc., (Univ. of Toronto), engr., Canadian Westinghouse Company, Hamilton, Ont.

YOUNG, William Hugh, B.Sc., (Queen's Univ.), dftsman., Howard Smith Paper Mills Ltd., Cornwall, Ont.

Affiliate

JOYCE, Alexander George, chief boiler operator, Aluminum Company of Canada, Arvida, Que.

Transferred from the class of Associate Member to that of Member

ADAMS, William Douglas, (Grad., R.M.C.), Toronto mgr., H. E. McKeen & Co. Ltd. of Montreal, Toronto, Ont.

GODSON, Reginald Gilbert, (R.M.C.), private practice, 28 Summerhill Gardens, Toronto, Ont.

GOEDIKE, Frederick Bertram, B.Sc., (Queen's Univ.), 578A Indian Road, Toronto, Ont.

KINNEAR, Clifford Rutherford, asst. engr. of way, Toronto Transportation Commission, Toronto, Ont.

MACPHERSON, Harold Nolan, B.A.Sc., (Univ. of Toronto), private practice and gen. mgr., Permanent Timber Products Ltd., Vancouver, B.C.

MENGES, Edwin A. H., (Univ. of Toronto), chief engr., Disher Steel Construction Co. Ltd., Toronto, Ont.

MILES, Edgar Stuart, B.A.I., (Univ. of N.B.), engr., A. W. Robertson Ltd., Toronto, Ont.

McNEICE, Leonard Galbraith, B.Sc., (Queen's Univ.), engr., Orillia Water, Light and Power Commission, Orillia, Ont.

O'GRADY, Brian Terence, (Royal Sch. of Mines, England), res. mining engr., Govt. of B.C., Vancouver, B.C.

RYAN, Charles Cedric, M.Sc., (McGill Univ.), res. engr., B.C. Pulp and Paper Co. Ltd., Port Alice, B.C.

SANGER, John William, (Faraday House, London), chief engr., City of Winnipeg Hydro-Electric System, and Commnr., Manitoba Power Commn., Winnipeg, Man.

SCOTT, William Orville Craig, B.Sc., (McGill), M.A.Sc., (Univ. of B.C.), 1414 West 14th Ave., Vancouver, B.C.

WADE, Mark Leighton, B.Sc., (McGill Univ.), asst. district engr., Dept. of Public Works of B.C., Kamloops, B.C.

WALKER, John, (Heriot Watt Coll.), divn. engr., C.N.R., Barrie, Ont.

WHITE, Harry Manning, M.E., (Univ. of Toronto), chief engr., western divn., Dominion Bridge Co. Ltd., Winnipeg, Man.

WILSON, John Armitstead, (St. Andrews Univ.), controller of civil aviation, Dept. of National Defence, Ottawa, Ont.

Transferred from the class of Junior to that of Member

RIDDELL, William Forrest, M.Sc., (Univ. of Man.), asst. professor, dept. of engrg., University of Manitoba, Winnipeg, Man.

Transferred from the class of Junior to that of Associate Member

ARMSTRONG, Arnold Victor, B.Sc., (McGill Univ.), engr. in charge of sales for Ontario, for Northern Electric Co. Ltd., Toronto, Ont.

BOWEN, John Alfred Clarke, B.A.Sc., (Univ. of Toronto), 70-36th St., Long Branch, Ont.

DUNLOP, Ronald William, B.A.Sc., (Univ. of Toronto), mech. engr., Imperial Oil Limited, Calgary, Alta.

HARBERT, Edward Thomas, B.Sc., (McGill Univ.), engr., Canadian Ingersoll-Rand Co., Sherbrooke, Que.

MARTIN, Frank John Ellen, B.Sc., (Univ. of Sask.), architect, 315 Avenue Bldg., Saskatoon, Sask.

PENNOCK, William B., B.Sc., (McGill Univ.), senior mech. engr., heating and ventilating, Dept. of National Defence, Ottawa, Ont.

YOUNG, John Douglas, B.Sc., (Queen's Univ.), sales engr., Bailey Meter Co. Ltd., Montreal, Que.

Transferred from the class of Student to that of Associate Member

BILLIE, Frank Robert V., B.Sc., (McGill Univ.), mgr. and partner, Charles V. Billie & Son, contractors, Smiths Falls, Ont.

CURRIE, George J., B.Sc., (N.S. Tech. Coll.), engr., Nova Scotia Light and Power Co. Ltd., Halifax, N.S.

Transferred from the class of Student to that of Junior

BROWN, William Boughton, B.Sc., (N.S. Tech. Coll.), engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont.

DODDRIDGE, Paul William, B.Sc., (Univ. of N.B.), sales engr., Can. Gen. Elec. Co. Ltd., Toronto, Ont.

GOLD, William John, B.Sc., (Univ. of Alta.), student course, Calgary Power Co. Ltd., Seebe, Alta.

McCANN, William Neil, B.Sc., (Univ. of Man.), instr'man., Water Development Committee, Swift Current, Sask.

McKEEVER, James Lawrence, B.A.Sc., (Univ. of B.C.), asst. engr., machine design, Can. Gen. Elec. Co. Ltd., Peterborough, Ont.

McLACHLIN, Hugh Frederick, (Grad., R.M.C.), engr. salesman, Canadian Westinghouse Company, Hamilton, Ont.

ROBERTSON, Gordon Gerrard Dickson, (Univ. of Alta.), 205-2nd St. West, Calgary, Alta.

ROY, Leo, B.A.Sc., C.E., (Ecole Polytech., Mtl.), B.Eng., (McGill Univ.), asst. engr., power sales divn., Shawinigan Water and Power Company, Montreal, Que.

SCHOFIELD, William, B.Eng., (McGill Univ.), dftsman., Howard Smith Paper Mills Ltd., Cornwall, Ont.

SIMMONS, Herbert John, B.Sc., (Queen's Univ.), time study engr., General Steel Wares Ltd., London, Ont.

TAPLEY, Donald Gordon, B.Sc., (N.S. Tech. Coll.), student engr., Can. Gen. Elec. Co. Ltd., Toronto, Ont.

WALTER, John, B.Sc., (Queen's Univ.), office engr., Dundurn Camp, Dundurn, Sask.

WILLIS, Ralph Richard, B.Sc., (Univ. of N.B.), land surveyor, West Bathurst, N.B.

Students Admitted

BEIQUE, Henri F., (McGill Univ.), 9269 LaSalle Rd., Ville La Salle, Que.

BERGMAN, Wesley Howard, (Univ. of Alta.), P.O. Box 36, St. Albert, Alta.

BREWS, Robert William, (Univ. of Alta.), 719-29th Ave. S.W., Calgary, Alta.

BRUCE, Rodney, (Queen's Univ.), Queen's University, Kingston, Ont.

GROUT, Raymond Edward, (Univ. of Alta.), 10941-89th Ave., Edmonton, Alta.

HARDING, Charles Malcolm, (Univ. of Alta.), 513-34th Ave. W., Calgary, Alta.

HASTIE, Frank James, (Univ. of Alta.), 9739-86th Ave., Edmonton, Alta.

HAWKEY, Bertram Jackson, (Univ. of Alta.), Fernie, B.C.

LAFLAMME, Marcil, (Ecole Polytech., Mtl.), 3698 St. Hubert St., Montreal, Que.

MACLEOD, Douglas Norman, B.Eng., (McGill Univ.), 4474 St. Catherine St. W., Montreal, Que.

MACLEOD, Gordon, B.Eng., (McGill Univ.), Weyburn, Sask.

McMANUS, Leslie Harold, B.Sc., (Univ. of Alta.), University of Alberta, Edmonton, Alta.

McMATH, Jack, (Univ. of Alta.), P.O. Box 56, Ranfurly, Alta.

PARK, Fillmore Robert, (Univ. of Alta.), Carseland, Alta.

REIKIE, W. Thorpe T., (Univ. of Alta.), General Delivery, Edmonton, Alta.

ROTHMAN, Saul Maurice, (Univ. of Toronto), 100 Auburn Ave., Toronto, Ont.

SCARLETT, Barnes Kossuth, (Univ. of Man.), 45 Arlington St., Winnipeg, Man.

SPROULE, William Kelvin, (McGill Univ.), 39 Thornhill Ave. Westmount, Que.

STAFFORD, James Walter, Jr., (Univ. of Alta.), 10576-83rd Ave., Edmonton, Alta.

THOMAS, Sidney Bayard, B.Sc., (Univ. of N.B.), 254 Carmarthen St., Saint John, N.B.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

American Institute of Consulting Engineers: Proceedings of Annual Meeting held January 13th, 1936.

The Society of Engineers: Transactions 1935.

Institution of Mechanical Engineers: Proceedings 1935, Vol. 130.

Society of Naval Architects and Marine Engineers: Transactions, 1935, Vol. 43.

Reports, etc.

Ontario Department of Mines: Report on the mineral production of Ontario in 1935.

Quebec (Province): Annual Report of the Bureau of Mines, 1934, Parts A and C.

Nova Scotia Power Commission: 16th Annual Report, 1935.

Institution of Civil Engineers: Charter, supplemental charters, By-laws and Regulations, February, 1936.

American Institute of Electrical Engineers: Year Book and List of Members, 1936.

Royal Society of Arts: List of Members.

National Resources Committee, Washington, D.C.: Report of special subcommittee of Water Resources Committee, Drainage Policy and Projects.

American Institute of Consulting Engineers: Constitution, By-laws and List of Members.

American Society of Mechanical Engineers: Boiler Construction Code, 1935 edition.

Institution of Civil Engineers: 15th report of Sea Action Committee; Deterioration of Structures in Sea Water.

University of Toronto: Calendar of Faculty of Applied Science and Engineering, 1936-1937.

Institution of Civil Engineers: List of Members, February, 1936.

American Society of Civil Engineers: Year Book 1936.

Research Council of Alberta: 16th Annual Report, 1936.

Technical Books, etc.

Moody's Steam Railroads, 1934.

The Practice of Lubrication, by T. C. Thomsen. (*McGraw-Hill Book Publishing Company.*)

BOOK REVIEWS

The St. Lawrence Deep Waterway

A Canadian appraisal, by C. P. Wright. The Macmillan Company of Canada, Limited, Toronto. 1935. 5¾ by 8¾ inches. 450 pages. Map. $4.50.

Reviewed by J. B. MACPHAIL, A.M.E.I.C.*

A treaty concerning the improvement of the upper St. Lawrence river has been signed by duly appointed representatives of the governments of Canada and the United States and is awaiting ratification. Accordingly some consideration should be given to Mr. Wright's opinion that neither government has had any complete quantitative and impartial estimate of the benefits to be expected from this very expensive project, either before the signing of the treaty or thereafter. The burden on Canada is relatively much greater, so correspondingly greater care should be taken to see that she can carry it, and that it is worth carrying. Instead, however, relatively less attention seems to have been given to Canadian interests, notwithstanding the efforts made in this direction by D. W. McLachlan, M.E.I.C., and others.

The treaty may be ratified by the United States, in their charmingly inconsequental way, for reasons quite apart from its own merits, and pressure on Canada to do likewise may then be applied. So while there is yet time, we should remember that we have made some economic mistakes in the past, and we should examine the evidence and decide whether or not this project will be another, and have our answer ready. A suggestion of this kind is often condemned as a subtle form of opposition, but that is not the case with Mr. Wright. He seems to have examined everything that has ever been written on the subject; he has gone into official reports and files of correspondence, and gives proper acknowledgment to those who have helped him therein; he wants as much river improvement as we can afford, but he remarks quite rightly that we do not yet know how much that is.

A person, even aided by the desire and capacity to be well informed, might quite reasonably be appalled by the mere task of collecting the necessary data, and this book will make an excellent beginning for his course of study. The first eight chapters are mostly historical and contain a full account of the operations of the various commissions, committees and boards which have been formed at various times; of the negotiations which were conducted; of legal and political influences which appeared; and of the various existing rights on the river and the attempts to acquire others. This section is an interesting and well written piece of history. An historian without opinions can be very dull, so the author comments freely and fairly on procedure, and on personalities when necessary to explain why things happened, or why certain points of view were expressed.

The engineering aspects of the scheme are not brought forward to any great extent, on the ground that there is no dispute about the thoroughness with which the engineers have done their part. The project is large, but not hazardous as was the Panama canal, and anything which is required can be built without much difficulty. It is not the purpose of the book to discuss matters of engineering and of unit costs, but there are many examples of government works having cost much more than was expected and all due care should be taken to see that this one does not add another.

Mr. Wright proceeds then to some questions of economics. He argues in some detail that the depth of the ship channel should be at least 30 feet and that the 27-foot depth which has been much mentioned has been selected on improper interpretations of data available. He shows that no demonstration of specifically Canadian need has been made for the new waterway; he gives great credit to Mr. McLachlan and Mr. Lindsay for their spontaneous investigations, and to Mr. Lesslie Thomson for his attempt to determine the savings in transportation costs and the persons to whom those savings would accrue, and he comments on their findings, a little gloomily.

Some other interesting points are discussed. The author deals with the allocation of costs, and remarks that it does not seem equitable that Canada, with her smaller population and wealth, and with her probable 20 per cent share of the traffic, should be paying half the cost and receiving no credit for numerous expenditures for improvements elsewhere which are used in the whole length of the route to the sea. He suggests that some toll system must be used so that the people who benefit from the waterway will pay for it instead of some other set, as would be the case if it were paid for by general taxation; and he offers some acute comments on the faults of the treaty which has been signed. His ideal of economic information, namely that we should have a tabulation of the costs for several depths and a complete assessment of the benefit to Canada of each depth, is probably unattainable. Perhaps a simpler way would be to estimate the respective annual costs for each depth and to state who is expected to pay these costs and how, and to get the opinions of those who will be taxed. In this connection, too, it might be opportune to remember a suggestion of the late Professor Mavor that transportation by ox-cart might prove to be the cheapest in the end.

In short, Mr. Wright presents good evidence that a proper examination of the matter from a Canadian point of view has not yet been made, and pleads for further consideration of the undertaking. It is desirable that we listen to his plea and act accordingly.

The book is notable as a critical study of a subject of primary concern to the whole of Canada. The picture it presents will be of striking interest even to those who may disagree with some of the author's conclusions. The value of the book is enhanced by an excellent index and by many references to the sources of information available.

Shawinigan Engineering Company, Montreal.

The Structure of Metals and Alloys

By William Hume-Rothery. Monograph and report series No 1 of the Institute of Metals. London, England. 1936. 5 by 8½ inches. Diagrams. 3s. 6d. net.

Reviewed by E. W. S.

The author of this work is well known for his important contribution to the theory dealing with the behaviour of atoms when packed together to form a metal, and his book entitled "The Metallic State" published in 1931, dealt in detail with this work.

The present publication is a monograph produced for the Institute of Metals dealing with the present state of knowledge upon the structure of metals and alloys.

The rapid advances made by the mathematical physicists in the theory of the structure of the atom, come so quickly one after another that the engineer who is not closely associated with this work finds difficulty in keeping up to date He is, however, greatly interested in understanding what a metal is, and why one element is a metal, whereas its neighbour in the periodic table may have non-metallic properties.

Similarly, alloys are of the greatest value to mankind, and it is of considerable importance that engineers should understand something about the structure to be expected in alloys of different kinds.

The work of the physical metallurgist has always appeared, in the past, to have been based upon rather haphazard methods. Metals have been mixed in varying proportions and the resulting alloys studied by temperature measurements and the microscope, in order to construct equilibrium diagrams, which, owing to the difficulties experienced in producing them, were always subject to change as experimental methods improved. The number of possible combinations of metals was almost infinite, and the discovery of a useful new alloy was largely a matter of luck. This work is now being revolutionized by the use of the X-ray, and by the assistance of modern theory.

The monograph under review outlines the present day theories upon the structure of metals and alloys, and gives an indication of the reasons why certain types of alloys are formed. It also gives the most recent ideas upon the formation of those so-called metallic compounds in alloys which have always been so difficult to understand. The theories at present cover only a very small portion of this enormous field, but they do assist us in understanding many important points.

It is perhaps a presumption for an engineer to attempt to review a book of this kind, but after having read it—admittedly without understanding some of the material it contains—one is left with the impression that a book which is so well written, in plain language, and which contains so much material of direct interest to the designer of engineering products should be recommended to all engineers as a thoroughly enjoyable book which will give them a good summary of the work that is being done in this important field for their own immediate benefit.

Physicists and metallurgists will undoubtedly find this publication to be a necessary addition to their libraries.

It is well produced and surprisingly inexpensive.

BULLETINS

Abrasive Products.—The Norton Company of Canada Limited, Hamilton, Ont., have issued a 180-page price list of grinding wheels and other bonded abrasive products. Before each process and class of wheel is given a complete set of rules for arriving at the basic list value for any size or shape of wheel required.

Machine Tools.—A 24-page pamphlet received from Morey Machinery Co. Inc., New York, contains particulars of a number of machine tools such as boring mills, presses, drills, cutters, grinders, etc.

Steel.—A 16-page circular issued by the International Nickel Company Inc., New York, contains data regarding the properties of nickel alloy steels, high ferro-nickel alloys and stainless steels at low temperatures.

Lifting Tools.—A 4-page leaflet received from the Canadian Fairbanks-Morse Company Limited, Montreal, gives details of the new Yale chain pull lift. This tool comes in capacities of ¾, 1½, 3 and 6 tons.

Sheet Piling.—The United States Steel Products Company, Montreal, have issued a 10-page bulletin containing information regarding the numerous uses of their Z piles. Tables of dimensions are included.

Bronze Bearings.—A 4-page circular received from the Bunting Brass and Bronze Company, Toledo, Ohio, gives particulars of bronze standardized bearings manufactured by that company.

Fencing.—The Steel Company of Canada Limited, Montreal, have issued a 20-page booklet containing photographs of various installations of their chain link and ornamental fencing.

Speaker at Western Branches

Vice-President P. L. Pratley, M.E.I.C., is at present travelling to Vancouver, and has kindly consented to address a number of the Branches of The Institute on his return trip.

Mr. Pratley will speak on the Ile d'Orleans bridge, of which the firm of Monsarrat and Pratley were the consulting engineers, and under the present arrangements will address the Vancouver Branch on May 5th, the Winnipeg Branch on May 9th and the Lakehead Branch at Fort William, Ont., about May 12th.

It will be appreciated if any other members who are contemplating trips, and are willing to present papers before any of our Branches, will communicate either with the General Secretary, or with R. L. Dobbin, M.E.I.C., chairman of the Papers Committee of The Institute, c/o Peterborough Utilities Commission, Peterborough, Ontario.

Rules Governing Award of Institute Prizes

The Sir John Kennedy Medal

A gold medal, called the "Sir John Kennedy Medal," was established in 1927, to be awarded under the following rules in commemoration of the great services rendered to the development of Canada, to engineering science and to the profession by the late Sir John Kennedy, past-president of The Engineering Institute of Canada.

(1) The medal shall be awarded by the council of The Institute, but only when the occasion warrants, as a recognition of outstanding merit in the profession or of noteworthy contribution to the science of engineering or to the benefit of The Institute.

(2) As a guide in making the award, the council of The Institute shall take into consideration the life, activities and standing in the community and profession of the late Sir John Kennedy.

(3) Awards shall be limited to corporate members.

(4) At the beginning of each year, every branch of The Institute shall be asked for its recommendation, supported by reasons, for the award of the medal, which must be submitted to council not later than May first. The council of The Institute shall then give consideration to the recommendations, but will not necessarily adopt any of them. If, in the opinion of the council, no corporate member of The Institute thus recommended is of sufficient merit or distinction, no award shall be made.

(5) The award shall be decided by letter ballot of the council in a form to be prescribed by the council. The ballot shall be mailed to each member of the council and shall state the date of the council meeting at which it is proposed to canvass the ballot, which shall not be less than twenty days after the issue of the ballot. At least twenty votes shall be cast to constitute an award. Three or more negative votes shall exclude from an award.

(6) Announcement of an award shall be made in The Engineering Journal and at the annual meeting, and, if possible, the presentation shall take place at that meeting.

The Past-Presidents' Prize

In recognition of the fund established in 1923 by the then living past-presidents and contributed to by subsequent past-presidents, a prize, called "The Past-Presidents' Prize," may be awarded annually according to the following rules:—

(1) The prize shall be awarded for the best contribution submitted to the council of The Institute by a member of The Institute of any grade on *a subject to be selected and announced by the council* at the beginning of the prize year, which shall be July first to June thirtieth.

(2) In deciding on the subject to be specified, the council shall confer with the branches, and use its discretion, with the object of selecting a subject which may appear desirable in order to facilitate the acquirement and the interchange of professional knowledge among the members of The Institute.

(3) The papers entered for the competition shall be judged by a committee of five, to be called the Past-Presidents' Prize Committee, which shall be appointed by the council as soon after the annual meeting of The Institute as practicable. Members and honorary members only shall be eligible to act on this committee.

It shall be within the discretion of the committee to refuse an award if they consider no paper of sufficient merit.

(4) The prize shall consist of a cash donation of the amount of one hundred dollars, or the winner may select books or instruments of no more than that value when suitably bound and printed, or engraved, as the case may be.

(5) All papers eligible for the competition must be the bona fide work of the contributors and must not have been made public before submission to The Institute.

(6) All papers to be entered for the competition must be received during the prize year by the general secretary of The Institute, either direct from the author or through a local branch.

(7) The award shall be announced in The Engineering Journal and at the annual meeting, and, if possible, the presentation shall take place at that meeting.

Duggan Medal and Prize

A prize of a medal and cash to a combined value of approximately *one hundred dollars* was established in 1935, to be given each year from the proceeds of a donation by Past-President G. H. Duggan, D.Sc., LL.D., M.E.I.C., for the purpose of encouraging the development of the branches of engineering in which he practised.

The prize will be awarded for the best paper presented to The Institute in accordance with the following rules:—

(1) Competition shall be open to all members of The Institute.

(2) The papers shall be presented to The Institute either at the regular meeting of a branch or at a professional meeting of The Institute, or directly to Headquarters. They shall not have been presented previously to any other body or meeting.

(3) Papers to be eligible for this competition shall deal with such subjects as arise in that sphere of constructional engineering which concerns the use of metals in moulded or fabricated shape for structural or mechanical purposes. Without limiting the generality of the foregoing, it is suggested that papers describing works should deal with the economic and theoretical elements of design, fabricating, machining, transporting, erecting, problems solved, methods of overcoming difficulties and other interesting features.

There will also be admitted to the competition papers describing new methods or the recording of important tests that add to engineering knowledge.

(4) Papers shall be the bona fide production of the author and proper credit shall be given for any assistance received from other parties, partners or reports. The relation of the author to the work shall be clearly stated. Papers shall be compiled and arranged with proper regard to literary value and shall constitute worthy contributions to the records of the engineering profession.

In judging the competition consideration will be given to the personal knowledge and appreciation of the problems and processes involved and the joint application of theoretical and practical considerations to the execution of the subject which are displayed on the part of the author.

(5) The papers shall be judged by a committee of three corporate members, eminent in the corresponding branch of the profession, appointed for the purpose by council as required.

(6) The award shall be made only when a paper of sufficient merit is presented. The prize year shall be from July 1st to June 30th and papers must be presented to Headquarters of The Institute by the 30th day of June.

(7) The prize shall be awarded at the annual meeting.

The Gzowski Medal

A gold medal, called "The Gzowski Medal," is provided from the fund established in 1889 by Col. Sir Casimir Gzowski, A.D.C., K.C.M.G., late past-president of The Institute, and will be awarded according to the following rules for papers presented to The Institute.

(1) Competition for the medal shall be open only to those who belong to The Institute.

(2) The award of medals shall not be made oftener than once a year, the medal year shall be the year ended June last previous to the annual meeting at which the award is to be made.

(3) The papers entered for competition shall be judged by a committee of five, to be called the Gzowski Medal Committee, which shall be appointed by the council as soon after the annual meeting of The Institute as practicable. Members and Honorary Members only shall be eligible to act on this committee.

(4) Papers to be eligible for competition must be the bona fide productions of those who contribute them, and must not have been previously made public, nor contributed to any other society in whole or in part.

(5) The medal shall be awarded for the best paper of the medal year, provided such paper shall be adjudged of sufficient merit as *a contribution to the literature of the profession of civil engineering*, but not otherwise.

(6) In the event of the committee not considering a paper in any one year of sufficient merit, no award shall be made; but in the following year or years, it shall be in the power of the committee to award the accumulated medals to the authors of different papers which may be deemed of sufficient merit.

(7) The medal shall be suitably engraved by The Institute, and shall be handed to the successful authors at the annual meeting, or be given to them as soon afterwards as possible.

The Leonard Medal

A gold medal, called "The Leonard Medal," is provided from the annual proceeds of a fund established in 1917 by the late Lieut.-Col. R. W. Leonard, and will be awarded in accordance with the following rules for *papers on mining subjects* presented either to The Canadian Institute of Mining and Metallurgy or to The Engineering Institute of Canada.

(1) Competition for the medal shall be open to those who belong to The Canadian Institute of Mining and Metallurgy or to The Engineering Institute of Canada.

(2) Award shall be made not oftener than once a year, and the medal year shall be the year ended June last previous to the year in which the award is made.

(3) The medal shall be presented at annual meetings of The Engineering Institute of Canada.

(4) A committee of five shall judge the papers entered for competition, all of whom shall be members both of The Canadian Institute of Mining and Metallurgy and The Engineering Institute of Canada, this committee to be appointed by the council of The Engineering Institute of Canada.

(5) All papers presented shall be the work of the author or authors and must not have previously been made public, except as part of the literature of The Canadian Institute of Mining and Metallurgy or The Engineering Institute of Canada.

(6) Should the committee not consider the papers presented in any one year of sufficient merit, no award shall be made, but in the following year, or years, the committee shall have power to award the accumulated medals or to award a second prize in the nature of a silver medal, or a third prize of books to be selected by the committee.

(7) The medal shall be suitably engraved, containing the name of The Engineering Institute of Canada, and the words, "The Leonard Medal" together with the adopted design, and on the reverse side the name of the recipient, the date and any other inscription that may be decided upon by the committee.

The Plummer Medal

A gold medal, called "The Plummer Medal," is provided from the annual proceeds of a fund established in 1917 by J. H. Plummer, D.C.L., and will be awarded according to the following rules for *papers on chemical and metallurgical subjects* presented to The Institute.

(1) Competition for the medal shall be open to those who belong to The Engineering Institute of Canada, and to non-members if their papers have been contributed to The Institute and presented at an Institute or Branch Meeting.

(2) Award shall be made not oftener than once a year, and the medal year shall be the year ended June last previous to the year in which the award is made.

(3) The medal shall be presented at annual meetings of The Engineering Institute of Canada.

(4) A committee of five shall judge the papers entered for competition, all of whom shall be members of The Engineering Institute of Canada, and shall be appointed by the council of The Institute.

(5) All papers presented shall be the work of the author or authors and must not have previously been made public, except as part of the literature of The Engineering Institute of Canada.

(6) Should the committee not consider the papers presented in any one year of sufficient merit, no award shall be made, but in the following year, or years, the committee shall have the power to award the accumulated medals or to award a second prize in the nature of a silver medal, or a third prize of books to be selected by the committee.

(7) The medal shall be suitably engraved, containing the name of The Engineering Institute of Canada, and the words, "The Plummer Medal," together with the adopted design, and on the reverse side the name of the recipient, the date and any other inscription that may be decided upon by the committee.

Prizes to Students and Juniors

(1) Five prizes may be awarded annually for the best papers presented by Students or Juniors of The Institute in the vice-presidential zones of The Institute, as follows:—

The H. N. Ruttan Prize,—
in Zone A—The four western provinces.
The John Galbraith Prize,—
in Zone B—The province of Ontario.
The Phelps Johnson Prize,—
for an English Student or Junior in Zone C—The province of Quebec.
The Ernest Marceau Prize,—
for a French Student or Junior in Zone C—The province of Quebec.
The Martin Murphy Prize,—
in Zone D—The Maritime provinces.

(2) Awards shall only be made if, in the opinion of the examiners for a zone, a paper of sufficient merit has been presented to a branch in that particular zone.

(3) The winner of a prize shall be required to specify such technical books or instruments as he may desire to the total value of approximately twenty-five dollars when suitably bound and printed or engraved, as the case may be.

(4) The award of prizes shall be for the year ending June thirtieth. On that date, each branch secretary shall forward to the examiners for his particular zone all papers presented to his branch by Students and Juniors during the prize year, regardless of whether they have been read before the branch or not.

(5) The prizes shall be awarded only to those who are in good standing as Students or Juniors of The Institute of June thirtieth following the presentation of the paper.

(6) The papers must be the bona fide production of those contributing them and must not have been previously made public or contributed to any other society in whole or in part. It is to be understood, however, that a paper which has won or been considered for a branch prize is nevertheless eligible for The Institute Prize. No paper shall be considered for more than one of the five prizes.

(7) The examiners for each zone shall consist of the vice-president of that zone and two councillors resident in the zone, appointed by council. In the case of Zone C, two groups of examiners shall be appointed under the two vice-presidents, one for the English award and one for the French award. The awards shall be reported to the annual meeting of The Institute next following the prize year, and the prizes presented as soon thereafter as is reasonably possible.

Prizes to University Students

At the Plenary Meeting of Council in September 1930, it was decided to offer annually to each of the eleven important engineering schools in the Dominion a prize to be known as "The Engineering Institute of Canada Prize," for competition among the registered students in the year prior to the graduating year. This offer was cordially accepted by the authorities of the following institutions:—

University of Alberta
University of British Columbia
Ecole Polytechnique, Montreal
University of Manitoba
McGill University
University of New Brunswick
Nova Scotia Technical College
Queen's University
Royal Military College
University of Saskatchewan
University of Toronto.

It was determined that these prizes would be continued for a period of five years, and this offer was renewed in February 1935 for a further five-year period.

It is the desire of council that the method of their award shall be determined by the appropriate authority in each school or university, so that a prize may be given to the student in any department of engineering who has proved himself most deserving, not only in connection with his college work, but also as judged by his activities in the student engineering organization, if any, or in the local branch of a recognized engineering society.

It is not necessary for the recipient to belong to The Institute, and in this respect the prizes are quite distinct from those offered to Students and Juniors of The Institute, or from the prizes which are offered by a number of our branches to the Students attached to them.

It is felt that the establishment of these prizes not only aids deserving students, but assists in developing their interest in engineering societies' work, and in the resulting acquirement and interchange of professional knowledge.

BRANCH NEWS

Borders Cities Branch

C. F. Davison, A.M.E.I.C., Secretary-Treasurer.
F. J. Ryder, S.E.I.C., Branch News Editor.

On Friday, March 20th, 1936, the monthly dinner meeting of the Border Cities Branch of The Institute was held at the Prince Edward hotel. The Branch chairman, T. H. Jenkins, A.M.E.I.C., was the speaker, his paper being "Improvements in Railroad Engineering."

Improvements in Railroad Engineering

One of the big developments in railroading in the last decade has been the introduction of the heavy motive type of engines. The main reason for this was the heavy increase in traffic. One method of overcoming this problem was to double-track the railroad. The alternate method was to increase the length of the train, thereby requiring heavier motive power. The heavier engines were also more economical in hauling pay loads. Some of the noted types were the V.N. 6100 class; G.T.W. 6300 class and there was the Santa Fe 4100 which could haul one hundred and fifty loaded cars at 40 m.p.h.

The heavy locomotives caused high stresses in the rails calling for the introduction of the 100 pounds per yard and then 130 pounds per yard rails. The use of treated ties and tie plates was a further improvement adding to the solidity of the roadbed. Treating the ties increased their life under the heavier loading. The tie plates that are generally used to-day are not satisfactory as they do not prevent wave motion in the rail.

With the introduction of high speed it was found necessary to increase the safety control systems. The automatic block system with the use of the searchlight type of signal has proved very satisfactory. The study of streamlining of trains was due to the awakening speed consciousness of the public. High speeds also called for more and more grade separation projects bringing forth new designs in structures and crib-walls. It was the speaker's opinion that the ulimate in weight has been reached and the present tendency is towards lighter equipment by the use of alloy steels that were not available a decade ago.

The use of the Diesel engine for switching purposes has been found a big improvement also. The air conditioning of equipment for passenger service is now under way and will add to the comfort of travelling.

After a general discussion, H. J. A. Chambers, A.M.E.I.C., moved a hearty vote of thanks, which was endorsed by all those present.

Halifax Branch

R. R. Murray, A.M.E.I.C., Secretary-Treasurer,
C. Scrymgeour, A.M.E.I.C., Branch News Editor.

At the regular monthly meeting of the Halifax Branch of The Institute for March, held at the Nova Scotia Technical College, R. S. Eadie, A.M.E.I.C., chief designer of the Dominion Bridge Company Limited gave a highly instructive and interesting address on "Steel Composite and Concrete Construction" accompanied by lantern illustrations, and with particular reference to the steel work of the New Federal Building now in course of construction at Halifax, N.S.

The meeting was attended by the Halifax members of the Branch as well as a large number of the students of the Nova Scotia Technical College, there being nearly two hundred in attendance.

C. S. Bennett, A.M.E.I.C., chairman of the Halifax Branch, introduced the speaker and at the conclusion of the address a hearty vote of thanks was tendered Mr. Eadie by Dr. Sexton, president of the Nova Scotia Technical College, and Colonel F. W. W. Doane, M.E.I.C.

Hamilton Branch

A. Love, M.E.I.C., Secretary-Treasurer.
A. B. Dove, Jr.E.I.C., Branch News Editor.

Aircraft Development in Europe

Reported by T. S. Glover, A.M.E.I.C.

Canada to England in twenty-four hours—Toronto to Winnipeg for lunch and back in the evening—these possibilities were presented to the Hamilton Branch by Professor T. R. Loudon, M.E.I.C., of Toronto University, at the regular monthly meeting on March 26th, 1936, at McMaster University.

At the outset it was made clear that Great Britain was the real centre of aeronautic activity, despite any appearance to the contrary. Canada was approximately five years behind but was catching up and, with the arrival in 1937 of Imperial Airways in Canada, flying will receive a great impetus in this country. The speaker recounted with amusement how, at one of the first flights in Toronto in 1911, he was called on to be present with two transits in order to measure the height reached by the airplane. Owing to the fact that the machine went a good deal faster and farther than was expected, accurate observations were not possible and the only report that could be made was that the machine went up "pretty high."

In dealing with the subject of research, it was brought out that a great deal of information can be obtained in a small wind tunnel from models but that full scale tunnels and machines are much more reliable. Closely comparable with the full scale tunnel is the compressed air tunnel in which a model operates under a pressure of 25 to 30 atmospheres.

Dealing with commercial flying, Professor Loudon made it clear that this was definitely out of the experimental stage. Some of the details of passenger travel were also described and the importance of accurate meteorological information was emphasized. In this respect Canada is splendidly equipped, having one of the best meteorological services in the world.

The development of the "flying flea" was also described and one was tempted to speculate whether this was to be the "Ford" of the air, to be used by everyone who was physically fit to fly.

At the conclusion of his lecture a vote of thanks was moved by H. Monaghan, President of the Hamilton Aero Club, whose members also attended the lecture.

In his opening remarks, H. B. Stuart, M.E.I.C., who called the meeting to order in the absence of the Branch chairman, made touching reference to the passing of H. U. Hart, M.E.I.C., a highly esteemed member of the Branch and an outstanding electrical engineer. Mr. Hart was a past chairman of the Branch and his loss is felt very keenly.

On the invitation of the chairman, L. W. Gill, M.E.I.C., chairman of the committee of Judges on the Student's contest, made some remarks about the papers and gave some helpful criticism. The papers were all of a high order and reflected great credit on the authors.

The evening concluded with the usual refreshments.

Lethbridge Branch

E. A. Lawrence, S.E.I.C., Secretary-Treasurer.

Some Observation of Railway Rails

The regular meeting of the Lethbridge Branch of The Engineering Institute of Canada was held in the Marquis hotel on Saturday, February 8th, 1936, commencing with a dinner at 6.30 p.m.

Chairman W. L. McKenzie, A.M.E.I.C., presided at the dinner with twenty-eight members and affiliates present. The usual excellent musical programme was enjoyed, consisting of dinner music, vocal solos and community singing.

Following the reading of the minutes of the last preceding meeting, a motion was moved and carried that the Lethbridge Branch express its appreciation of the honour conferred upon J. B. deHart, M.E.I.C., by the award of the Past-Presidents' Prize. Mr. deHart replied fittingly. At this meeting P. M. Sauder, M.E.I.C., was declared elected to hold office as chairman of the Branch for the coming season.

Following a short intermission, Mr. McKenzie called on J. M. Campbell, A.M.E.I.C., to introduce the speaker of the evening, Thomas Lees, M.E.I.C., district engineer for the Canadian Pacific Railway Company, Calgary. The title of Mr. Lees' address was "Some Observation of Railway Rails," and proved most interesting. At the conclusion of Mr. Lees' address discussion was entered into by some of the members, after which a hearty vote of thanks was moved the speaker by C. S. Clendening, A.M.E.I.C., for his very able and interesting address.

Annual Meeting

The annual meeting of the Lethbridge Branch of The Engineering Institute of Canada was held in the Marquis hotel on Saturday, March 14th, at 5 p.m., with about thirty members present. Following the business meeting the members sat down to dinner. The usual excellent musical programme was enjoyed during the luncheon along with vocal solos and community singing following the dinner.

Chairman W. L. McKenzie took the opportunity to welcome the incoming president, P. M. Sauder. Following a short intermission, P. F. Peels, A.M.E.I.C., of the Canadian General Electric Co. Ltd., Calgary, gave an interesting paper on "Electron Tubes and Their Application to Industry," illustrating the paper with a number of slides and motion pictures.

Electron Tubes

The term electron tube usually brings to mind the ordinary radio tube; however, the application is not limited to radio. In the industrial field the various forms of the tube fulfil a variety of uses and perform a multitude of operations, from the delicate detection and control of minute currents to the large tubes used in direct current generation in central power stations. Its development is without doubt the greatest single advance that science has ever made.

The credit for the invention of the electron tube goes to Thomas Edison, who first observed that current was conducted in only one direction when a hot filament, called a cathode, and a cold plate, called an anode, were placed in a vacuum. This is the fundamental principle of our rectifier tubes. The introduction of a third element (or grid) by Dr. Lee DeForest gave a very sensitive current controlling device, the grid acting as a sort of valve for the control of current. It was through the work of Dr. DeForest that the radio tube as we know it today was first developed. Filling the tubes with a gas such as mercury, makes them capable of carrying very large currents, and if instead of using a hot filament a radio-active substance is used to coat the cathode, the tube will deliver a minute current, the amount depending on the intensity of the light impressed upon it, thus giving us the photo-electric or light sensitive tube. The small current delivered by the photo-electric tube may be amplified by other tubes and used to control any desired mechanical apparatus.

For convenience the tubes may be divided into the following classes: Kenotron—vacuum tube with two elements; pliotron—vacuum tube with three elements, that is, a kenotron with the addition of a grid; magnetron—magnetic type of grid control; planotron—a gas filled two element tube; thyratron—a gas filled three element tube; photo-electric or light sensitive tubes; X-ray and cathode ray tubes.

Of these the thyratron and photo-electric tubes are the most important in industry. By the proper control of the voltage on the grid of the thyratron it may be used as a converter of direct current to alternating current or of alternating current to direct current. If used with a suitable transformer it will serve as an excellent voltage regulator.

The photo-electric tube finds its application wherever a change in the intensity of light may be associated with a change in conditions and its uses are innumerable.

The advantages of the electron tube over corresponding mechanical apparatus are: Greater accuracy; saving of space; saving of time; more reliable; less expensive. Thus due to the introduction of the electron tube great changes have been made in certain branches and without doubt a great many more will be seen in the near future.

London Branch

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

The regular monthly meeting was held in the City Hall Auditorium on Thursday, March 26th, 1936, the speaker being Mr. J. S. Milligan of the Pigott Construction Company Ltd., Hamilton.

The New Canadian Home

Jas. E. Ferguson, A.M.E.I.C., chairman of the Branch, called upon Murray Dillon, designing and consulting engineer, to introduce the speaker.

Mr. Milligan, after a few preliminary remarks, said he could not do better than quote from Mr. Pigott's address given before the annual meeting of the Canadian Construction Association held at Hamilton. His address, in part, follows:—

It is estimated that at least $300,000,000 worth of housing needs to be built in Canada to bring the market up to date.

Actual building of these houses depends on credit, low interest, long terms and some change of a physchological nature to start people building again.

A new interest, a new presentation, is needed before any real volume of building develops.

Albert Bemis, an outstanding authority on almost everything pertaining to housing, says, in part, "the existing house structure was mostly developed before the industrial age and grew out of the materials and methods and social standards of the earlier centuries. The structure is physically sound but not well adapted to recent technical advances in materials and applied mechanics. We are clearly putting new wine into old bottles when we implant modern heating, lighting and plumbing into the house structure and architecture of two centuries ago."

Three definite principles have been established:—

1. The structural frame wherein steel or re-inforced concrete takes the place of masonry.
2. Fireproof construction, whereby concrete, gypsum, tile and other incombustible materials replaces the fire hazards of wood, etc.
3. Controlled combustion, temperature control with its attendant problems of insulation and air conditioning.

In large office buildings, hotels, hospitals, etc., those principles are now adopted and are even commonplace, surely they are just as important for home building.

Standardization is important if low costs are to obtain, but standardization must be considered or the houses won't sell. People do not like repetition in the case of their homes.

Following the speaker's address a moving talking picture was exhibited showing the building and construction of a $16,000 house recently built by the Pigott Construction Company. The materials used were chiefly steel frame, steel open framework joists, concrete and gypsum with cork slab insulation 3 inches thick. A small amount of wood was also used for doors, window frames and nailing strips. The house was equipped with gas heating thermostatically controlled, stove, kitchen equipment, metal sink and drainer, cupboards, mechanical refrigerator, etc., air conditioning machinery, water softener and all modern appliances. The house was built in three and a half months.

Mr. Tuft of the London Life Insurance Company was then introduced by S. W. Archibald, A.M.E.I.C., and gave a description of the provisions and conditions of the new Dominion Government Housing Loan Act for which $10,000,000 has been set aside and $800,000 of which has already been issued.

Mr. Tuft's address can best be illustrated by a concrete example. If a $5,000 house, including lot, is required, $1,000 or 20 per cent must be put up in cash by the owner, the remaining 80 per cent is split, and 60 per cent advanced by a lending company and 20 per cent by the government. Five per cent interest over ten years with provisions for renewal up to twenty years. Monthly payment for ten years, applied to reduction of capital and 5 per cent interest $26.42, also 1/12 of the taxes to be paid which would vary, an average would be say $15, amounting to $41.42 monthly.

All plans, etc., are submitted to the government for approval and they issue the specifications, which are rather elaborate for small houses.

A vote of thanks to the speakers was proposed by E. V. Buchanan, M.E.I.C., seconded by J. R. Rostron, A.M.E.I.C., and carried unanimously.

Sixty-five members and visitors were present, amongst the latter being a number of architects and builders.

Montreal Branch

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

Junior Section

On March 23rd, 1936, Mr. Gordon Cape, welding supervisor with the Dominion Bridge Company Limited, addressed the Junior Section on "Shop Procedure with Relation to Distortion Control." This paper was a sequel to a talk given to the Junior Section by the author last year, and which created considerable interest at the time. L. Jehu, S.E.I.C., was chairman.

The St. Lawrence River Water Levels Problem

J. L. Busfield, M.E.I.C., managing director, Gardner Engines (Eastern Canada) Limited, presented an exceptionally interesting paper before a well attended meeting of the Branch, dealing with the "St. Lawrence River Water Levels Problem," in which he dealt with the past history of the St. Lawrence ship channel, the effects of dredging, the causes of the lowering of water levels and possible remedial measures. Considerable discussion ensued. C. C. Lindsay, A.M.E.I.C., was in the chair.

Why Pay Taxes?

At a meeting of the Branch held on April 2nd, H. Carl Goldenberg, M.A., B.C.L., sessional lecturer in economics in the engineering faculty of McGill University, and a member of the law firm of Jacobs, Phillips and Sperber, addressed the Branch, his subject being "Why Pay Taxes?" The speaker made special reference to municipal taxation and its effect on home ownership and construction. Professor R. de L. French, M.E.I.C., was chairman.

Junior Section

On April 6th, Leo Roy, S.E.I.C., presented a paper before the Junior Section on "Home Air Conditioning." Mr. Roy, who is with the power sales division, commercial and distribution department of the Shawinigan Water and Power Company, Montreal, treated his subject under five headings as follows: (1) effect on health; (2) heating, (3) humidifying, (4) cooling, and (5) reverse refrigeration. Mr. W. F. Mainguy presided.

British Voltage Regulating Transformers

Mr. R. J. Spencer Phillips, of the Bepco Engineering staff, on April 9th, spoke on the subject of "British Voltage Regulating Transformers." Mr. Phillips first discussed the fundamental principles involved, and then went on to describe and illustrate with slides the various methods at present used for maintaining a constant voltage on a.c. networks such as exist in any large city. R. E. Heartz, M.E.I.C., was in the chair.

Economical Production of Steam and Power from Anthracite Screenings

At a meeting of the Branch held on April 16th, J. R. Groundwater, of the Bruck Silk Mills at Cowansville, Que., presented a paper on the "Economical Production of Steam and Power from Anthracite Screenings," being the results of his recent work on the satisfactory combustion of anthracite screenings. It was felt that the extraordinary conclusions reached in the mill as the result of purely logical development would be encouraging to other engineers in applying the resources of modern steam engineering to the specific problems of the industrial plant. The paper was illustrated with slides. P. W. MacFarlane was in the chair.

Note: Advance copies of the papers presented by Messrs. J. L. Busfield and R. J. Spencer Phillips are available upon request at Headquarters, 2050 Mansfield Street, Montreal.

Niagara Peninsula Branch

P. A. Dewey, A.M.E.I.C., Secretary-Treasurer.
C. G. Moon, A.M.E.I.C., Branch News Editor.

The Branch held an open dinner meeting on the night of April 15th, 1936, at the Welland House in St. Catharines, with Mr. C. A. Cline of Hamilton as the principal speaker. The meeting was well attended by representatives from various public or semi-public bodies and by members of the press. Mayor Morrison and city engineer W. L. McFaul, M.E.I.C., of Hamilton, Mayor Westwood of St. Catharines, and other speakers touched upon the subject under discussion and indicated their interest therein.

A Niagara Free Port

Mr. Cline commenced by defining a free port as "a segregated area in which goods, not otherwise prohibited, may be unloaded and stored, subject to varying restrictions as to storing, grading, repacking, manipulation and manufacturing, and in which such goods or authorized manufactures therefrom may be reloaded and shipped to foreign destinations, all without the imposition of the customs formalities and duties applicable to similar goods entering customs territory."

In the speaker's opinion, the area between the Welland Ship canal and the United States border would form an ideal situation for such a port. It is centrally located with respect to the largest manufacturing districts in both Canada and the United States. Imported goods could be brought in from the Atlantic ports by rail during the winter and directly from the country of origin by vessel during the navigation season. Manufacturers would have an easily accessible place to visit for the inspection, selection and purchase of such commodities as they might want and no duty would be paid until such goods moved out of the area or were consumed by the local industries.

Shipping on the upper lakes should benefit from the location of a free port at such a point because west-bound cargoes would be available. Importers could bring in cargo lots at a minimum shipping charge because the tramp steamers would have a good prospect of a turn-around cargo of grain or flour to be picked up either at Niagara or lower down the St. Lawrence. The load-factor is the important point in this connection and will have to be given careful study but all prior investigations have indicated that it would prove favourable and that return cargoes would be available in the great majority of cases, particularly if the grain trade improves.

There is no question of such an area not remaining a part of Canada as national, provincial and municipal jurisdiction remain as at present. The customs frontier only is affected. Immigration and all other dispositions are unchanged. Existing manufacturers and business of all kinds within the area enjoy their present facilities unimpaired. They benefit to the extent of a larger market and lower transportation charges. Such a port has recently been established in New York harbour.

A lengthy discussion followed this address and many questions were put to the speaker. A. W. F. McQueen, A.M.E.I.C., then proposed a vote of thanks and the meeting was adjourned by vice-chairman George H. Wood, A.M.E.I.C., who presided.

Ottawa Branch

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

Social Credit and the Engineering Profession

Norman Jaques, federal representative for the electoral district of Wetaskiwin, addressed the Ottawa Branch at the noon luncheon on March 26th, 1936, on the subject "Social Credit as it Relates to the Engineering Profession."

E. Viens, M.E.I.C., chairman of the local Branch, was in the chair. Head table guests in addition to the chairman and the speaker included: J. A. Marshall, M.P., V. Quelch, M.P., C. A. Bowman, A.M.E.I.C., J. B. Hunter, A. E. MacRae, A.M.E.I.C., R. F. Howard, M.E.I.C., C. M. Pitts, A.M.E.I.C., B. F. Haanel, M.E.I.C., Alex C. Smith and A. K. Hay, A.M.E.I.C.

Up to approximately two hundred years ago, stated Mr. Jaques, conditions were more or less static and production was stable, depending almost entirely upon human effort. Money itself was stable being mostly in the form of currency issued under the prerogative of the Crown. Today, by the use of machinery largely developed by the engineer, production can be expanded to any desired amount and is no longer so dependent upon human effort. We have also discovered the powers of credit, one result from these changes being the creation of real unemployment which, however, he characterized rather as a symptom than a disease. He likened present-day efforts to cure it to an attempt to cure a patient of the smallpox by sending him to a beauty parlour to have his rash treated.

The speaker differentiated between permanent unemployment caused by the introduction of machinery and advanced methods and processes of manufacture, and artificial unemployment caused by a lack of sufficient money in the people's pockets to purchase what had been produced. Social credit did not regard unemployment as an evil and believed that a good standard of living could be maintained for all. It also believed that the money system could be so adapted that we could consume to the limits of our desires or our powers to produce—whichever eventuated first. Social credit also denied that the object of industry was merely to provide working men with wages, but the object was rather to provide and distribute a maximum of goods and services with the least possible amount of work.

Our present financial system grew up in an age of scarcity, he maintained, and will not properly function in an age of plenty. He urged his listeners to forget their old ideas and to look at conditions from an engineering standpoint. Anything worthwhile which is physically possible should be made financially possible. As it is now, the ruling tendency of the financier is to make physically possible only those things which are financially desirable.

Soil Drifting

Dr. E. S. Archibald, director of the Dominion Experimental Farms, spoke at the noon luncheon on March 12th on the subject of "Soil Drifting." He was introduced by E. Viens, M.E.I.C., chairman of the Ottawa Branch, and head table guests in addition were: M. J. Coldwell, M.P.; D. D. Gray, superintendent of the Central Experimental Farm; Dr. E. S. Hopkins, Dominion Field Husbandman; Dr. Charles Camsell, M.E.I.C.; Dr. R. W. Boyle, M.E.I.C.; C. P. Edwards, A.M.E.I.C.; A. K. Hay, A.M.E.I.C.; C. M. Pitts, A.M.E.I.C.; J. M. Wardle, M.E.I.C.; F. H. Peters, M.E.I.C.; John McLeish, A.M.E.I.C.; and L. L. Bolton, M.E.I.C.

Dr. Archibald stated that the major aspect in the control of the drought problem was in field husbandry. "Great as has been the courage of the farmers that have been affected by these drought conditions during the past few years," he maintained, "the rebuilding of the west will depend more upon scientific methods than upon the courage of the men affected."

Various indictments has been made against the west, prominent amongst which was the charge that western soils were becoming worn out from the standpoint of profitable wheat production, as evidenced by the heavy soil drifting in certain areas during the seasons 1932, 1933 and 1934. Dr. Archibald dealt with these indictments in turn, paying particular attention to the aspect of soil drifting.

Peterborough Branch

W. T. Fanjoy, A.M.E.I.C., Secretary-Treasurer.
E. J. Davies, A.M.E.I.C., Branch News Editor.

Mining Industry

At the meeting on March 12th, 1936, Mr. G. C. Monture, editor-in-chief of publications in the Federal Mines Branch, Ottawa, gave an interesting address on the recent developments in the methods of modern mining. He stressed particularly the close co-operation afforded mining engineers by the other branches of engineering which has made possible many advances in the past thirty years.

Although little change in the fundamentals of mining have been evident, the development in the direction of deeper mining is notable. The advance to deep mining had its beginning little more than ten years ago as far as Canada is concerned. In 1925 the deepest level at Kirkland Lake was 1,500 feet, while to-day a depth of 6,000 feet is being worked at the Teck Hughes property. Hollinger is now at a depth of 5,000 and, in all, more than ten mines in Canada are below the 3,000-foot level.

There is every indication that the ore bodies in the Porcupine and Kirkland Lake fields continue to at least a depth of 10,000 feet. Below 5,000 feet difficult problems appear, particularly the problem of increasing temperatures. It is estimated, for instance, that the temperature at Kirkland Lake at 10,000 feet will be 104 degrees F. Efforts to meet this problem are being made at the Rand Mines in South Africa, where the depth is approaching 10,000 feet. Developments in ventilation and cooling have grown from this necessity.

Mr. Monture spoke of an important angle of development in mining which has led to improved living conditions for miners. Much greater attention is being paid to safety, to recreation provisions and to educational efforts to-day. He dealt also with the great part played by the airplane.

Development in the mechanics of mining centres to a large extent on the remarkable improvement in the miner's principal tool—the pneumatic drill. Thanks to the strong, light alloys of steel produced by the metallurgist, the compressed air rock drill has been improved greatly in efficiency and durability. While the rock drill of 1912 penetrated between 5 and 7 inches of granite per minute, the drill of 1932 penetrated 22 inches.

A feature of the address was the presentation of a five-reel film, "Noranda Enterprise." Dealing with the Noranda mines, the film illustrated a large-scale mining endeavour from the prospect through to produced metal.

Quebec Branch

Jules Joyal, M.E.I.C., Secretary-Treasurer.

Trois Conférences

Lundi, le 30 mars dernier, la section de Québec de l'Institut des Ingénieurs du Canada tenait, au Château Frontenac, une réunion générale de ses membres.

Cette soirée qui avait été spécialement organisée pour mettre en vedette le groupe de nos jeunes ingénieurs fut véritablement un succès et l'assistance nombreuse a eu, une fois de plus, l'occasion de passer une soirée agréable et instructive.

Les conférenciers au programme étaient MM. J. H. A. Laplante, S.E.I.C. et J. H. Thériault, I.C., du Ministère de la Voirie puis M. Maurice Archambault, I.C., du Ministère des Mines.

Le fauteuil présidentiel était occupé par M. Alex. Larivière, M.E.I.C., président de notre section, et c'est lui qui présenta chacun des conférenciers à l'auditoire.

Le Revêtement Économique des Chaussées

Ce sujet qui fut brièvement traité par M. J. H. A. Laplante constitue un problème qui a toujours retenu l'attention des ingénieurs intéressés aux questions de voirie. En même temps que le perfectionnement rapide de l'automobile et l'accroissement formidable du nombre des véhicules moteurs réclamaient des routes plus nombreuses et plus larges, aux tracés et profils plus parfaits, s'imposait la nécessité de pavages unis et durables, pouvant permettre une circulation rapide, supporter l'usure et les charges, puis apporter toutes les garanties possibles de sécurité.

Il est généralement admis qu'il existe plusieurs formes de pavages capables de satisfaire les usagers les plus exigents, mais ces pavages sont généralement très dispendieux et il n'y a qu'un faible pourcentage de notre réseau routier où le trafic est assez intense pour légitimer leur application: par exemple aux sorties des grandes agglomérations et sur les grandes artères de première importance.

Depuis quelques années le problème des revêtements économiques a reçu une grande part de l'attention des ingénieurs et des développements considérables ont été réalisés tant dans le domaine des matériaux que dans celui des méthodes et de l'outillage pour la construction de ces revêtements.

Le conférencier fit une revue des procédés en usage pour la construction des revêtements économiques qui sont presque tous à base de bitume et qui, pour être bons doivent être stables, imperméables et durables: ces qualités, le pavage doit les emprunter aux deux seuls ingrédients dont il est formé, à savoir: le bitume et les agrégats ou matériaux inertes.

L'orateur parle ensuite du traitement des sols à l'huile asphaltiques, des tapis bitumineux, des mélanges sur place, des mélanges faits à l'usine, et donne un aperçu général des procédés suivis dans chaque cas; M. Laplante conclut en disant: "Tous ces procédés souffrent des variantes d'une place à l'autre. L'ingénieur doit faire un choix judicieux, comme il doit aussi user de jugement, quand il s'agit de déterminer quel genre de pavage il doit employer; il faut bien étudier les préoccupations très souvent antagonistes de prix et de qualité."

Un vote de remerciements à l'adresse des trois conférences fut proposé par M. Ludger Gagnon, A.M.E.I.C., secondé par M. E. D. Gray-Donald, A.M.E.I.C., et adopté aux applaudissements de l'assistance.

Des extraits des conférences de MM. Archambault et Thériault seront publiés plus tard.

Sault Ste. Marie Branch

N. C. Cowie, Jr.E.I.C., Secretary-Treasurer.

The March meeting for members and guests of the Sault Ste. Marie Branch was held at the Windsor hotel, Sault Ste. Marie, on Friday, March 6th, 1936.

Thirty-one members and guests were present at the dinner which commenced at 6.45 o'clock p.m.

J. L. Lang, M.E.I.C., chairman of the Branch, being absent from the city, the Branch vice-chairman, Wm. Seymour, M.E.I.C., presided at the business meeting which was called to order at 8.00 p.m.

Several items of business including the minutes of the last meeting, the presentation of the auditors' report by A. Russell, A.M.E.I.C., and the passing of outstanding bills were first considered by the meeting.

AERONAUTICAL DEVELOPMENT AND AERONAUTICAL DESIGN

Mr. Seymour then introduced the speaker, Mr. Geo. Ponsford, Director of the Province of Ontario Air Service, who spoke on "Aeronautical Development and Aeronautical Design," briefly and clearly tracing the development of aeronautical activities from the days of the Wright Brothers' epoch-making flights. The speaker then clearly defined many of the common terms used by aeronautical engineers in the study and design of heavier than air craft. A brief discussion of fuels, instruments and the use of radio in the aeroplane followed.

Following this interesting talk, those present at the meeting accepted Mr. Ponsford's invitation to visit the local Air Service aerodrome. A most interesting hour was spent inspecting two new planes in the process of construction and in studying the methods of checking and overhauling aircraft instruments.

The hearty appreciation of all present was tendered Mr. Ponsford for his interesting paper and hospitality by J. H. Jenkinson, A.M.E.I.C., seconded by E. M. MacQuarrie, A.M.E.I.C.

Vancouver Branch

T. V. Berry, A.M.E.I.C., Secretary-Treasurer.
J. B. Barclay, A.M.E.I.C., Branch News Editor.

The Vancouver Branch of The Engineering Institute of Canada met on April 15th, 1936, at a dinner meeting, and was fortunate in having Mr. W. D. McLaren, M.Inst.C.E., M.I.Struct.E., M.I.N.A., consulting engineer, Vancouver, B.C., give an address on the $75,000 San Francisco-Oakland Bay bridge which is to be opened in 1938.

Mr. McLaren spoke with first hand information, having recently visited the site, and was fortunate in having a very fine collection of lantern slides of aerial views, diagrams, and photographs of all parts of the structure and of its details.

The bridge has a total length of 8¼ miles. The West Bay crossing consists of twin suspension spans of 2,310 feet each made of two cables 28¾ inches in diameter. The extreme ends of these cables are anchored to the shore, San Francisco on one side and Yerba Buena Island on the other. The other ends are connected together and a centre pier takes the unbalanced tension from live load and other causes. The main piers are over 500 feet and rise 282 feet above high water. The deepest foundation is 235 feet.

Yerba Island is tunnelled for 540 feet and on the East Bay crossing is a 1,400-foot central span cantilever with anchor arms of 511 feet. The remainder of the bridge has five spans of 509 feet and fourteen spans of 291 feet, connected to the Oakland shore line by viaduct and fill. This bridge claims the distinction of the following features:—

It exceeds in cost all other bridges.

It spans the largest stretch of major navigable water heretofore bridged.

It involves the deepest foundations ever undertaken.

It includes the largest tunnel cross-section yet constructed, and the first major twin suspension bridge.

The bridge will carry six lanes of vehicular traffic on the upper deck, and three lanes of trucks and two street car lines on the lower deck. Traffic estimated is as follows:—

	1937	1943
Automobiles	8 million	10 million
Passengers	16 million	20 million
Street car passengers	35 million	36 million

It is interesting to note the relative rate of increase between automobile passengers and street car passengers.

The speaker stated that he found one of the most impressive features about the project was the thought and consideration that had been given to organization, resulting in the harmonious operation of all branches. Preliminary drilling cost $130,000 and for the water foundation work 25 per cent of the total cost of the piers was spent on plant and equipment.

An interesting discussion followed the address and Mr. McLaren was accorded a hearty vote of thanks.

Winnipeg Branch

J. F. Cunningham, A.M.E.I.C., Secretary-Treasurer.
H. L. Briggs, A.M.E.I.C., Branch News Editor.

The regular Branch meeting on March 19th, 1936, was turned over to the Manitoba Junior Engineer's Association, with President Wallace Walkey in the chair. Two papers were presented.

HARD SURFACING OF HIGHWAYS

Mr. Frank Dempsey described the hard surfacing of highways, as carried out for sections of Manitoba roads in 1935, using an asphaltic gravel material mixed at a central plant.

Plant mix surfacings are more expensive than road mix surfacings, but much better proportioning of materials, better bond between materials, and a harder and more durable road surface result. The hot mix allows high viscosity asphaltic compounds to be used; on the projects in question the viscosity ran as high as 2,500 seconds at 122 degrees.

After careful preparation and forming of the subgrade, a quarter gallon of penetration asphalt per square yard was placed on the roadbed, than a thin layer of roadmix asphalt, which was rolled out with an 8-ton roller. The final surface was a 4 per cent asphalt, plant mixed, applied 4 inches thick and rolled to 3½ inches thick.

The total cost of 41 miles of such construction averaged $7,638 per mile, including several miles of special construction through sandhills.

CREOSOTING

The second paper was presented by Mr. D. C. Brazier, who described the history of wood preservation methods up until the present time. In 1934 there were 120,000,000 gallons of coal tar creosote used on this continent alone. The paper then described the detail of various open tank methods of treating poles and timbers, also the closed tank pressure and vacuum processes which are currently used.

F. W. Alexander, M.E.I.C., moved the vote of thanks to the speakers and to the Junior Engineer's Association for the instructive papers which had been enjoyed by all present.

SEWERS IN TUNNELS

This paper was presented by Mr. Hew M. Scott, superintendent, Nelson River Construction Company, on April 2nd.

Mr. Scott described sewer tunneling methods which he had employed at various times throughout his extensive experience in this type of work.

The ground conditions at Winnipeg, for the 6½ miles of interceptor sewer contracted for by his company, had been almost ideal. A uniform clay, practically no water, and very little gas had been met with in the underground work. No air pressure system was necessary.

In tunnelling for the interceptors, 1,400 feet was the maximum distance selected between shafts. Three shifts were run—monkeyhole, mining, and lining. The progress of each heading was uniformly 12 feet per day. Each lining shift would line the sewer to within 4 feet of the face. Outer forms were unnecessary; the inner forming was done with steel ribs and 3-inch lagging.

In open work at a crossing of the Assiniboine river some springs were encountered in the hardpan. One of these, tapped at 11 feet below river level, proved very troublesome, discharging 1,000 gallons of water per minute.

After the paper, Mr. Scott kindly answered a large number of questions. G. H. Herriott, M.E.I.C., moved the vote of thanks.

N. M. Hall, M.E.I.C., drew attention of the meeting to the honour recently conferred upon Winnipeg Branch chairman G. E. Cole, A.M.E.I.C., on the occasion of his election to the presidency of the Canadian Institute of Mining and Metallurgy at their recent convention.

Preliminary Notice

of Applications for Admission and for Transfer

April 29th, 1936

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, 1936.

R. J. Durley, Secretary.

*The professional requirements are as follows:—

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

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

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

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

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

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

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

FOR ADMISSION

CALDWELL—THEODORE S., of Burks Falls, Ont., Born at Powassan, Ont., Feb. 4th, 1908; Educ., 1928-30, Univ. of Toronto; with the Dept. of Northern Development as follows: 1929-30 (summers), chainman and rodman; 1930-31, instr'man., Bracebridge Bridge; 1931-35, instr'man., chief of party, and 1935 to date, divnl. engr., at Burks Falls, Ont.

References: D. C. Beam, S. W. Hall, D. S. Laidlaw.

CHURCH—CHARLES EDWARD, of 21 Main St. East, Hamilton, Ont., Born at Dublin, Ireland, Sept. 19th, 1897; Educ., 1915-17, Dublin Technical School. Passed London City and Guilds Institute exams., heat engines, machs. and mach. design, Grades 1 and 2, also Board of Technical Education exams., first 3 years; 1914-17, articled engrg. ap'tice, shops and dfting room, William Spence & Son Ltd., Contracting Engrs. and Foundrymen, Dublin; 1918-19, Corporal Instructor on aircraft engines and Cadet Officer, R.A.F. Training Station, Wendover, England; 1921, entered firm of Fetherstonhaugh & Co., Solicitors of Patents, etc., Toronto, Ont.; 1924-28, member of the firm and mgr. of office of Fetherstonhaugh & Co., Buffalo, N.Y.; 1929-34, mgr. of this firm's office in Hamilton, Ont.; 1934 to date, in practice as Patent Solicitor under own name, having acted or acting as patent counsel in close engineering relationship with the following firms: Hamilton Bridge Co. Ltd.; Irving Engrg. Corpn., Buffalo; Johns Conveyor Corpn., Newark, N.J.; Herbert Morris Crane & Hoist Ltd., Niagara Falls; E. P. Muntz, Ltd., Dundas, Ont.; N. Slater Co. Ltd., Hamilton; Spillman Engrg. Corpn., North Tonawanda, N.Y. Admitted to practice as Patent Attorney before U.S. Patent Office and Canadian Patent Office.

References: E. P. Muntz, B. Candlish, W. G. Milne, R. K. Palmer, W. Hollingworth, J. L. Miller, D. Shepherd.

DAVIDSON—CECIL ALEXANDER, of Edmonton, Alta., Born at Glasgow, Scotland, Nov. 23rd, 1889; Educ., 1910-11, Royal Technical Coll. Private tuition; R.P.E. of Alta.; 1917-18, overseas. Lieut., C.E.; 1912-13, contracting; 1913-14, C.P.R. location survey; 1919-21, rodman, dftsman. and foreman on constrn., Dominion Parks; 1921-23, res. engr., Banff-Windermere Highway, Canadian National Parks; 1923-24, constrn. engr., and 1924 to date, Highways Commissioner, Province of Alberta; 1932 to date, Director of Town Planning and Member, Town and Rural Planning Advisory Board.

References: J. M. Wardle, L. C. Charlesworth, J. D. Baker, R. S. L. Wilson, C. A. Robb, H. P. Keith, F. K. Beach.

DEBNEY—PHILIP LAWRENCE, Major, M.M., of Edmonton, Alta., Born at Wimbledon, Surrey, England, July 4th, 1889; Educ., Swansea Grammar School. R.P.E of Alta.; 1912, dftsman., location and constrn., C.N.R. (Goose Lake Line); 1913-14, dftsman., head office, E.D. & B.C. Rly.; 1914-15, res. engr., A. & G.W. Rly.; 1915-19, overseas, C.F.A.; 1919-23, res. engr., L. & N.W. Rly. in charge location, constrn., and operation; 1923-24, constrn. of distribution system, Northwestern Utilities, Edmonton, Alta.; 1925 to date, constrn. engr., City of Edmonton. (1927 to date, registrar, Assn. Prof. Engrs. of Alta.)

References: R. J. Gibb, F. K. Beach, W. R. Mount, J. D. Baker, J. Garrett, P. M. Sauder, C. E. Garnett.

DE STEFANO—FRANK JOSEPH, of 9 Florence St., Copper Cliff, Ont., Born at Copper Cliff, Nov. 23rd, 1909; Educ., B.Sc., Michigan College of Mining and Technology, 1935; with the International Nickel Co., as follows: 1928 (June-Aug.), rodman and chainman; 1928-30, instr'man. on constrn.; 1930-32, asst. field engr., i/c laying out bldg. foundations, machy., etc., pump house constrn. surveys; macadam road constr., town sewer system extensions; asst. in engrg. supervision of constrn. of various bldgs. and complete installn. of all necessary equipment up to time of plant operation; Summers 1933-34, same as above; 1935, dftsman.; 1935-36, designing dftsman., and at present, asst. field engr., responsibilities similar to 1930-32.

References: J. F. Robertson, H. H. Hawkes, W. J. Ripley, C. O. Maddock, F. A. Orange, R. L. Peek.

DUNCAN—CONRAD MUNRO, of 30 Lipton St., Winnipeg, Man., Born at Stonewall, Man., Sept. 18th, 1909; Educ., B.Sc. (C.E.), Univ. of Man., 1932; Summer work; 1927-28, chainman and gen. field work, Dom. Forestry Dept.; 1929-32, rodman and instr'man., Prov. Reclamation Dept.; 1934-36, asst. to engr. in charge of development of townsite of Wasagaming and vicinity, in Riding Mountain National Park, Manitoba.

References: G. H. Herriot, J. N. Finlayson, R. W. McKinnon, W. F. Riddell E. W. M. James, A. E. MacDonald.

GENET—JOHN ERNEST, Major, M.C., of Edmonton, Alta., Born at Brantford, Ont., Oct. 5th, 1891; Educ., Brantford Public and High Schools; 1914-18, overseas, Can. Engrs., Signal Service; 1920-24, Dist. Signal Officer, M.D. No. 2, Toronto; 1924-25, training in wireless and radio communication, Royal Candn. School of Signals, Camp Borden; 1925-30, asst. to the Director of Signals, Ottawa; 1930-32, on exchange to Imperial Army. Commanded No. 1 Coy., 2nd Divn. Signals, Aldershot, England; 1932-35, chief instructor, Royal Candn. School of Signals, Camp Borden; Sept. 1935 to date, Officer in charge, Northwest Territories and Yukon Radio System, West Edmonton, Alta.

References: J. D. Baker, C. M. Benett, J. L. H. Bogart, H. C. Craig, C. S. L. Hertzberg, W. L. Laurie.

HEROLD—WILLIAM HENRY, of 116 Forest Ave., St. Thomas, Ont., Born at Toronto, Ont., Mar. 21st, 1897; Educ., B.A.Sc., Univ. of Toronto, 1921; 1917-18, Cadet and Pilot, R.A.F.; 1920, ap'tice helper, C.N.R. shops, Stratford, Ont.; 1922, research dept., industrial section, Consumers Gas Co., Toronto; 1925 (summer), supervising installn. water and distributing system, Forest, Ont.; 1927-30, teacher, shop, maths. and dfting., Guelph Vocational School; 1930 to date, head of dept. of dfting., and at present head of dept. of mech'l. drawing, Vocational School, St. Thomas, Ont.

References: W. C. Miller, F. A. Bell, J. A. Vance, R. W. Angus, C. R. Young, W. J. Smither.

HURST—ALBERT DOUGLAS, of Gravenhurst, Ont., Born at Gravesend, England, Dec. 28th, 1885; Educ., Private study in bldg. constrn.; 1897-1900, Gravesend School of Science; 1900-04, ap'tice, H. Waterman, contractor; 1904-05, improver, H. H. Carter Co., contractor, Grays, Essex; 1905-06, Wm. Gray Construction Co., London, England; 1906-08, supt. for Robbins Ltd., Hamilton, Ont., and 1908-10, their successors, Crompton & Crompton, on erection of homes; 1910 to date, on mech'l. staff, National Sanitarium Association, Gravenhurst, Ontario, last twenty years as general foreman. (Applying for admission as an Affiliate of The Institute.)

References: L. G. McNeice, J. Walker, D. C. M. Hume, W. P. Dale, C. Connell, H. M. Cawthra-Elliot.

JAMES—WILLIAM ALBERT, of 4547 Draper Ave., Montreal, Que., Born at Montreal, Aug. 4th, 1901; B.Sc. (C.E.), McGill Univ., 1927. One year, Mass. Inst. Tech.; 1923-24, asst. to res. engr. for H. S. Taylor & Co., on E. B. Eddy Co. paper mill; 1928-30, cons. engr., Royal York Hotel, and 1930, asst. supt., C.P.R. high level terminals, for Anglin Norcross Ltd.; With the Imperial Tobacco Co. of Canada Ltd.,

as follows: 1927, i/c of constrn. at Leamington, Ont.; 1930-31, i/c of constrn. at Delhi, Ont.; 1931-33, factory engr., Montreal; 1933-35, factory engr., Granby, Que.; 1935, to date, gen. engrg. office, Montreal, Que.
References: N. C. Cameron, J. T. R. Steeves, R. E. Jamieson, B. R. Perry, H. S. Taylor, E. V. Gage.

MacKINNON—CHARLES ERIC, of 809-4th St. West, Calgary, Alta., Born at Cranbrook, B.C., Sept. 27th, 1903; Educ., B.A.Sc., Univ. of Toronto, 1928. R.P.E. of B.C.; 1916-23, ap'tice training, Cranbrook foundry, Cranbrook, B.C.; 1927 (summer), H.E.P.C. of Ontario, mtce. and repair dept., Toronto; With the Cons. Mining and Smelting Co. Ltd., as follows: 1926 (summer), at Sullivan Mill, and 1928-31, asst. to master mechanic, at Sullivan Mill, Kimberley, B.C.; 1931-33, field engrg. staff (mech'l), at Calgary, Alta. in charge operations in Sask.; 1933-34, test engr. (mech.), Sullivan Mill; June 1934 to date, asst. designer and production engr. of fertilizer application machinery, Calgary, Alta.
References: A. Dickson, R. S. Trowsdale, H. J. McLean, G. H. Morton, E. A. Wheatley.

MALONE—WILLIAM HARCOURT, of Temiskaming, Que., Born at Montreal, Que., Jan. 18th, 1898; Educ., B.Sc., McGill Univ., 1923; 1918-20, dftsman. ap'tice, Canadian Vickers Ltd.; 1923-24, shop clerk, Dominion Engrg. Works; 1924-25, dftsman. Canadian Vickers Ltd.; 1925-26, instr'man., Aluminum Co. of Canada, Arvida, Que.; 1926-27, factory mgr., Malone Moulding and Framing Co. Ltd., Montreal; 1927-28, topog'r. and dftsman., also instr'man., C.P.R.; 1928-29, mill mtce. dftsman., Spruce Falls Power and Paper Co. Ltd., Kapuskasing, Ont.; 1929-32, mill mtce. dftsman., Can. International Paper Co., Temiskaming, Que.; 1932-33, temporary employment; 1933 to date, mill mtce. dftsman., Can. International Paper Co., Temiskaming, Que.
References: A. K. Grimmer, B. Grav, J. G. MacLaurin, W. R. Hughson, J. J. Freeland.

MICKELSON, ANDREW JULIUS, of 39 Ray Blvd., Port Arthur, Ont., Born at Port Arthur, Dec. 14th, 1904; Educ., B.Sc. (C.E.), 1926, C.E., 1932, Tri-State College of Engrg., Angola, Indiana; 1922-23, rodman, and 1926-28, instr'man and dftsman on constrn., Provincial Paper Mills, Port Arthur; 1928-31 (3½ years), concrete design on grain elevators, Barnett McQueen Constrn. Co., Fort William, Ont.; 1934-35, instr'man. and asst. to res. engr. on highway location and constrn., Dept. Northern Development, Thunder Bay District; 1935 (temp.), junior engr., Dept. Public Works, Canada, Fort William; Jan. 1936 to date, designing and checking reinforced concrete, C. D. Howe & Co. Ltd., Consltg. Engrs., Port Arthur, Ont.
References: H. M. Lewis, P. E. Doncaster, J. M. Fleming, G. R. McLennan, J. Antonisen, H. Os.

PHIPPS—HENRY ROBERT, of Mobert, Ont., Born at Winnipeg, Man., Nov. 7th, 1882; Educ., St. Johns College, Winnipeg; 1903-06, chainman and leveller, C.P.R.; 1906-08, transitman, C.P.R.; 1908-11, res. engr., Transcontinental; 1911-12, location engr., B.C. Electric; 1912-15, res. engr., C.P.R.; 1915-16, asst. supt., Drainage Tunnel, Park City, Utah; 1916-19, Overseas, Rly. Troops. Major, M.C.; 1919-20, salesman, Denver Rock Drill Co.; 1920-29, mgr., Whittall Can Co. Ltd., Toronto; 1929-31, mgr., Watson Jack Co., Toronto; With Dept. of Northern Development of Ontario, as follows: 1932-33, camp. supt., 1933-34, res. engr., 1934-35, locating engr., and 1935 to date, divn. engr., Mobert, Ont.
References: T. S. Armstrong, T. F. Francis, W. J. Bishop, T. C. Macnabb, W. A. Mather, H. A. Lumsden.

RICHARDSON—EDWARD WILLIAM, of Wells, B.C., Born at Vancouver, B.C., Sept. 14th, 1909; Educ., B.A.Sc., Univ. of B.C., 1932. R.P.E. of B.C.; 1930-32, with Greater Vancouver Water Board on summer surveys, dfting and instrument work; 1932-35, gen. engrg. and surveying work (B.C. Land Surveyor); 1935 to date, engr. for the Wells Townsite Co. and the Cariboo Gold Quartz Mining Co., Wells, B.C.
References: J. Robertson, P. Sandwell, P. H. Buchan, E. A. Wheatley, A. S. Wootton.

SISSON—HEBER PERCIVAL, of 11 Crown St., Port Arthur, Ont., Born at Bethany, Ont. Dec. 20th, 1883; Educ., 2nd Class Ontario Teacher. I.C.S. Highway Engrg.; 1908-22, overseer in charge of roads and bridges; 1922-24, in full charge of bridge work for Ontario Dept. of Public Works, Thunder Bay District; 1924 to date, inspector of roads and bridges, Districts of Port Arthur and Fort William, Dept. of Northern Development.
References: O. O. Flanagan, C. E. Sisson, G. R. Duncan, C. B. Symes, H. G. O'Leary, P. E. Doncaster.

VERSCHOLYE, PATRICK DONNITHORNE, of Rogate, Petersfield, Hants, England., Born at Rogate, Oct. 4th, 1912; Educ., B.Sc. (Chem.), McGill Univ., 1935; 1931, 1933 and 1934 (summers), With Price Bros. & Co. Ltd. as asst. in testing lab. and chemical lab., also strength tester; Nov. 1935 to date, training to become asst. to the chief chemical equipment technical manager, Lafarge Aluminous Cement Co. Ltd., Forden Works, West Thurrock, England.
References: G. H. Duggan, E. Brown, J. B. Phillips, J. G. Dodd.

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

FRASER—JOHN PHILIP, of 330 Waverley St., Winnipeg, Man., Born at Hamiota, Man., June 24th, 1893; Educ., B.E.E., Univ. of Man., 1914; 1914-17 and 1919-20, engr. ap'tice, Canadian Westinghouse Company, Hamilton, Ont.; 1920-23, erection work, and 1923-29, designing engr. with same company; 1929-32, elect'l. engr., Northwestern Power Co.; 1933-34, statistical and rates engr., 1934-36, district gen. mgr., and at present, gen. supt., Manitoba Power Commission, Winnipeg, Man. (*A.M. 1929.*)
References: E. V. Caton, J. W. Sanger, N. M. Hall, E. P. Fetherstonhaugh.

FOR TRANSFER FROM THE CLASS OF JUNIOR

HOOPER—WILLIAM HENRY, of 14 MacNaughton Rd., Leaside, Toronto 12, Ont., Born at May, Idaho, U.S.A., Jan. 30th, 1902; Educ., B.Sc. (E.E.), McGill Univ., 1927; 1925-26 (summer and part time), asst. to engr., Ottawa-Montreal Power Co.; 1926 (summer), elec'l. installn., Can. Comstock Co.; 1927-28, test course, Can. Gen. Elec. Co. Ltd.; With the Can. Gen. Elec. Co. Ltd., as follows: 1928, design of direct current machines; 1928-30, design of induction motors; 1930 to date, elect'l. engr., coil dept., Canada Wire and Cable Co. Ltd., Toronto, design and manufacture of all types of coils. (*St. 1928, Jr. 1929.*)
References: B. Ottewell, V. S. Foster, W. E. Ross, A. B. Gates, L. DeW. Magie.

PATTERSON—ELMER GOODWIN, of Westmount, Que., Born at Toronto, Ont., April 16th, 1900; Educ., B.Sc., Queen's Univ., 1924; 1917-23 (summers), rodman, Greater Winnipeg Water District, dftsman., field dftsman. and instr'man., with the C.N.R. and C.P.R.; 1924, dftsman., St. Lawrence Paper Mills; 1925, instr'man., and 1925-27, asst. res. engr., International Paper Co.; 1928, res. engr., International Fibre Board; 1929-34, constrn. engr., and 1935 to date, engr., special products mfg. dept., Northern Electric Co. Ltd., Montreal, Que. (*Jr. 1927.*)
References: A. I. Cunningham, J. H. Brace, J. S. Cameron, H. J. Vennes, W. H. Eastlake.

THOMSON—WILLIAM JOHN, of 858 Burlington St. E., Hamilton, Ont., Born at Orillia, Ont., Oct. 7th, 1902; Educ., B.Sc., Queen's Univ., 1927; 1924-27, summer work with Standard Chemical Co., International Nickel, Canada Electric Castings, and Bethlehem Steel Co.; 1928-29, sampling, surveying and assay lab., Treadwell Yukon Mines, Bradley, Ont.; 1929-30, analysis of raw materials, American Cyanamid, Niagara Falls, Ont.; 1930 to date, chemist, Abrasive Co. of Canada Ltd., Hamilton, Ont., 1932 to date, in charge of technical control. (*Jr. 1931.*)
References: W. Hollingworth, A. Love, E. P. Muntz, E. H. Darling, F. A. Orange.

WALLACE—REGINALD HENDERSON, of Cardinal, Ont., Born at Staten Island, N.Y., Feb. 18th, 1902; Educ., B.Sc. (Mech.), McGill Univ., 1926; 1920 (summer), engrg. helper, 1922-23, dftsman., and 1923-24, instr'man., Kerry & Chace Ltd., Toronto; 1925 (summer), checker, E. G. M. Cape & Co.; 1926-28, foreman in mech'l. dept., Laurentide Paper Co., and 1928 (Aug.-Dec.), dftsman. and instr'man. in engrg. dept., for same company; 1928-29, asst. to supt., and 1929-32, supt., operating control dept., Belgo Mill, Canada Power and Paper Corpn., Shawinigan Falls; 1932-34, engr. in charge of steam and power and the use of steam and power, and Sept. 1934 to date, plant engr., Canada Starch Co. Ltd., Cardinal, Ont. (*St. 1924, Jr. 1929.*)
References: J. H. Hunter, A. S. Fraser, H. E. Bates, E. B. Wardle, W. B. Scott.

FOR TRANSFER FROM THE CLASS OF STUDENT

COSSER—WALTER GEOFFREY, of Schumacher, Ont., Born at Boksburg, Transvaal, Union of South Africa, April 17th, 1908; Educ., B.Sc. (Mech.), McGill Univ., 1930; 1930-31, McIntyre Porcupine Mines Ltd.; 1931-33, McCarthy & Robinson Ltd., sales engr., Kirkland Lake, Ont.; 1933 to date, dftsman., mech. dept., Hollinger Cons. Gold Mines, Ltd., Schumacher, Ont. (*St. 1930.*)
References: H. Idsardi, A. D. Campbell, C. M. McKergow, C. Stenbol, J. R. Bradfield.

FRASER—CAMPBELL, of Port Hope, Ont., Born at Fitch Bay, Que., July 10th, 1909; Educ., B.Sc. (C.E.), Queen's Univ., 1934; Summer 1928, chainman, O.L.S.; 1928-30, rodman, instr'man., chief of party, dam site location, trans. line location, road constrn., Rapide Blanc project, Shaw. Water and Power Co.; 1934-36, Ontario Dept. of Highways, mtce. inspr., and at present, inspr. i/c bridge constrn., Murray Canal. (*St. 1930.*)
References: W. P. Copp, A. A. Smith, W. L. Saunders, W. P. Wilgar, G. R. Rinfret.

GILLETT—GEORGE HERBERT, of 4720 Westmount Blvd., Westmount, Que., Born at Westmount, Jan. 17th, 1902; Educ., B.Sc., McGill Univ., 1924; 1923 (summer), Canadian Car and Foundry Co., Montreal; With the Can. Gen. Elec. Co. Ltd., as follows: 1924-25, test course; 1925-26, industrial control engrg. dept., Peterborough; 1926, transformer engrg. dept., Toronto; 1926-28, preparation of transformer estimates and propositions, Head Office, Toronto; 1928 to date, sales engr., Montreal District Office. (*St. 1924.*)
References: L. deB. McCrady, G. K. McDougall, A. Laurie, S. E. M. Henderson, A. D. Ross, M. S. Macgillivray.

HAWKINS—JAMES EDWARD, of 636-11th St. S., Lethbridge, Alta., Born at Strome, Alta., Oct. 1st, 1908; Educ., B.Sc. (E.E.), Univ. of Alta., 1932; 1928 (summer), trans. line constrn.; 1929 (summer), Ghost River Power Plant constrn., Calgary Power Co.; 1932-33, placer mining, Northern B.C.; 1934 to date, instructor in electricity and mech'l. drawing, Lethbridge Collegiate. In charge of shop courses in all technical work. (*St. 1932.*)
References: W. L. McKenzie, J. T. Watson, P. M. Sauder, H. J. MacLeod, W. Meldrum, J. B. deHart, R. S. L. Wilson.

HOLMES—JOHN RODOLPH, of 11a Querbes Ave., Outremont, Que., Born at Montreal, June 22nd, 1906; Educ., B.Sc. (E.E.), McGill Univ., 1929; 1924-25 (summers), elec. rly. repairs and power house, Montreal Crushed Stone Co.; 1926-27-28 (13 mos. in all); telephone trans. engrg., Bell Telephone Co. of Canada; 1929-30, sales engrg., air compressors, Canadian Ingersoll-Rand Co. Ltd.; 1930 to date, sales engr., Robbins & Myers Co. Ltd., Montreal, in charge of sales of electric motors and generators, in the Prov. of Quebec and Eastern Ontario. Prep. of layouts for industrial plants, recommendations, estimates. (*St. 1929.*)
References: R. H. Mather, J. F. Plow, F. W. Angus, C. V. Christie, O. A. Fogarty, W. R. Bunting, R. Ford, G. Kearney.

ODDLEIFSON—AXEL LEONARD, of 590 Victor St., Winnipeg, Man., Born at Winnipeg, Mar. 15th, 1909; Educ., B.Sc. (E.E.), Univ. of Man., 1931; 1929-30 (summers), dftsman., Hudson Bay Mining and Smelting Co.; 1931 (3 mos.), constrn. helper with Winnipeg Electric Co.; 1932 (3 mos.), elec. journeyman, for San Antonio Mine, Bissett P.O., Man.; 1935 (1 year), labourer on constrn. of power site, Kanuchuan Rapids, Man.; Sept. 1935 to date, elec. helper, Winnipeg Electric Co., Winnipeg, Man. (*St. 1928.*)
References: W. M. Reynolds, E. P. Fetherstonhaugh, L. M. Hovey, C. P. Haltalin, D. M. Stephens.

PARKER—CLARENCE COLLINS, of 84 St. George St., Toronto, Ont., Born at Humber Bay, Ont., Sept. 21st, 1906; Educ., B.A.Sc., 1929, M.A.Sc., 1933, Univ. of Toronto; 1927 (summer), timekpr., Law Constrn. Co., Toronto; 1928 (summer), dftsman., Chapman & Oxley, Toronto; 1929-30, struct'l. detailer and shop foreman, Manitoba Bridge and Iron Works, Winnipeg, also night school instructor in blue print reading, Winnipeg Technical School; 1930-31, struct'l. designer, field engr., James, Proctor & Redfern, Toronto; 1930-32, research asst. and graduate student, Univ. of Toronto; 1934-35, field engr. on bridge constrn., Dept. of Highways of Ontario, Toronto; 1936 to date, bridge designer, Dept. of Northern Development, Toronto, Ont. (*St. 1926.*)
References: R. E. Smythe, E. M. Proctor, C. R. Young, J. M. Oxley, A. A. Smith.

RENOUF—EDWARD T., of Montreal, Que., Born at Montreal, Oct. 22nd, 1899; Educ., B.Sc., McGill Univ., 1923; 1923-25, shops and drifting room, Charles Walmsley (Canada) Ltd.; 1925-27, engr. in charge of Amiesite paving on Quebec Highways, La Société Générale du Pont et Chaussée Ltée; 1927 to date, production manager and editor of technical and scientific books, Renouf Publishing Co., Montreal, Que. (*St. 1923.*)
References: J. H. Hunter, C. M. McKergow, C. K. McLeod, A. S. Rutherford, J. L. E. Price.

SHEARER—JOHN LEABOURNE, of 475 King Edward Ave., Ottawa, Ont., Born at Ottawa, May 17th, 1904; Educ., B.Sc. (C.E.), Queen's Univ., 1928; Summer work: 1922-23, lab. for testing materials, Dept. of Public Works, Ottawa; 1924-25, helper, and recorder on primary triangulation, Geodetic Survey of Canada; 1926, rodman on constrn. of Field-Golden highway, National Parks of Canada; 1927, in charge of section of Jasper-Edmonton highway, National Parks of Canada; 1928 (8 mos.), instr'man. on sewer and waterworks constrn. in Jasper Townsite, National Parks of Canada; 1929 (8 mos.), inspecting engr. for Calgary Power Co. during constrn. of Ghost River hydro-electric development. Inspr. and latterly in charge of concrete inspection and testing; 1929-32, dfting office, sewer and water dept., City Engineer's Office, Vancouver, B.C. Design and estimate of cost of sewers, separate and combined; special structures used in sewer work, investigating pumping areas and design and estimate of cost of sewage pumping installns.; 1933-35, engr. in charge of tunnel sewer constrn., sewer branch, engrg. dept., City of Ottawa, Ont. (*St. 1928.*)
References: W. F. M. Bryce, A. K. Hay, N. B. MacRostie, J. N. Stinson, E. Viens, C. D. Wight.

SOZANSKY—JOHN, of Montreal, Que., Born at Montreal, Feb. 22nd, 1907; Educ., B.Sc. (Elec.), McGill Univ., 1929; With the Otis Fensom Elevator Co. Ltd. as follows: 1926-29 (19 mos.), student training course during college vacations; 1929-30, sales engrg. dept.; 1930-33, sales representative—layouts, design, estimates, surveys and reports for constrn. and service depts. on elevators and hollow metal doors; 1933 (May-Oct.), sales engr. and supt. Alemite systems, Climax Co. Ltd., Montreal; 1933-34, inspr. on materials and sub-assemblies, R.C.A. Victor Co. Ltd., Montreal; 1934-35, sales engrg. on air conditioning, Drying Systems Ltd., Ottawa; 1935 (Feb.-May), design of electric and oil furnaces and other equipment, Ferro-Enameling Co., Ottawa; May 1935 to Mar. 1936, laboratory engr., fire hazard testing lab., National Research Council of Canada, Ottawa; Mar. 1936 to date, with Coca-Cola Co. of Canada, plant engr., in charge of garage for truck fleet. Design of equipment, sales surveys, assting. plant supt. (*St. 1928.*)

References: R. W. Boyle, J. H. Parkin, E. Brown, C. V. Christie, B. G. Ballard, W. J. W. Reid.

WARNOCK—ROBERT NICHOLSON, of Westmount, Que., Born at Westmount, April 19th, 1909; Educ., B.Sc., McGill Univ., 1931; (Grad. R.M.C.); 1931 to date, with Charles Warnock & Co. Ltd., Montreal, 1931-32, office duties, 1932-35, office and inspection work, and at present, inspecting engr. (*St. 1931.*)

References: J. M. R. Fairbairn, J. E. Armstrong, R. B. Jones, C. B. Brown, W. A. Duff.

Canadian Relief Camps

Members will note with interest references which have recently been made in the House of Commons to the way in which the relief camps for single homeless men, established under the Relief Act of 1932, have functioned. Referring to the report of the Special Committee investigating these camps, the appointment of which was one of the first acts of the present government on assuming office, Mr. Grote Stirling, M.E.I.C.* said:—

"...It appears to me that had the Department of National Defence wanted to write a justification of what it had done and a description of how it had been done, they hardly could have done it in fairer language than is contained in this paragraph (of the Committee's Report):—

'The Department of National Defence has built up an organization that has been fair to the men under its charge and efficient in the administration of the various activities in the management of the camps. The work is being carried on in addition to the ordinary departmental duties assisted by a small civilian staff, reflecting a decided saving to the exchequer. It should be pointed out that the staff officials of the Department of National Defence are by training eminently suited to the task of organization work of this character, and in this regard have rendered a distinct service during a most trying time. To brand the camps as military establishments is unfair. In our inspection not the slightest trace of the general conception of military discipline was in evidence. In fact, the officers of the Department of National Defence have leaned backwards in this regard. Not one man was seen in military uniform. Those in the service whose duties carried them into the camp wore civilian clothes. As far as we could observe, the administration is of a non-political character, a factor of vital importance in an undertaking requiring the utmost discretion if serious trouble is to be avoided.'

I am very glad indeed to have this opportunity of paying in a few words public tribute to the officers of the Department of National Defence. They were given work to do that was distinctly not theirs. They did that work excellently. There was no eight-hour day about their work, and they were glad to make that contribution to the general welfare of the people of Canada.

I would add to that another word of commendation of the superintendent staffs who actually came into contact with the men themselves in those camps all over Canada. The men of these staffs were recruited to a general extent through the assistance of The Engineering Institute of Canada and of the engineering associations throughout the provinces. Some few of them had been accustomed to work of this description, construction work, handling men in camps, but the majority of them had not, and had it to learn. There also the work they had to do was not in every case pleasant. It was pleasant handling the camps where the men were appreciative of what the taxpayer of Canada was doing for them and were ready to work, but it was anything but pleasant in those camps into which subversive elements had obtruded, and the difficulties of the superintendent staffs were enormously increased not only by insulting behaviour but in some cases by bodily harm. I myself know of cases where superintendents have taken the younger men in the camps aside and endeavoured to advise them, cautioned them, warned them and have done so effectively. Those superintendents drawn from all over Canada and used all over Canada were men from various walks of life who adapted themselves to this operation and to whom also I consider that a public word of thanks is well due."

*Hansard, April 8th, 1936, page 2079.

A.S.T.M. Meeting

The 1936 annual meeting of the American Society for Testing Materials is to be held in Atlantic City at Chalfonte-Haddon Hall, from June 29th to July 3rd, 1936.

To provide ample time for the presentation of reports, papers and discussion, some twenty sessions are scheduled.

Several outstanding groups of papers are to be given, the most extensive of which are a symposium on X-ray Crystallography and Radiography, and a symposium on limitations of laboratory and service tests in evaluating rubber products.

Papers dealing with various phases of spectographic analysis are on the programme and one session will be devoted entirely to the subject of water for industrial uses, this being sponsored by the Joint Research Committee on Boiler Feed Water Studies. Other technical contributions will cover non-ferrous metals, wire, soils, corrosion, fatigue and effect of temperature on metals and cement and concrete.

List of New and Revised British Standard Specifications

(Issued during January and February, 1936)

B.S.S. No.

15—1936. *Structural Steel for Bridges, etc., and General Building Construction.* (Revision.)
Amendments include removal of the division of the material into A steel and B steel; a reduction in the number of bend tests and an increase in the rolling margin allowed on thin plates and small round or square bars.

598—1936. *Methods for the Sampling and Examination of Bituminous Road Mixtures.*
Provides detailed procedures for the sampling and testing of asphaltic and tarmacadam road mixtures, both before and after laying. It includes all those methods customary in routine testing, and other methods for application where a more detailed study of the road mixtures or of the road surface is required.

657—1936. *Dimensions of Clay Facing and Backing Bricks.*
Specifies the dimensions of ordinary bricks, clay and shale as used for building purposes and provides for three sizes of bricks which differ only in respect of depth.

Copies of the new specifications may be obtained from the Publications Department, British Standards Institution, 28 Victoria Street, London, S.W.1, and from the Canadian Engineering Standards Association, 79 Sussex Street, Ottawa, Ontario.

Canadian Chemical Convention

This convention is a general meeting of the Canadian Chemical Association and the Canadian Institute of Chemistry, and both organizations have drawn up interesting programmes.

The Niagara District Chemical and Industrial Association will act as hosts for the convention which will be held at Niagara Falls, Ontario, on June 9th to 11th, 1936.

Among the principal speakers will be Dr. C. E. K. Mees of the Eastman Kodak Company, Mr. Louis Blake Duff, the eminent historian of the Niagara Falls district, and Dr. Billings of the Hercules Powder Company.

The industrial engineering section is arranging an excellent sectional programme as are also the educational section, the bio-chemical section, the foods and cereals section and the pure chemistry section.

Specification for Fuel Oil

The National Research Council, Ottawa, has recently issued a specification for fuel oil. This applies to hydro-carbon fuel derived from petroleum for use in various types of domestic and industrial oil burner equipment. Copies may be secured from the Council.

Hydro-Electric Progress in Canada in 1935

The annual review of hydro-electric progress in Canada prepared by the Dominion Water Power and Hydrometric Bureau of the Department of the Interior, discloses a substantial addition to the total developed water-power capacity in the Dominion during 1935. New installations aggregating 362,080 h.p. were completed and made ready for operation, thereby bringing the total for the Dominion at the end of the year to a figure of 7,909,115 h.p.

While the increase in generating capacity is noteworthy, of greater significance is the continued growth in power demand that has taken place during 1935. This is reflected by the monthly records compiled by the Dominion Bureau of Statistics which show a substantial increase in the output of central electric stations month by month over the figures for the corresponding months of 1934. For the nine months of 1935 for which records have been compiled there has been a total increase of more than eleven per cent. This increase in power output has not been confined to any one part of the Dominion but is evident from coast to coast.

The new installations in 1935 comprised, chiefly, additions to existing developments such as the Canyon plant of the Ontario government on the Abitibi river and the Beauharnois plant of the Beauharnois Light, Heat and Power Company on the St. Lawrence. Increased activity in the mining industry was responsible for new installations in the Yukon Territory and in British Columbia, Manitoba and Ontario.

Bank Loans and Bank Deposits

During the recent election campaign and of late years in the debates of Parliament the assertion was frequently heard, and no doubt confidently believed by many, that all bank deposits are made by bankers themselves, and that "money" is thus created by mere bookkeeping entries in the ledgers of the chartered banks.

But questionings must undoubtedly have arisen even on the part of the general public who, although not skilled in the technique of banking, nevertheless have a fair grip upon plain, everyday common sense, and are slow to believe that something can be made out of nothing.

The query naturally arises: How have the many exponents of this theory reached a conviction so greatly at variance with fact? Merely by adopting without critical examination the catch-cry, "Bankers create deposits by making loans." From the partial truth embodied in this assertion they jump to the fallacious conclusion that deposits are illusory and can be swollen to any desired amount by the simple process of loaning with or without security.

It is a fact that when a loan is made by a bank to a farmer, a manufacturer or other borrower a credit called a deposit is set up in his favour in the books of the bank. This is to enable him to draw cheques against this deposit, with which he pays for labour and supplies necessary to the operations of his business of creating products, from the sale of which he will repay his bank loan and make his ultimate profit. The proceeds of the credit or deposit so drawn upon find their way back to the bank or other banks by way of individual deposits of those to whom the proceeds of the credit were paid by the borrowers or others with whom they dealt. But the essential point is that against the credit or deposit in his favour the capital of the borrower in question —that is to say, his actual wealth and, if the loan is made for productive purposes, the value of his production during the continuance of the loan—becomes security to the bank for repayment of the loan. If this were not deemed adequate security by the bank the loan and the so-called deposit would never have come into being. Credits, therefore instead of being manufactured out of "blue sky" or by "bookkeeping entries" rest upon the financial worth or capital and business capabilities of borrowers, whose aggregate loans, so secured, are shown on the assets side of the banks' balance sheets.

Another vital feature of banking is also overlooked. When credits are created in favour of customers, whether borrowers or savings depositors, a bank must be always prepared to meet cash demands of depositors and cheques drawn and deposited with other banks against these credits by payment through the daily bank clearings, not in their own notes, but in legal tender which is issued, not by the banks, but by the Bank of Canada. This is the reason why a bank must always keep "liquid" to the extent found necessary under the experience of bankers in the conduct of their business along safe lines. To maintain the requisite degree of liquidity, varying with varying conditions, banks must hold a considerable percentage of their assets (about ten per cent of their liabilities in normal times) in legal tender —that is to say, Bank of Canada notes, or, what is the same thing, deposits with the Bank of Canada. They also hold a much greater percentage of short-date government securities which can be readily converted into legal tender if required. The legal tender yields them no interest and the short-date government securities a very low rate as compared with commercial loans. In addition to these immediately liquid resources, banks carry secondary reserves in longer-date government securities, industrial and other bonds and call loans upon stocks and bonds. The aggregate of credit which banks can safely extend at any given time is thus conditioned by the degree of liquidity which they possess through the holding of legal tender and their secondary reserves.

From the foregoing it will be seen that under a sound system of banking the obligations of banks to their customers must be at all times secured by the financial resources of those who borrow from them, whether producers who require temporary credit pending the creation and marketing of their finished products, or governments in respect of their securities, or borrowers against bonds and stocks.

Credits are not, therefore, manufactured out of nothing, blue-sky or by bookkeeping entries, but against real wealth, which through the technique of banking is rendered liquid to serve the financial needs of the agriculture, industry and commerce of the nation.

—Monthly Commercial Letter, Canadian Bank of Commerce.

"Engineers' Day" in Cleveland, Ohio

The Cleveland Engineering Society, local sections of the national societies and other technical and semi-technical organizations are planning an "Engineers' Day" which will be held at the Great Lakes Exposition on Saturday, July 11th, 1936.

This exposition marks the one hundredth anniversary of the incorporation of the city of Cleveland and the affair will be dedicated to the romance of iron and steel. The opening date of the exposition is Saturday, June 27th, and it will run for one hundred days or until October 4th.

The committee in charge of "Engineers' Day" extends a most cordial invitation to the membership of The Engineering Institute of Canada to attend the exposition more particularly on Engineers' Day.

Modern Trends in Warship Design

It is perhaps not easy to-day to pick out definite tendencies in the development of warship design, but one at least seems to be clearly marked—that is, the tendency towards reduction in the size of battleships. It is true that there are only two battleships in service to-day which were completed since 1921, and those two are the largest afloat, the Nelson and Rodney. But they were built in a hurry, while the admiralties of the world were still in the grip of the theory that each new ship built must be more powerful, and therefore bigger, than the last. That theory had held sway, with hardly an intermission, since the 'sixties of the last century, when wooden ships first began to be replaced by those of iron, and later steel. Up till the end of the 'eighties there was a general agreement in all navies that 10,000 tons was about the maximum displacement of the well-designed battleship. Thereafter dimensions began to grow, following the lead given by the British Navy. By 1894 we were building the Majestic class of battleships of 15,000 tons. Ten years later we had passed to the King Edward VII class of 16,350 tons, to be followed by the Lord Nelson, 16,500 tons. Then began a more rapid increase, heralded by the much-advertised new departure—really a reversion to earlier ideas—of the "all-big-gun" ship, of which the Dreadnought was the first. Her displacement was 17,900 tons, but the later ships of the same type grew to the 22,500 tons of the Orion class, while their guns were increased from the 12-in. calibre, which had been standard for so many years, to 13.5 in. Just before the war we increased again to the 25,750 tons of the Royal Sovereign and 27,500 tons of the Queen Elizabeth classes, and the guns grew once more to 15 in.; while during the war the capital ships laid down—of which only one, the Hood, was completed—were of 42,000 tons. Ships of even greater displacement were projected after the war, and would have been built but for the halt called by the Washington Treaty. The British Navy led the way in this "battle of the building-yards," but it was followed by all others. Now, however, a distinct tendency in the opposite direction is to be noted. Of the battleships under construction for the French Navy, the first two are not of the maximum displacement permissible under the Washington Treaty; they are of no more than 26,500 tons, and armed with 13-in. guns. It is true that they are in one sense an illustration of the "bigger and better" habit, since they were admittedly a reply to the German "pocket battleship" of 10,000 tons, armed with 11-in. guns. The latter cannot be cited as an illustration of the tendency towards diminution which I have quoted, because they were a product of the restrictive clauses of the Treaty of Versailles, and they were not affected by the limitation provisions of the Washington Treaty. But later developments in Germany do illustrate the tendency. When Germany had thrown off the Versailles restrictions, and embarked on the reconstruction of her navy, she did not at once proceed to the full Washington limits; she laid down two battleships which are no more than 26,000 tons, and are to be armed still with 11-in. guns. The third French battleship under construction, and the other yet to be laid down, are to be of 35,000 tons with 15-in. guns. They represent a reversion to the cult of the great ship, but this action seems to have been forced upon France by Italy's action in 1934. Italy, it is true, has now on the stocks two battleships of 35,000 tons. But the circumstances in which the decision to build these two ships was taken in 1934 have not been made public, and from the later action of the Italian government it appears doubtful if it represents the considered judgment of the Italian Naval Staff; for Italy, in the Naval Conference, strongly supported the efforts of the British and French governments in the London Conference to induce the United States to agree to the adoption of limits of battleships much lower than those of Washington, to the length of making the question a pretext for holding up the conclusion of a new naval treaty. Japan, too, has strongly urged drastic reduction in the size of battleships. Though the Japanese delegation quitted the Naval Conference on other grounds before it reached the stage of discussing qualitative limitation in detail, it has since been reported from Tokyo that Japan will be disposed to accept any qualitative limitations upon which the Powers still in the Conference may agree, provided they are not discriminatory against her. There can be little doubt that, but for American insistence upon retaining the high limit of 35,000 tons for battleships, there would to-day have been universal agreement to adopt a much lower limit.—Rear-Admiral H. G. Thursfield to the Institution of Naval Architects reported in *Engineering*.

The Opla Company, structural engineers, P.O. Box 66, East Orange, N.J., are the publishers of a "Civil Engineers' Digest," Number 1 of Volume I of which appeared in April 1935. Digests of recently published articles by such men as Odd Albert, M. G. Spangler, M. A. Drucker, L. K. Oesterling, J. K. Finch, Inge Lyse and M. A. Ravenor, M.E.I.C. are included. It is intended to publish Volume II, containing 24 articles, during 1936. The price is $3.36 per volume, but if two or three volumes are ordered to the same address the prices will be $2.40 and $1.92 respectively.

It is desired to secure for the Library of The Institute, Annual Reports of the Ontario Department of Mines for the years 1894-1904 inclusive. Will any reader possessing these volumes, and willing to dispose of them communicate with Headquarters, 2050 Mansfield Street, Montreal.

EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada

2050 Mansfield Street, Montreal

Situations Vacant

SALES ENGINEER, engineering graduate with four or five years sales experience in heating and ventilating equipment or similar work. In replying give full information as to training and experience. Apply to Box No. 1279-V.

SALES ENGINEER, young man in capacity of sales engineer and department manager for automatic sprinkler contractors. Should have experience in selling and estimating in mechanical equipment for old and new buildings. Knowledge of French preferred. State qualifications and experience. Location Montreal. Apply to Box No. 1291-V.

DESIGNERS, for pulp and paper mill construction. Men experienced in the design and layout of steam plant, sulphite mill, machine, wood, grinder and screen rooms. Apply to Box No. 1309-V.

Situations Wanted

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

ENGINEER AND ACCOUNTANT, JR.E.I.C., (Capt. Can. Engrs., reserve). Age 35, Canadian. Experienced in mechanical and civil engineering, Diploma; general office, draughting and instrument work; assistant engineer erection Royal York hotel; assistant resident engineer T. & N.O. Ry. const. Desires position in Toronto where combination of technical and business experience will be of value, as have been director and accountant last three years. Apply to Box No. 377-W.

ENGINEER, A.M.E.I.C. Age 30. Single. Employed. Civil and mining experience, capable of designing and superintending construction of timber, concrete and steel structures, rock crushing and ore plants. Would consider position with mining or engineering company designing and building mills. Apply to Box No. 431-W.

CIVIL ENGINEER, B.Sc. '25, A.M.E.I.C., P.E.Q., single, experienced in pulp and paper mill construction and hydro-electric developments; also experienced in highway construction and topographical surveying. Available at once, location immaterial. Apply to Box No. 473-W.

MECHANICAL ENGINEER, B.Sc. Age 31. Married. Last ten years includes:—Mechanical structural and reinforced concrete design in pulp and paper mills, industrial plants, hydro-electric, mine, sewers and sewage disposal plant construction. My experience also includes shop production, steam plant combustion, fuel analysing, inspecting, supervising and instrument work on industrial construction. Permanent position preferred. Apply to Box No. 521-W.

CONSTRUCTION ENGINEER, age 26, unmarried, graduate C.E. Experience includes hydro-electric, railroad, highway, and industrial plant construction, both field and office, including cost accounting, estimating, stores, layout, general engineering and supervision, as well as practical work in mechanical trades. Apply to Box No. 567-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aerophotographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

Situations Wanted

ELECTRICAL ENGINEER, McGill '31, desires permanent position in engineering field. Experience includes draughting, designing and testing of induction motors, radio supervision and test, and some construction. Available immediately. Apply to Box No. 626-W.

ELECTRICAL ENGINEER, B.Sc., 1926. One year maintenance, one year operating, large hydro-electric plant. Five years hydro-electric construction, as wireman and foreman, on relay, metal, and remote control installations. Also conduit and switches. Three years maintenance electrician, in pulp and paper mill. Also small power system. Desires position of responsibility. Sober, reliable and not afraid of work. Available at once. Excellent references. Apply to Box No. 636-W.

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office experience including general design and plant layout. Also two years general shop work including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer, estimator. Available on short notice. Apply to Box No. 676-W.

ELECTRICAL AND RADIO ENGINEER, B.Sc. '30. Variously engaged on receiver development work, testing, and transformer development, under direction. More recent experience includes transmitter test room procedure and short wave beam transmission engineering. For further information apply to Box No. 680-W.

Employment Service Bureau

This bureau is maintained by The Engineering Institute of Canada for the benefit of members and organizations employing technically trained men.

An enquiry addressed to 2050 Mansfield Street, Montreal, will bring full information concerning the services offered. Details can also be obtained from Branch secretaries who are located in the larger centres throughout Canada.

Brief announcements of men available and positions vacant will be published without charge in The Engineering Journal and the Bulletin. Replies addressed in care of the required box number will be forwarded to the advertiser without delay.

An additional service also offered those who are unemployed or wish to change their positions, is the opportunity of placing their names and records on file at 2050 Mansfield Street for consideration by employers wishing to employ engineers. This is of great assistance as many employers will not advertise or wish to locate a suitable man on short notice. If desired the information contained in these records can be kept confidential.

Forms for registration purposes may be obtained from The Institute Headquarters or Branch secretaries.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.Sc. Elec. '29, B.Sc. Civil '33. JR.E.I.C. Age 29. Experience includes four months with Can. Gen. Elec. Co., approximately three years in engineering office of large electrical manufacturing company in Montreal, the last six months of which was spent as commercial engineer. For the last year and a half employed in electrical repair shop. Best of references. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.Sc., '27, JR.E.I.C. Four years maintenance of high speed Diesel engine units, 200 to 1,300 h.p. Also maintenance of d.c. and a.c. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

Situations Wanted

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.Sc. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER, M.Sc., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering. Read, write and talk French. Married. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

RADIO AND ELECTRICAL ENGINEER, B.Sc., '31, JR.E.I.C. Single. Age 29. One year and a half actual field experience in power and lighting equipment. Extensive work in telephone and radio layouts in switchboard and installation depts. Particularly interested and experienced in sales and traffic work in telephone and radio company. At present supervisor over sales and service of radio and electrical company. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, B.Sc. '29, A.M.E.I.C. Married. One year building construction. One year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

MANAFACTURERS' REPRESENTATIVE, at present doing business with leading industrial organizations in Canada, wishes to represent manufacturers of mechanical equipment. Such work as would involve technical data, and the preparation of plans where necessary, would be handled by an engineer whose experience with outstanding firms and projects, would be valuable to those seeking representation. Apply to Box No. 764-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

PLANT ENGINEER or SUPERINTENDENT, capable of supervising all phases of industrial plant operation, graduate electrical, eleven years diversified industrial experience including test course, four years on large Quebec industrial development, on construction and operation, also six years with prominent consulting firm supervising electrical and mechanical engineering projects. Age 31, single. Apply to Box No. 795-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. '32 (Univ. of N.B.). Age 25. Married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

Situations Wanted

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.Sc. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

SALES ENGINEER, A.M.E.I.C., graduate engineer, age 34, practical experience in the manufacture of power plant equipment, thoroughly conversant with Canadian power plant practice and equipment for the metal working industries. Available on short notice. Apply to Box No. 860-W.

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

CIVIL ENGINEER, B.Sc., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

CIVIL ENGINEER, B.Sc. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, S.E.I.C., B.Sc., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No. 1010-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.Sc. (Queen's, '14), A.M.E.I.C., Dominion Land Surveyor, 5 months special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply to Box No. 1035-W.

ENGINEER, Jr.E.I.C., E.E. '29, is very interested in applying electrical methods to cement testing and research work. Apply to Box No. 1062-W.

Situations Wanted

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.Sc. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

ELECTRICAL ENGINEER, B.Sc.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

MECHANICAL ENGINEER, B.A.Sc. (Univ. of B.C. '29); M.S. Age 27. Single. Four years experience in research work in applied mechanics and materials testing. Desires position involving analytical work in design, development or testing. Available on short notice. Apply to Box No. 1123-W.

PETROLEUM CHEMIST, B.Sc. in Chem. Eng. Age 25. Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

CIVIL ENGINEER, B.A.Sc., S.E.I.C., age 26, single. Experience includes one year in bridge construction, plain and reinforced concrete, pneumatic caissons and surveying. Available at once. Any location. Apply to Box No. 1204-W.

PHYSICIST ENGINEER, B.Sc.Mech. (Queen's 1913), M.Sc., Ph.D.Physics (McGill 1929, '30). Experience in municipal engineering, producer gas installation and operation, university plant maintenance. Experienced teacher of college physics. Industrial and pure physical research experience. Age 42. Married. Apply to Box No. 1207-W.

MECHANICAL ENGINEER, B.Sc. (Queen's Univ. '28), age 36, married, desires position of trust and responsibility. Experience includes fitting and assembly of machine tools, production, draughting, and maintenance. Five years teaching draughting and mathematics. Available on reasonable notice. Location immaterial. Apply to Box No. 1210-W.

CIVIL ENGINEER, B.A., B.A.Sc., S.E.I.C., Canadian, age 27, single. Experience includes eighteen months in general building construction. Writes and speaks both French and English fluently. Available at once for any suitable position in general engineering. Apply to Box No. 1211-W.

ENGINEER, with twenty years experience in industrial, pulp and paper mill, and general engineering and design. Age 41. Last five years chief engineer of paper mill making newsprint specialties and toilet tissues. Apply to Box No. 1246-W.

Situations Wanted

ELECTRICAL ENGINEER, B.Sc. '34 (Univ. of N.B.), S.E.I.C. Age 21, single. Desires any kind of electrical work. Will consider any location. Apply to Box No. 1262-W.

CIVIL ENGINEER, B.A.Sc. (Toronto '33), S.E.I.C., age 25. Married. One year as instrumentman with provincial highways dept. Experience in concrete and retread construction, draughting, estimating and accounting. One year with department of National Defence on grading and reinforced concrete construction. Apply to Box No. 1265-W.

ELECTRICAL GRADUATE, S.E.I.C., B.Sc. '32, M.Sc. '34. Experience includes four years as part time operator and announcer for a radio broadcast station. At present employed in radio repair dept. of a large wholesale firm. Apply to Box No. 1283-W.

ELECTRICAL ENGINEER, B.Sc., E.E., A.M.E.I.C. University of Manitoba '28. Age 32. Married. Experience one year power line construction, five years resident and assistant district engineer on highway construction; two years highway traffic regulation in charge of district office. Good connections in Manitoba and Saskatchewan. Excellent references. Available at once and will go anywhere. Located in Winnipeg. Apply to Box No. 1316-W.

ENGINEER AND DRAUGHTSMAN, Jr.E.I.C., age 33, married. Diplomas from Mtl Tech. Inst. in R.C. and Structural Design. 11½ years experience in civil engineering, draughting and instrument work. This includes 7 years with M.L.H. & P. Cons. as field engineer on construction and maintenance of gas mains. Present location Montreal. Available at once. Apply to Box No. 1326-W.

GRADUATE ENGINEER, (McGill), in responsible charge of design, construction and operation of hydro-electric plants. Also power design and mechanical maintenance of industrial plants. Apply to Box No. 1328-W.

MECHANICAL ENGINEER, recent grad. University of Toronto, B.A.Sc. in mech. engrg, 24 years old, S.E.I.C., now managing a chain store, desires engineering work. Present location So. Ontario. Location immaterial. Best of references. Apply to Box No. 1348-W.

CIVIL ENGINEER, A.M.E.I.C. Married. Age 38. Twenty years experience in organization, design and estimating, and cost accounting. Active service in France. Apply to Box No. 1367-W.

ENGINEERING PHYSICIST, B.Sc., M.Sc. (McGill) S.E.I.C. Age 26. Single. Summer experience powei house maintenance, draughting and general work ir small shop. Interested in development and research ir radio or electrical work requiring more advanced theoretical training than usual electrical degree. Apply tc Box. No. 1387-W.

FIRE PROTECTION AND SAFETY ENGINEER A.M.E.I.C., B.Sc. '24 (Mech. Engrg.). Age 33. Bilingual Ten years experience with insurance underwriter inspection bureau covering phases of field work. Thoroughly familiar with insurance requirements. Positioi desired industrial or other concern maintaining sel insurance or relative departments. Location Montres or vicinity preferred. Apply to Box No. 1395-W.

ENGINEER SUPERINTENDENT, A.M.E.I.C., R.P.E. Que. and Alta. Age 47. Married. Twenty years experience as engineer and superintendent in charge o hydro-electric, industrial, railroad, and irrigation construction. Specialized in rock excavation and suctioi dredging. Intimate knowledge of costs, estimating anc organizing. Available immediately. Apply to Box No 1411-W.

1935 GRADUATE IN CIVIL ENGINEERING, B.Sc (Queen's Univ.), S.E.I.C. Experience includes clevei months summer work as county engineer's assistant ii charge of the surveying party, and two months a surveyor's assistant during construction of concret formwork and installation of machinery. Keenl interested in graphical analysis, draughting, design organization and report writing. Now available fo any location. Apply to Box No. 1415-W.

For Sale

Spot light on tripod, trade mark Carl Zeiss-Jena 8367C Apply to Box No. 25-S.

THE ENGINEERING JOURNAL

THE JOURNAL OF THE ENGINEERING INSTITUTE OF CANADA

Published monthly at 2050 Mansfield Street, Montreal, by The Engineering Institute of Canada, incorporated in 1887 as The Canadian Society of Civil Engineers.

ENTERED AT THE POST OFFICE, MONTREAL, AS SECOND CLASS MATTER.

"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."

June, 1936 — Volume XIX, No. 6

CONTENTS

Price 50 cents a copy, $3.00 a year, in Canada, British Possessions, United States and Mexico. $4.50 a year in Foreign Countries.
To Members and Affiliates, 25 cents a copy, $2.00 a year.

Published Monthly at 2050 Mansfield St., Montreal

THE ENGINEERING INSTITUTE OF CANADA

Incorporated in 1887 as The Canadian Society of Civil Engineers

BRANCHES:

Halifax Branch, Halifax, N.S.
Cape Breton Branch, Sydney, Cape Breton.
Moncton, Branch, Moncton, N.B.
Saint John Branch, Saint John, N.B.
Saguenay Branch, Kenogami, Que.
Quebec Branch, Quebec, Que.
St. Maurice Valley Branch, Three Rivers, Que.
Montreal Branch, Montreal, Que.
Ottawa Branch, Ottawa, Ont.
Kingston Branch, Kingston, Ont.
Peterborough Branch, Peterborough, Ont.
Toronto Branch, Toronto, Ont.
Hamilton Branch, Hamilton, Ont.
Niagara Peninsula Branch, Niagara Falls, Ont.
London Branch, London, Ont.
Border Cities Branch, Windsor, Ont.
Sault Ste. Marie Branch, Sault Ste. Marie, Ont.
Lakehead Branch, Port Arthur, Ont.
Winnipeg Branch, Winnipeg, Man.
Saskatchewan Branch, Regina, Sask.
Lethbridge Branch, Lethbridge, Alta.
Edmonton Branch, Edmonton, Alta.
Calgary Branch, Calgary, Alta.
Vancouver Branch, Vancouver, B.C.
Victoria Branch, Victoria, B.C.

Members of Council 1936

PRESIDENT
E. A. CLEVELAND, Vancouver, B.C.

VICE-PRESIDENTS
*E. V. CATON, Winnipeg, Man.
†H. W. McKIEL, Sackville, N.B.
†A. B. NORMANDIN, Quebec, Que.
†R. L. DOBBIN, Peterborough, Ont.
*P. L. PRATLEY, Montreal, Que.

PAST-PRESIDENTS
F. A. GABY, Toronto, Ont.
O. O. LEFEBVRE, Montreal, Que.
F. P. SHEARWOOD, Montreal, Que.

COUNCILLORS
*C. G. R. ARMSTRONG, Windsor, Ont.
†Y. C. BARRINGTON, Sydney Mines, N.S.
*C. B. BROWN, Montreal, Que.
†G. S. BROWN, Lethbridge, Alta.
*G. H. BURBIDGE, Port Arthur, Ont.
†H. CIMON, Quebec, Que.
*A. COUSINEAU, Montreal, Que.
†A. B. CREALOCK, Toronto, Ont.
†T. H. DICKSON, Moncton, N.B.
†A. FRIGON, Montreal, Que.
†A. B. GATES, Peterborough, Ont.
*L. F. GOODWIN, Kingston, Ont.
*B. GRANDMONT, Three Rivers, Que.
†A. K. HAY, Ottawa, Ont.
‡F. S. B. HEWARD, Montreal, Que.
*G. H. KIRBY, Riverbend, Que.
*H. S. JOHNSTON, Halifax, N.S.
†T. C. MAIN, Winnipeg, Man.
†E. P. MUNTZ, Hamilton, Ont.
†E. P. MURPHY, Port Colborne, Ont.
†H. J. McLEAN, Calgary, Alta.
‡F. NEWELL, Montreal, Que.
†E. A. RYAN, Montreal, Que.
†F. SMALLWOOD, Sault Ste Marie, Ont.
*R. E. SMYTHE, Toronto, Ont.
*E. W. STEDMAN, Ottawa, Ont.
†H. L. SWAN, Victoria, B.C.
*J. A. VANCE, Woodstock, Ont.
*G. A. VANDERVOORT, Saint John, N.B.
*H. R. WEBB, Edmonton, Alta.
*A. S. WOOTTON, Vancouver, B.C.
*S. YOUNG, Regina, Sask.

*For 1936
†For 1936-37
‡For 1936-37-38

TREASURER
J. B. CHALLIES, Montreal, Que.

SECRETARY
R. J. DURLEY, Montreal, Que.

OFFICERS OF BRANCHES

HALIFAX
Chairman, C. S. BENNETT
Vice-Chair., C. SCRYMGEOUR
Sec.-Treas., R. R. MURRAY, 87 Cambridge St., Halifax, N.S.
Executive, J. R. KAYE, I. P. MACNAB, J. D. FRASER, J. F. F. MACKENZIE, W. H. NOONAN, J. W. McLEOD, J. B. HAYES
(Ex-Officio) H. FELLOWS, H. S. JOHNSTON

CAPE BRETON
Chairman, W. E. BOWN
Sec.-Treas., SYDNEY C. MIFFLEN, 60 Whitney Ave., Sydney, N.S.
Executive, M. R. CHAPPELL, W. S. WILSON, C. M. ANSON, W. E. CLARKE
(Ex-Officio) Y. C. BARRINGTON

SAINT JOHN
Chairman, J. R. FREEMAN
Vice-Chair., G. H. THURBER
Sec.-Treas., F. A. PATRIQUEN, P.O. Box 24, Saint John, N.B.
Executive, T. C. MACNABB, T. MOFFAT, S. HOGG
(Ex-Officio) V. S. CHESNUT, G. A. VANDERVOORT

MONCTON
Chairman, H. B. TITUS
Vice-Chair., G. L. DICKSON
Sec.-Treas., V. C. BLACKETT, Engrg. Dept., C.N.R., Moncton, N.B.
Executive, F. O. CONDON, JAS. PULLAR, T. H. DICKSON, C. S. G. ROGERS, A. S. GUNN, G. C. TORRENS
(Ex-Officio) H. W. McKIEL, J. G. MACKINNON

SAGUENAY
Chairman, J. SHANLY
Vice-Chair., S. J. FISHER
Sec.-Treas., L. R. BEATH, P.O. Box 211, Kenogami, Que.
Executive, W. L. YACK, E. LAVOIE, H. B. PELLETIER, M. G. SAUNDERS
(Ex-Officio) G. E. LAMOTHE, J. W. WARD, G. H. KIRBY

QUEBEC
Hon. Chair., A. R. DECARY
Chairman, ALEX. LARIVIERE
Vice-Chair., J. T. F. KING
Sec.-Treas., J. JOYAL, Quebec Public Service Comm., Court House, Quebec, Que.
Executive, R. B. McDUNNOUGH, L. P. METHE, L. BEAUDRY, A. G. SABOURIN, J. G. O'DONNELL, A. ROBERGE
(Ex-Officio) A. B. NORMANDIN, HECTOR CIMON

ST. MAURICE VALLEY
Chairman, B. GRANDMONT
Vice-Chair., J. E. FLEURY
Sec.-Treas., J. A. HAMEL, 642 Notre Dame St., Three Rivers, Que.
Executive, F. W. BRADSHAW, C. L. ARCAND, H. J. WARD

MONTREAL
Chairman, J. B. D'AETH
Vice-Chair., H. MASSUE
Sec.-Treas., C. K. McLEOD, 1440 St. Catherine St. W., Montreal, Que.
Executive, R. H. FINDLAY, C. C. LINDSAY, B. R. PERRY, T. C. THOMPSON, J. A. LALONDE, J. A. E. GOHIER
(Ex-Officio) F. S. B. HEWARD, A. COUSINEAU, C. B. BROWN, P. L. PRATLEY, O. O. LEFEBVRE, E. A. RYAN, F. NEWELL, A. FRIGON, F. P. SHEARWOOD

OTTAWA
Chairman, E. VIENS
Sec.-Treas., F. C. C. LYNCH, Dept. of Mines, Victoria Memorial Museum, Ottawa, Ont.
Executive, E. M. DENNIS, T. A. McELHANNEY, N. B. MACROSTIE, G. R. TURNER, B. F. HAANEL
(Ex-Officio) E. W. STEDMAN, R. W. BOYLE, A. K. HAY

PETERBOROUGH
Chairman, H. R. SILLS
Sec.-Treas., W. T. FANJOY, 223 Crescent St., Peterborough, Ont.
Executive, V. R. CURRIE, A. L. KILLALY, E. J. DAVIES, W. M. CRUTHERS
(Ex-Officio) A. L. DICKIESON, A. B. GATES, R. L. DOBBIN

KINGSTON
Chairman, R. A. LOW
Vice-Chair., Lt.-Col. N. C. SHERMAN
Sec.-Treas, Major L. F. GRANT, Royal Military College, Kingston, Ont.
Executive, G. G. CARR-HARRIS, S. STEPHENSON, J. E. GOODMAN
(Ex-Officio) W. CASEY, L. F. GOODWIN

TORONTO
Chairman, O. HOLDEN
Vice-Chair., A. U. SANDERSON
Sec.-Treas., W. S. WILSON, Mining Bldg., University of Toronto, Toronto, Ont.
Executive, W. P. DOBSON, N. MACNICOL, W. E. P. DUNCAN, A. M. REID, D. D. WHITSON, C. E. SISSON
(Ex-Officio) W. E. BONN, A. B. CREALOCK, R. E. SMYTHE, F. A. GABY

HAMILTON
Chairman, W. HOLLINGWORTH
Vice-Chair., E. G. MACKAY
Sec.-Treas., A. LOVE, 40 Paisley Ave. S., Hamilton, Ont.
Executive, W. J. W. REID, A. R. HANNAFORD, V. S. THOMPSON, D. W. CALLANDER
(Ex-Officio) E. P. MUNTZ

LONDON
Chairman, JAS. FERGUSON
Vice-Chair., A. O. WOLFF
Sec.-Treas., D. S. SCRYMGEOUR, London Structural Steel Co. Ltd., London, Ont.
Executive, E. V. BUCHANAN, W. C. MILLER, J. R. ROSTRON, H. A. McKAY
(Ex-Officio) S. W. ARCHIBALD, S. G. JOHRE, J. A. VANCE

NIAGARA PENINSULA
Chairman, G. H. WOOD
Vice-Chair., L. C. McMURTRY
Sec.-Treas., P. A. DEWEY, 1224 Ontario Ave., Niagara Falls, Ont.
Executive, S. HAIRSINE, W. D. BRACKEN, M. H. JONES, C. S. BOYD, R. A. BRADLEY, C. G. MOON, A. W. F. McQUEEN
(Ex-Officio) P. E. BUSS, E. P. MURPHY

BORDER CITIES
Chairman, T. H. JENKINS
Vice-Chair., C. F. DAVISON
Sec.-Treas., BOYD CANDLISH, 170 Rankin Blvd., Sandwich, Ont.
Executive, E. M. KREBSER, D. T. ALEXANDER, C. G. WALTON
(Ex-Officio) C. G. R. ARMSTRONG, H. J. COULTER

SAULT STE. MARIE
Chairman, J. L. LANG
Vice-Chair., W. SEYMOUR
Sec.-Treas., N. C. COWIE, 15 Hearst St., Sault Ste. Marie, Ont.
Executive, H. O. BROWN, C. W. HOLMAN, T. FOULKES, H. W. SUTCLIFFE
(Ex-Officio) F. SMALLWOOD, A. E. PICKERING

LAKEHEAD
Chairman, F. C. GRAHAM
Vice-Chair., G. R. DUNCAN
Sec.-Treas., G. R. McLENNAN, 80 North High St., Port Arthur, Ont.
Executive: H. G. O'LEARY, J. M. FLEMING, K. A. DUNPHY, E. A. KELLY, E. L. GOODALL, W. J. BISHOP
(Ex-Officio) G. H. BURBIDGE, R. J. ASKIN

WINNIPEG
Chairman, G. E. COLE
Vice-Chair., A. E. MACDONALD
Sec.-Treas., J. F. CUNNINGHAM, 918 Somerset Ave., Fort Garry, Man.
Executive, F. W. ALEXANDER, H. L. BRIGGS, W. D. HURST, R. W. McKINNON, W. F. RIDDELL
(Ex-Officio) E. V. CATON, F. V. SEIBERT, T. C. MAIN

SASKATCHEWAN
Chairman, W. E. LOVELL
Vice-Chair., STEWART YOUNG
Sec.-Treas., J. J. WHITE, City Hall, Regina, Sask.
Executive, A. R. GREIG, J. W. D. FARRELL, J. McD. PATTON, H. S. CARPENTER, H. J. BYRD, S. R. MUIRHEAD
(Ex-Officio) A. P. LINTON

LETHBRIDGE
Chairman, W. L. McKENZIE
Vice-Chair., J. M. CAMPBELL
Sec.-Treas., E. A. LAWRENCE, 207-7th St. S., Lethbridge, Alta.
Executive, G. S. BROWN, R. F. P. BOWMAN, J. HAIMES
(Ex-Officio) C. S. DONALDSON, J. B. DEHART

EDMONTON
Chairman, E. STANSFIELD
Vice-Chair., A. RITCHIE
Sec.-Treas., M. L. GALE, 9914-111 St., Edmonton Alta.
Executive, J. D. BAKER, W. E. CORNISH, C. E. GARNETT, A. J. GAYFER, E. NELSON
(Ex-Officio) F. K. BEACH, H. R. WEBB

CALGARY
Chairman, JOHN DOW
Vice-Chair., H. W. TOOKER
Sec.-Treas., JAS. McMILLAN, 506 Insurance Exchange Bldg., Calgary, Alta.
Executive, J. J. HANNA, W. T. McFARLANE, H. J. McEWEN
(Ex-Officio) J. HADDIN, F. M. STEEL, H. J. McLEAN

VANCOUVER
Chairman, JAS. ROBERTSON
Vice-Chair., H. N. MACPHERSON
Sec.-Treas., T. V. BERRY, 3007-36th Ave. W., Vancouver, B.C.
Executive, E. C. THRUPP, P. SANDWELL, G. L. BOOKER, J. P. MACKENZIE, P. H. BUCHAN, C. P. HAMILTON, F. O. MILLS
(Ex-Officio) G. M. GILBERT, E. A. CLEVELAND, A. S. WOOTTON

VICTORIA
Chairman, I. C. BARLTROP
Vice-Chair., J. C. MACDONALD
Sec.-Treas., KENNETH REID, 1336 Carnsew St., Victoria, B.C.
Executive, G. M. DUNCAN, G. M. IRWIN, G. M. TRIPP, C. D. SCHULTZ
(Ex-Officio) D. MACBRIDE, H. L. SWAN

THE

ENGINEERING JOURNAL

THE INSTITUTE as a body is not responsible either for the statements made or for the opinions expressed in the following pages.

VOLUME XIX — MONTREAL, JUNE, 1936 — NUMBER 6

Steel Piling

Some Notes on its Development and Use

Robert F. Legget, A.M.E.I.C.,
Engineer, Canadian Sheet Piling Company Limited, Montreal, Que.

Paper presented before the Toronto Branch of The Engineering Institute of Canada, March 6th, 1936.

SUMMARY.—The paper gives a historical sketch of the development of steel sheet piling, followed by a discussion of its various uses in temporary and permanent work, the considerations affecting the design of sheet piling structures and examples of its employment for foundations, shore protection, wharves and other purposes.

In the choice of materials for structural engineering work, there are always two fundamental questions which must be answered before a choice can be made. These are—(1) Will the material, when it is in place in the work, have the properties and perform effectively the functions considered in design calculations? and (2) Is the material the most economical of all those available? These two questions may usefully be discussed before passing to the consideration of one particular type of structural unit.

Effective Performance of Materials

In design calculations, certain physical and mechanical properties of the material must be assumed as a necessary basis for calculation. Design calculations assume also that the materials will have these assumed properties when called upon to carry their designed load in the structure.

Timber can be taken to have reasonably uniform properties which can be checked up in a laboratory and therefore used with confidence in design. On the other hand, when in place, timber in its untreated state is affected by destructive influences such as dry rot, the ravages of insects, and, in particular, to deterioration when exposed to sea water on most of the coasts of Canada. When treated with suitable preservatives, timber has a more definite life, but even then eventual deterioration must be considered.

Reinforced concrete, if it is to have uniformly good properties such as are assumed in design, requires careful and constant supervision and a certain amount of skilled labour for its installation. Even with this available, the material in place in the work may not have exactly the structural arrangement and properties assumed in design. Present methods of securing test cylinders as a check on strength are also far from ideal, whilst the use of precast units of any considerable size leads to heavy handling charges, and possible overstressing and surface damage. These comments are not intended to be critical of reinforced concrete, of the value of which the author is well aware, but they suggest its limitations and explain in some measure why high factors of safety must still be used.

Steel is probably the most uniform of all construction materials; its manufacture is constantly under the control of skilled workmen; and its testing is a thoroughly reliable check on its general mechanical and physical properties. Structural sections can be handled even quite roughly, without suffering damage or being even temporarily overstressed. Their installation is a relatively simple matter, and field connections can be well checked and inspected. It must be added that steel certainly corrodes to some extent when exposed to the influences of air and water, but this is a slow process; it can be retarded by the use of special types of steel; and with the exercise of a little care in maintenance and painting, it can be virtually eliminated on most types of structure.

Economical Use of Materials

The second question suggested has relation to the true economy of the material to be used. The insertion of the word "true" is called for by the frequent judgments as to economy which are made on the basis of first costs only, instead of the basis of annual costs which include all charges against the structure. These will generally consist of: (1) Interest on capital invested, i.e. first cost; (2) depreciation allowance necessary to repay the cost of the structure based on the anticipated effective life of the material; and (3) annual maintenance charges. As a general rule timber will probably have the lowest annual charge in group (1) with reinforced concrete the highest; steel and reinforced concrete will approximate to the lowest annual charge for group (2) on large jobs; and reinforced concrete will probably have the lowest annual charge for group (3). Only by a comparison of the total annual charges for the three groups for any materials considered can the true economy of a proposed design be judged. Further, there arise in certain circumstances local factors which sometimes have an indirect bearing on the true economy of a structure. For example, the useful life of a structure may be known in advance to be a matter of only ten or twenty years, in which case first cost will probably govern any ultimate decision. In other cases, considerations relating to the use of local material and local labour may influence the decision to be made.

Use of Steel in Construction

Consideration of these two leading questions suggests that the use of steel in civil engineering structures, apart from superstructure works such as building frames and bridges, has been strangely limited. The place of steel in one branch of civil engineering work may be considered as of some special interest, and that is the relation of steel to piling work.

Steel Bearing Piles

Piling may be divided into two main classes, bearing piles and sheet piles. Bearing piles do not give rise to many problems of design if one excepts that unfailing topic for engineering debate—the resistance to penetration and the bearing capacity of piles. Such piles have generally one function only to perform, that of transferring a certain specified load from a foundation structure to ground strata. They are usually unaffected by air and water, being permanently buried. If ground conditions are suitable, therefore, timber piles, and especially in Canada, are very often the most suitable and the most economical. When driving conditions are severe, however, and when unusually heavy loads have to be carried, other materials must be considered.

Reinforced concrete piles of various designs and sizes have in the past fifty years been usually the only alternative to timber bearing piles. It is difficult to see why steel piles have had so small a share of this work. It is, however, interesting to find that steel I beams have been used quite extensively in the Western part of this continent, over ten thousand small bridges having been constructed between 1900-1932 (about) founded on steel beams. Early in the century, similar foundations were utilized for some trestle bridges in the Chatham district of Ontario. Today, not only are steel beams being utilized as bearing piles, but specially designed steel sections are available, and driving conditions which might in the past have proved too severe for even reinforced concrete piles can now be met by the use of heavy steel H sections.

Reference may be made to the screw pile, a circular shaft fitted at the foot with a large diameter screw blade, and installed by being screwed into the ground. Naturally, such piles can only be used in relatively soft material and they have been specially developed for such use. In places where the only foundation bed available is a deep layer of mud giving at its surface practically no bearing power at all, important structures have been successfully erected using this type of pile. Although of general interest, this type of pile is not often used in Canadian engineering practice, and attention will, therefore, now be turned to the second class of piling, i.e. sheet piling.

Steel Sheet Piling: Historical

The use of metallic sheet piling is today regarded on this continent as standard practice for temporary cofferdam work and it is gradually becoming accepted as a valuable type of permanent construction. This position makes the historical development of its use of unusual interest, since the first metallic sheet piles which were used well over a hundred years ago were evolved as a unit of permanent construction. Certainly the modern type of deep-arch interlocking steel pile was developed in the first place especially for permanent work.

In the first volume of the Transactions of the Institution of Civil Engineers, published in 1836, there will be found a paper "Memoir on the Use of Cast Iron in Piling Particularly at Brunswick Wharf, Blackwall," written by M. A. Borthwick* which describes the use of cast iron sheet piles by Mr. Mathews of Bridlington in Yorkshire, in the construction of the north pier of the harbour of that town about the beginning of the nineteenth century. Independently, a Mr. Ewart took out a patent in 1822 on a cast iron sheet pile which was quite widely used in British harbour work, notably for dock construction at Liverpool, where piles were even coupled together something after the manner of modern fishplating. Another type of pile was used by Mr. Cubitt at Norwich having a Tee section with varying web depths. The Brunswick wharf mentioned in the title of the paper was constructed on the River Thames in the years 1833-34 by Messrs. Walker and Burges at Blackwall near the West India Company's docks. In section, it has a strangely "modern" look, the piles having a good penetration and being secured by means of tie-rods. The price of the piles, £7 per ton delivered in London, is another feature of interest today. Wrought iron, in built up sections, was also used at a later date in the century, and sheet piles of both varieties of iron must have been used to some extent in these succeeding years, although records of them are hard to trace.

The introduction of steel on a commercial scale gave renewed impetus to the use of metallic sheet piles, and many types were evolved. They suffered generally from two defects, unsatisfactory or very costly connections, and low sectional strength in comparison to the weight of metal used. At the end of the last century the first of these problems was solved independently by two engineers, one in Germany and the other in the United States of America, the designs being known as the Larssen and Friestedt sections. The Larssen pile was intended for use as a permanent unit of construction in Bremen harbour. Invented in 1897, the first piling was rolled and used in 1903, the section being partially fabricated. It was not until 1914, after further experimental work, that the sections were rolled as they are today. Its special joint is well known; its other leading feature, the deep-arch section, was of equal importance, since the metal was employed efficiently by being located away from the neutral axis of the section. The wide adoption of the deep-arch principle for steel piling sections and the high structural strength thus made possible was responsible to a large extent for the development of steel sheet piling. The Friestedt section was also a fabricated one and may be regarded as the precursor of the United States and Lackawanna straight web sections of steel piling, the use of which, for temporary work, is so well known in all parts of this continent.

The development and use of deep-arch piling in Europe continued steadily until the post-war period, when interest in the possibilities provided by interlocking piling for permanent work was renewed. A considerable quantity of deep-arch piling was imported into North America for shore protection work on eastern coasts about 1926. Little development work had taken place in America in the preceding years, but in 1928 the American steel companies developed deep-arch sections of their own design promoting their use for permanent work, and these are now well known. Other types of piling were evolved in Europe and successfully rolled, including sections having separate interlock bars and 'Z' shaped piles. British steel mills started the production of deep-arch piling in 1928 and of a 'Z' shaped pile in 1933. More recently a type of deep-arch piling has been rolled in Canada and American steel mills announce the imminent production of a heavy 'Z' shaped pile. The records of the various patent offices contain many examples of interlocking steel pile designs. The Canadian patents taken out by Mr. William Hunter of Kincardine, Ontario, are of special interest. Without attempting to discuss the relative merits and demerits of different types of sections, it may be noted that in the choice of a piling section the following requirements must be met: the piling must be capable of being driven into position without distortion of its section; it must be capable of being driven under the most severe conditions without failure of the interlocks; it should combine the use of the least possible weight of metal with the highest possible sectional strength and possess a robustness of shape which will permit of rough handling on construction without fear of damage.

*As this volume is very rare, it may usefully be mentioned that the paper is reprinted to a large extent in Appendix VI of "Ordinary Foundations" by C. E. Fowler, second edition of 1906.

Steel Sheet Piling for Temporary Work

Many engineers still regard steel sheet piling as essentially a temporary expedient for use in cofferdam construction. It is, therefore, of significance to note that of the steel piling used in Canada in recent years only about ten per cent has been used for cofferdam construction and even of this quantity probably at least

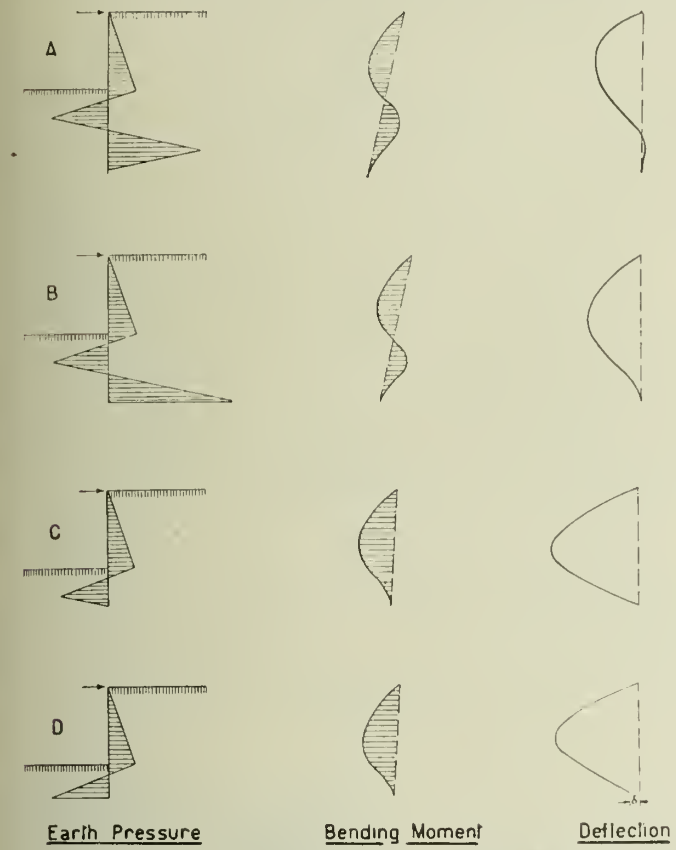


Fig. 1—Effect of Penetration on Bending Moment.

one-half was left in place as permanent protection to bridge piers and other structures. For cofferdam work, especially where some depth of water is to be encountered, steel sheet piling is invaluable and the use of modern deep-arch sections with water-tight interlocks has permitted the use of open cofferdams to depths previously impossible.

Canadian bridge practice has already provided many interesting applications of steel sheet piling to this branch of construction. One of these may be mentioned, namely the formation by steel sheet piling of a central cofferdam and upstream and downstream guard piers, all connected by side walls of steel piling supported by timber cribs, for the pivot pier for the swing span of the highway bridge across the Saguenay river at Chicoutimi. This is an example of the combination of both temporary and permanent use of steel sheet piling, all the steel having been left in place as a permanent protection to the swing span and its support. The job was of interest also in that the piling used was supplied in lengths of 65 to 70 feet, and driven in these lengths with no difficulty.

Steel Sheet Piling for Permanent Work

In the past retaining structures have almost invariably obtained their stability from the weight of material. Mass concrete walls, mass stone walls, timber cribs, concrete cribs, concrete caissons and many other similar types of wall construction have all featured the use of the constituent material or materials as useful mainly in providing weight. The use of sheet piling for the construction of such retaining walls introduces a different principle, since the material is used as a series of beams, its full strength in tension and compression being effectively employed with consequent economy in cost and increased facility in construction.

Stability of such sheet piling structures depends essentially on two main factors: (*a*) The correct calculation of the earth pressure on the back of the steel piling wall and the determination of the resistance to movement provided by the material into which the sheet piling is driven; and (*b*) the correct design of the steel piling to be used and the steel work utilized for supporting this piling and connecting it to a suitable anchorage. Considering first the question of earth pressures, the calculation methods for arriving at these design essentials are reasonably well established, but they depend for their accuracy on the assumptions made with regard to the characteristics of the soil materials in question, and in particular on the weight, dry and in the water, and the coefficients of internal friction and cohesion. In this way steel piling design is closely associated with the general subject of soil mechanics.* The test boring carried out on sites of steel piling works must be most carefully done (wash borings in some cases being worse than useless), in such a way that samples of the undisturbed material can be obtained and tested in a soil laboratory. In addition all such exploratory work must be correlated with the geological structure of the surrounding district, especially when the materials encountered are of a clayey nature. If this attention is devoted to soil characteristics, then earth pressure and resistance diagrams for design can be prepared with some degree of accuracy.

Once such diagrams have been prepared, the design of sheet pile retaining structures becomes a matter of structural analysis. In the past this was largely a matter of approximation, but in recent years more accurate methods have been evolved. In particular, one which is now widely known and used was evolved by Ing. Dipl. Blum, an engineer on the staff of the European company supplying Larssen piling. It was first published in January 1931.†

It will be useful to illustrate the principle on which the

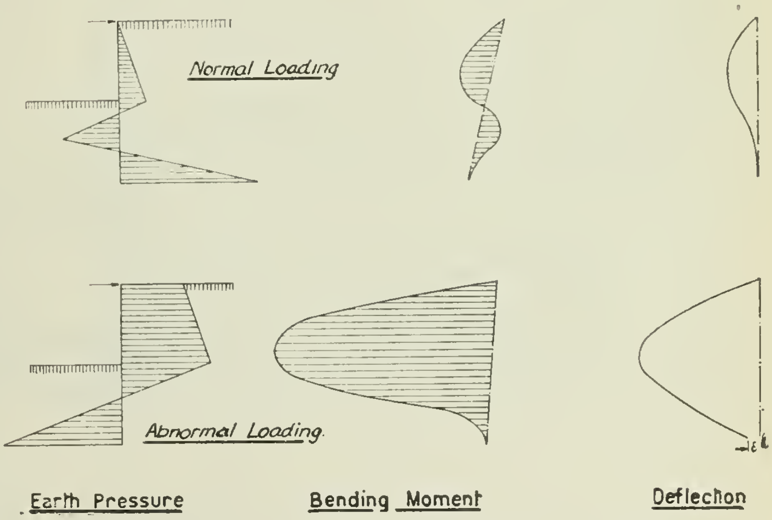


Fig. 2—Effect of Over-Loading a Steel Pile Wall.

method is based. In the accompanying sketches (Figs. 1 and 2), different conditions of earth loading for a steel piling

*An International Conference on Soil Mechanics and Foundation Engineering is to be held at Harvard University on June 22nd to 30th, 1936. This is the first international gathering dealing with this important topic and a number of Canadian engineers will attend.

†Translations into English of the method appeared in "Civil Engineering" (London) issues of December 1932 and January 1933, and also in the Carnegie Steel Company's steel piling catalogue dated January 1st, 1933.

wall are illustrated. These are to some extent self explanatory, and it will, therefore, be seen from the first four diagrams that the depth of penetration to which a steel pile is driven will affect the bending moment and deflection diagrams to the extent that with deep penetration the pile will be rigidly fixed in the ground, whereas with a smaller penetration the lower portion of the pile has just started to move forward, the pile then becoming a beam simply supported between tie-rod and earth resistance against the foot. The

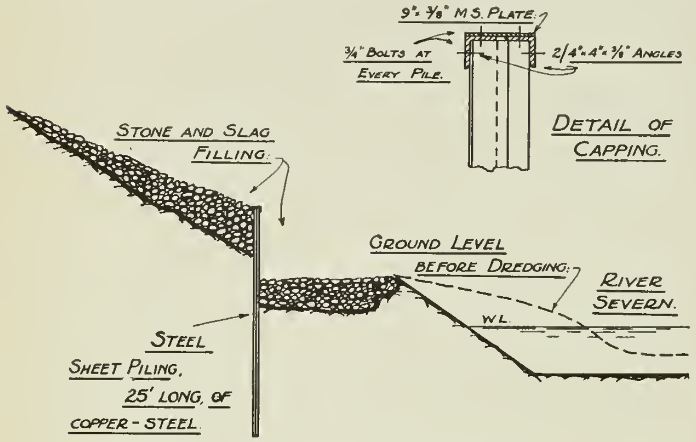


Fig. 3—Typical Cross Section and Detail of Coping.

condition assumed in design calculations is that shown as *B*, the piling being considered as a beam simply supported by the tie-rod at the top and fixed in the ground at the lower end. If now for any reason the wall is overloaded beyond loadings assumed in design, the lower diagram represents the condition which must obtain before movement of the wall will take place. It will be seen that the bending moment diagram passes from that of the fixed beam to that of a simply supported beam before there is any possibility of the toe of the piling moving outward. Although this will increase the stress in the piling well beyond normal working limits, it will normally still be under the stress at yield point at the worse condition before movement starts. It will thus be seen that with this generally accepted method of steel piling bulkhead wall design a large factor of safety exists. When this advantage is considered in relation to the economy of the type of construction the increasing number of applications of steel sheet piling for permanent work is readily explained.

Steel corrodes when exposed to air and water and this has been sometimes regarded as a reason against the use of steel piling for permanent work. It can be stated in reply that there are now available records of steel piling structures which have been in successful use for periods up to almost fifty years and which present indisputable evidence that for normal conditions an effective life for a properly designed steel piling structure can be taken as from sixty to eighty years. Further, research has shown that the use of 0.20 to 0.35 per cent of copper in ordinary structural steel greatly increases its resistance to corrosion. The use of special high tensile rust-resisting steels recently developed is another innovation tending to make the question of corrosion even less serious than it is with standard steel.

In the following sections are given actual examples of several different types of structure for the construction or reconstruction of which interlocking steel sheet piling has been successfully utilized. In presenting such examples, the several different standard types of wall design will naturally be covered.

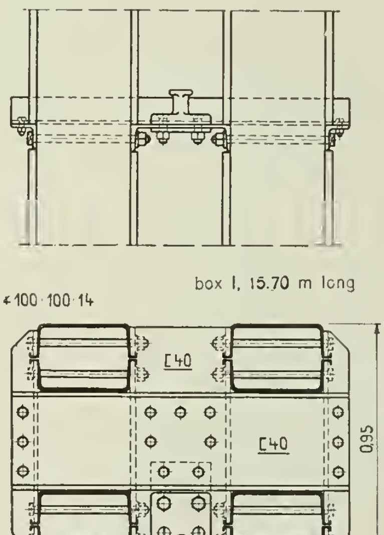
Foundations

For many cases of deep foundations for buildings, the use of steel sheet piling can introduce economies, and when a porous sub-soil is encountered with ground water level above excavation level, its use is often imperative. Even deep shafts to rock level, to serve as foundation supports, are now often lined with interlocking piling, while its use when the foundation beds under adjacent buildings have to be safeguarded is often of great value.

In many cases it is found economical to retain the piling in the completed foundation structure. An interesting recent innovation has been the use of the configuration of a wall of deep-arch piling as a form for a vertical Tee-beam foundation wall design, the troughs in the piles being thus doubly advantageous. One of the first examples of this design adaptation was for the new building of the Royal Institute of British Architects in London, England.

An interesting Canadian application of steel piling to foundation work, although it includes few unusual features, was the use of steel piling for the construction of the boiler-room excavation for the new Postal Terminal building in Montreal. Sub-surface conditions on this site were unusually difficult, including a bed of gravel through which sub-surface water flowed at an appreciable rate, and the use of steel piling was of considerable assistance in the successful completion of the work by the foundation contractors.

Steel sheet piling plays its part in the construction of bridge foundations mainly by providing adequate coffer-dams inside which bridge piers and abutments can be constructed. In some cases, the steel piling is used further as a form for the concreting of a pier base, to which it will provide a permanent protection when left in place. In other bridge designs steel piling has been used to enclose



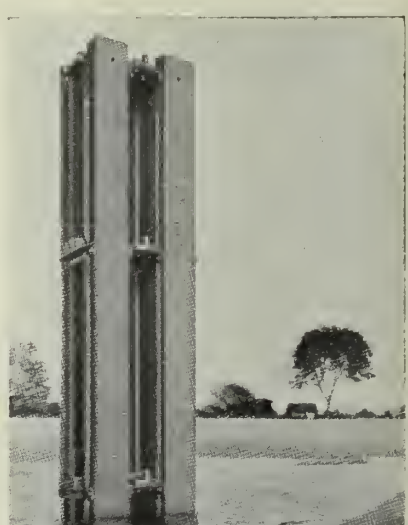


Fig. 4—Steel Pile Dolphin. Union Box Piles.

the ground on which a spread footing is constructed so as to confine it and increase its bearing capacity.

As a means of providing a watertight and economical cut-off below dam structures founded on pervious foundation beds steel piling provides an admirable solution. Recent construction in the United States of America has provided the most remarkable example of such an application by the use of 17,390 tons of steel sheet piling for the construction of the 10,146 foot cut-off wall to the Fort Peck dam in Montana, a maximum depth of 161 feet being reached through the use of spliced piles. In Canada steel piling has been similarly used, notably at the Flamand dam in the St. Maurice Valley for the Shawinigan Water and Power Company and also in the construction of the Abitibi Canyon development, as well as for many smaller works.

River Protection Walls

The protection of river banks from erosion caused by either normal river flow around bends or by flood flows in even straight stretches of water courses is of growing importance. Steel sheet piling provides an admirable

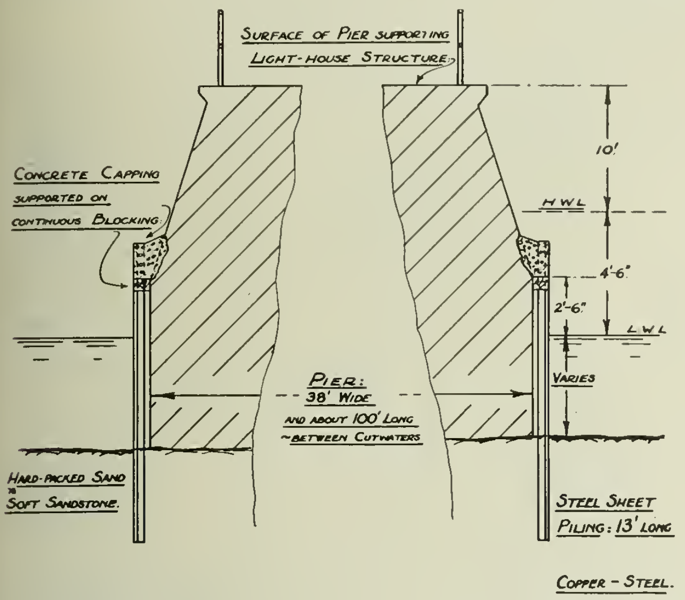


Fig. 5—Reconstruction of Pier Sub-structure, Sandy Beach Lighthouse.

method of attaining such protection. The fact that erosion does take place generally indicates that the site consists of unconsolidated material, so that normally the driving of steel piling along river banks is a simple matter. In many cases a row of sheet piling can be installed without additional support, acting as a cantilever retaining wall. In such cases the penetration necessary for stability should be adequate even when considering the possibility of future scouring, since, if at any time severe scouring does take place, a system of walers and tie-rods can be installed.

Steel piling has not as yet been widely applied for this type of work in Canadian practice, although an interesting example is to be seen under the Ferguson Highway north of New Liskeard, where two rows of steel piling provide training walls for the creek which passes under the Calamity Gulch bridge. An illustration must, therefore, be presented from British practice and that illustrated in Fig. 3 is a river protection wall on the River Severn near Coalport in Shropshire. This is a standard cantilever type retaining wall backed with stone and slag filling and it protects a bank from erosion and from trouble previously encountered with landslides.

Shore Protection

In a similar way steel piling plays its part in the construction of retaining walls for the protection of either lake or sea coastal lands. A standard type of shore protection wall consists of a concrete superstructure with a steel pile toe wall serving as a cut-off to prevent any possibility of scouring taking place beneath the main part of the wall. Several works of this nature in the Toronto district will probably be familiar, amongst them the retaining wall along the lake shore in front of the new Victoria Park pumping station works at the east end of the city. Many of the retaining structures which form Toronto's justly famous water-front are of this type of construction, the most recent addition to this retaining work being the Exhibition Seawall at the foot of Strachan avenue.

Another type of shore protection work is provided by groynes, these being retaining walls built out at an angle to the coast line in order to interfere with littoral drift and so prevent the scouring away of beach material. Piles of this class of work can be jetted into place, and in sand this leads to great economy in construction.

Mooring Dolphins

Dolphins for the use of large vessels have to withstand severe forces, so that the suitability of heavy sections of steel piling, together with their elasticity, will be appreciated. A standard type of steel dolphin now in use with much success in Europe is a cluster of steel box piles driven with a suitable interval between each, the cluster being rigidly framed together by means of steel connections and timber spacers, the timbers in some cases being extended for use as rubbing pieces. The design of such structures is naturally somewhat specialized work but determinate methods are available. An illustration shows a typical view of a steel dolphin in use at the entrance to Hemelingen lock near Bremen, together with a cross section of this structure. (See Fig. 4.)

Lighthouse Foundations

Many of Canada's lighthouses are relatively small structures and in view of local conditions, the materials available for their construction have been somewhat limited in the past, with the result that the repair of lighthouse structures is a matter of constant concern to government engineers.

In certain cases where foundation bed conditions are suitable steel piling can be used for such foundation work and especially for reconstruction. An interesting example

Fig. 6—Cellular Sheet Pile Breakwater, Calumet Harbour.

is the reconstruction of the pier base of the Sandy Beach lighthouse in Gaspe Bay. This structure stands some distance from the shore in water which is always rough although quite shallow, as the light is at the end of a long sand bar. Although the superstructure was in good order, the substructure was causing concern, and early in 1935 it was therefore surrounded with a continuous wall of copper-bearing steel piling, driven close to the existing pier and capped with a concrete coping connecting with the existing concrete pier. It is of special interest to note that this work was carried out in the winter, off the sea ice, the pile driver being operated on the ice. A solid job in this way was easily obtained without any of the usual difficulties of construction in exposed tidal water. The concrete cap was naturally added later in the year. (See Fig. 5.)

Breakwaters and Moles

Since the use of steel piling can minimize dangers of scouring, breakwater design when steel piling is used is founded on a reasonably determinate basis. Important breakwaters so constructed are to be found at Kiel in Germany (27 feet of water); Derindje, in Turkey (26 feet of water); in Japan, the Argentine Republic, the Philippine Islands and elsewhere, with perhaps the North Mole of Bremen harbour (Germany) as the outstanding example, this structure standing in almost 40 feet of water, protecting the harbour entrance from the open sea, and constructed of two rows of steel piling securely braced together.

Breakwater construction provides also one of the most suitable applications for what is known as the cellular type of steel piling construction, the name being descriptive of a system of using straight web piling in a series of cell-structures, interconnected by means of junction piles, suitably filled and capped in some solid fashion. The piling acts, in such structures, more in the nature of a series of cylinders under internal stress than in the manner indicated for straight pile walls. This type of construction has been used for several important breakwaters on the Great Lakes. As an example, a breakwater constructed by the United States government at Calumet harbour, Lake

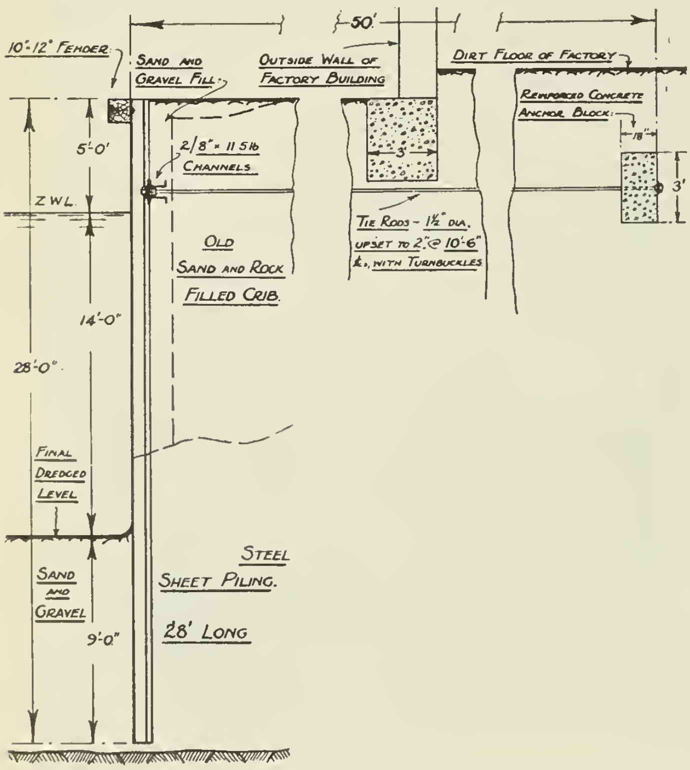


Fig. 7—Reconstructed Wharf Wall, Port Hope Harbour.

Michigan, may be mentioned. (See Fig. 6.) This cellular structure is 5,025 feet long and was built in water from 27 to 36 feet deep during 1934 and 1935.*

Wharf Structures

Coming finally to wharf structures, Fig. 7 shows a wharf construction at Port Hope, Ontario, a large part of the harbour of which has now been reconstructed by means of steel piling. The wall structures there are generally of the standard type, consisting of a continuous wall of steel piling driven for a suitable distance into the underlying stratum, every second pile being connected to a continuous waler beam consisting of two channels, which, in turn, transfers the load from the piles to a system of tie-rods spaced at regular intervals leading back to anchorage blocks of reinforced concrete. Part of the earth pressure

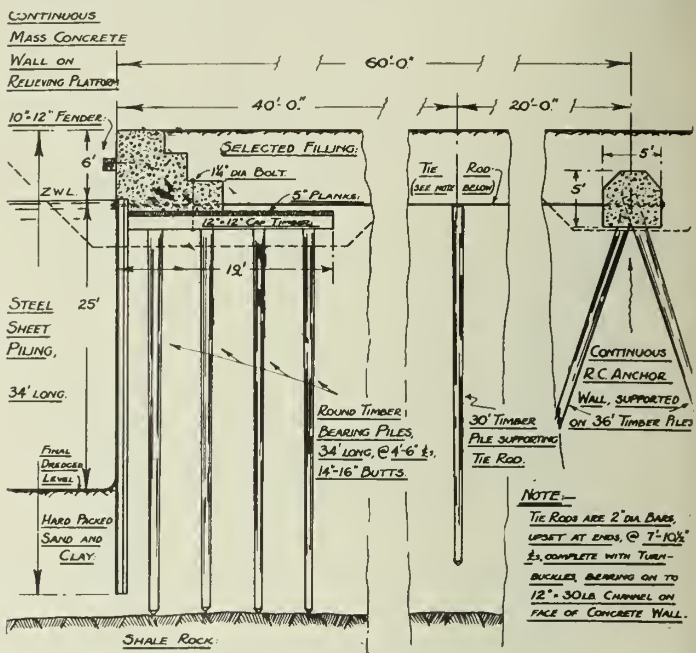


Fig. 8—Steel Pile Wharf Wall, showing Relieving Platform.

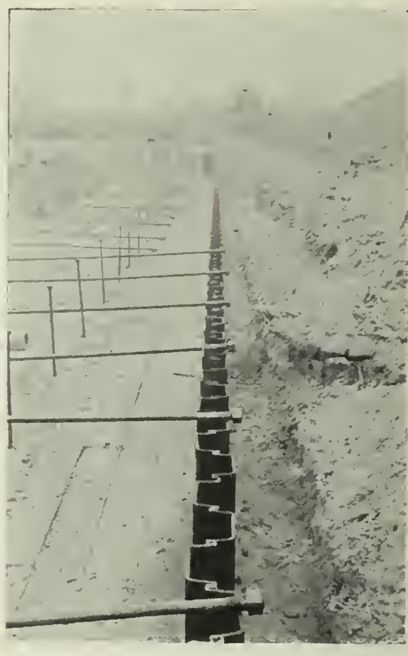


Fig. 9—Relieving Platform Type of Wharf Wall under Construction.

on such a wall is transmitted (as already shown) to the ground into which the piling is driven; the remaining reaction is transmitted by the distributing bolts to the waler beam and so through the tie-rods to the anchorage blocks.

In the case of wharf structures which have to retain earth filling against a considerable depth of water (25 feet and over) a convenient method of reducing the earth pressure on the steel pile wall and so of reducing the section

*This work was fully described on pages 86 to 91 of Engineering News-Record of July 18th, 1935.

of piling necessary is by the use of a timber relieving platform. Such a platform transfers the superload and upper earth pressure through bearing piles to the ground behind the steel pile wall and therefore "shields" the steel pile wall from the full earth pressure which would otherwise come upon it.

An example of this type of structure is given by the new wharf walls constructed in Oshawa harbour, shown in Figs. 8 and 9. In this case the piling was driven and the wall

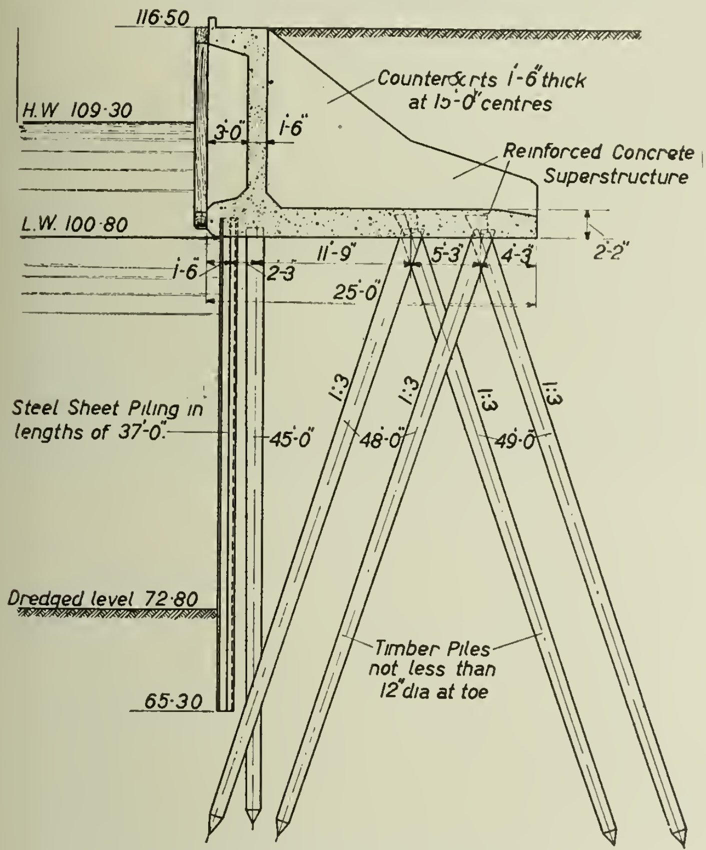


Fig. 10—Typical Cross Section Through No. 1 Quay, Port Adelaide Development.

constructed before excavation was carried out in front of the completed wall. The excavation necessary to convert it into a wharf wall having 25 feet of water alongside was then carried out by means of a floating dredging plant.

Another type of wharf wall structure is that in which tie-rods are dispensed with altogether. It is in effect a special type of relieving platform wall, the relieving platform being integral with the upper retaining wall and constructed of concrete. An illustration of this type of wall, the wharf construction carried out at Port Adelaide, South Australia, may be mentioned. (See Fig. 10.) Referring to the cross section, it will be seen that the outward thrust on the wall is taken up by the bearing piles resisting the resolved component of the thrust and the weight of the upper structure, together with the tension taken up by the back raking timber piles. This type of design requires refinements in calculation and accurate knowledge of the soil materials.

Wharf Structures Surrounding Old Cribwork

Numerous old timber crib structures are found along the sea coasts and on all navigable waters in Canada. These have performed useful service, but are in many cases deteriorating. Their reconstruction by ordinary methods involves pulling down the old structure first, always a costly operation, and then combining a new section with what is good of the old. With the use of steel piling, however, it is possible to leave these structures almost exactly as they are and surround them with a wall of steel piling driven close to the existing face, this reconstruction work being done either completely in one operation or partially as funds permit year by year. The economy of such work will be clear when it is considered that no old work has to be demolished and the reconstruction work can proceed with little interference to the use of the wharf structure.

As an example of this type of work, the first application of steel piling to work in the Gaspe Peninsula may be mentioned, this having been at L'Anse au Beaufils fishing harbour, the entrance to which was completely wrecked by a cloudburst above the harbour on October 25th, 1933. Figures 11 and 12 illustrate the state of the cribwork protection jetties at the entrance to this harbour as they were after this occurrence. The harbour entrance had to be reconstructed and ready for the opening of the 1934 fishing season, since many fishing boats were wintering inside the harbour. After most careful consideration, it was decided to use steel piling for this purpose and the cross section shows a typical part of the reconstruction work. In some cases the steel piling used had to be driven through old timbers of the wrecked cribwork, but no difficulty was experienced in doing this. A further photograph illustrates the condition of the entrance early in the summer of 1934 and this view may well be left to speak for itself. Since that time reconstruction in steel piling has been continuing both in the outer and the inner sections of this harbour.

Conclusion

Steel sheet piling will no doubt be used in many major works to be undertaken in the future in the Dominion, but in the author's opinion will be even more widely employed in

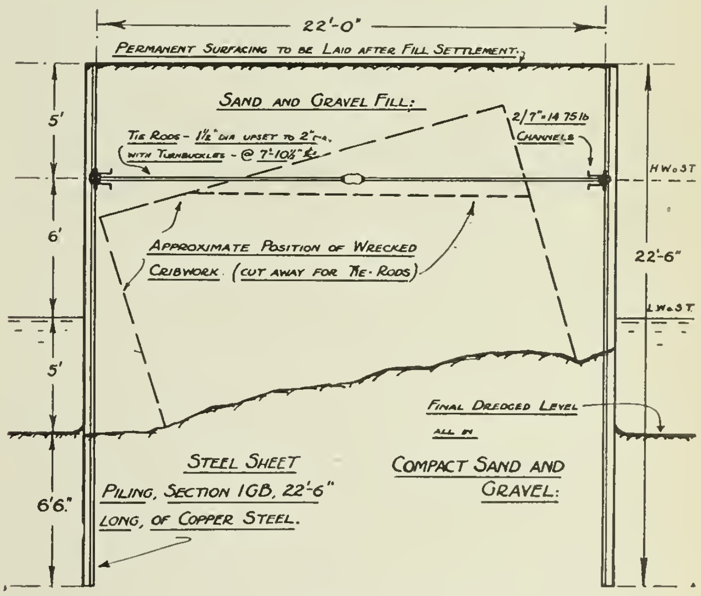


Fig. 11—Reconstruction of Entrance Jetties, L'Anse au Beaufils

the smaller construction and reconstruction works. There are naturally special features affecting the use of steel sheet piling in Canada, several of them occasioned by ice conditions, as for example the desirability of keeping channel walers inside steel pile walls instead of on the outside.

The author believes that there is no real competition between timber and steel piling in future civil engineering work in Canada. In the past, timber has been so plentiful that little thought was given to the economics of its use, and it was often the only material considered for many structures such as have been described. That state of affairs has gone and with it much of the great heritage of timber which

Canada possessed, leaving a situation so serious that quite recently the National Research Council have appointed a special committee to consider all aspects of research in connection with reforestation. When it is realized that in many parts of eastern Canada it is impossible to obtain local 10 inch by 10 inch timbers in any useful lengths it will be appreciated that the sooner engineers and others grapple with the problem of timber conservation the better it will be for the good of the country. In such conservation work the judicious use of steel piling for permanent structures can be of real assistance.

Fig. 12—New Jetties, L'Anse au Beaufils.

Although the notes of structures given in this paper are necessarily brief, the author wishes to record the names of the engineers and contractors responsible for them. This information is, therefore, given in an appendix. Thanks for permission to reproduce certain of this information are due to K. M. Cameron, M.E.I.C., chief engineer of the Department of Public Works, Canada, Ottawa, to H. V. Anderson, M.E.I.C., of the Department of Marine, Ottawa, and to J. G. R. Wainwright, A.M.E.I.C., chief engineer to the Toronto Harbour Commissioners.

Steel sheet piling, considered generally as a construction unit, is one of the specialized commercial products of the steel industry. The promotion of its use has thus been developed by various steel and piling companies whose resources have made possible much experimental work in connection with rolling and new design. The author desires to record his appreciation of the assistance and information received from the following companies, all of whom have been closely associated with the use of steel sheet piling in civil engineering construction:—Carnegie-Illinois Corp., Pittsburgh, Pa. (and United States Steel Products Co., Montreal); Bethlehem Steel Corporation, Bethlehem, Pa. (Bethlehem Steel Export Corporation, Montreal); Steel Union-Sheet Piling Inc., New York; British Steel Piling Co. Ltd., London, England; and Canadian Sheet Piling Co. Ltd., Montreal.

The Economical Production of Steam and Power from Anthracite Screenings

J. R. Groundwater,
Plant Engineer, the Bruck Silk Mills, Cowansville, Que.

Paper presented before the Montreal Branch of The Engineering Institute of Canada, April 16th, 1936.

SUMMARY.—The author describes the development and operation of the boiler plant of a silk mill, capable of supplying some 45,000 pounds of steam per hour for use in process work and in steam-driven generating sets of about 600 kw. capacity. Data are given as to performance, efficiency, and the difficulties encountered in operation.

The industrial power plant described in this paper contains several unusual features. These have been logical developments, each one having led to another, and the final result has been very satisfactory. It is hoped that the description of these steps will encourage other engineers to develop similar possibilities, and to apply the resources of modern steam engineering to the special problems of the industrial plant.

To illustrate the various steps in the development of this steam plant, it is proposed to give first a brief history of the manufacturing plant itself.

In 1922 the first of the buildings shown in Fig. 1 was purchased by Mr. I. I. Bruck at Cowansville, Que., and the Premier Silk Mill came into being. Later it was found that this name belonged to an English company, and so it was changed to Bruck Silk Mills Limited. This was the start of the first broad silk mill in Canada.

It must have required considerable courage and foresight to start such an industry in this country at that time. General business conditions were poor, there were no silk workers in Canada, and, in addition, a market had to be created for the product. Nevertheless, the company was successful from the beginning and today has a large and thriving business.

The original building had been heated by a cast iron boiler, which was immediately replaced by a semi-locomotive type of 40 h.p. designed for 100 pounds pressure.

It was soon found that more space was needed, and during the same year the extensions shown were built. In the following year (1923) further extensions were made, and two more locomotive type boilers were added. Further additions were made in 1924, 1925 and 1926, and in 1926 a 500-h.p. vertical Wickes boiler with a V-type over feed stoker was installed. In 1928 a new weave shed was added followed in 1931 by a print building.

In 1932 the weave shed was again extended, and the factory had reached a size where steam and power supply required more consideration. The number of steady employees had risen to 850 and the floor space had increased to 168,000 square feet.

Up to this time the mill had been buying power from the local power company. Unfortunately, power interruptions were not infrequent, and while of short duration were an expensive matter, for in a silk mill any sudden and unexpected stoppage, however short, causes great trouble in the spinning and weaving department. The dye-house was run on direct current supplied through a 50-kw. motor generator, and in event of power failure, from a stand-by storage battery. This battery was capable of running all the d.c. motors in the dye tubs until the fabrics were saved, or removed from the dye.

In addition to purchasing about 750 h.p. of electric power, the company was using large quantities of coal to generate steam for process work. Mr. Bruck therefore decided to investigate the possibilities of power generation with this steam.

During 1932 this was studied, and finally a start was made by replacing all the locomotive boilers with a 375-h.p. straight tube boiler of 220 pounds w.p. It was oil-fired, by two steam atomizing burners, with a capacity of 20,000

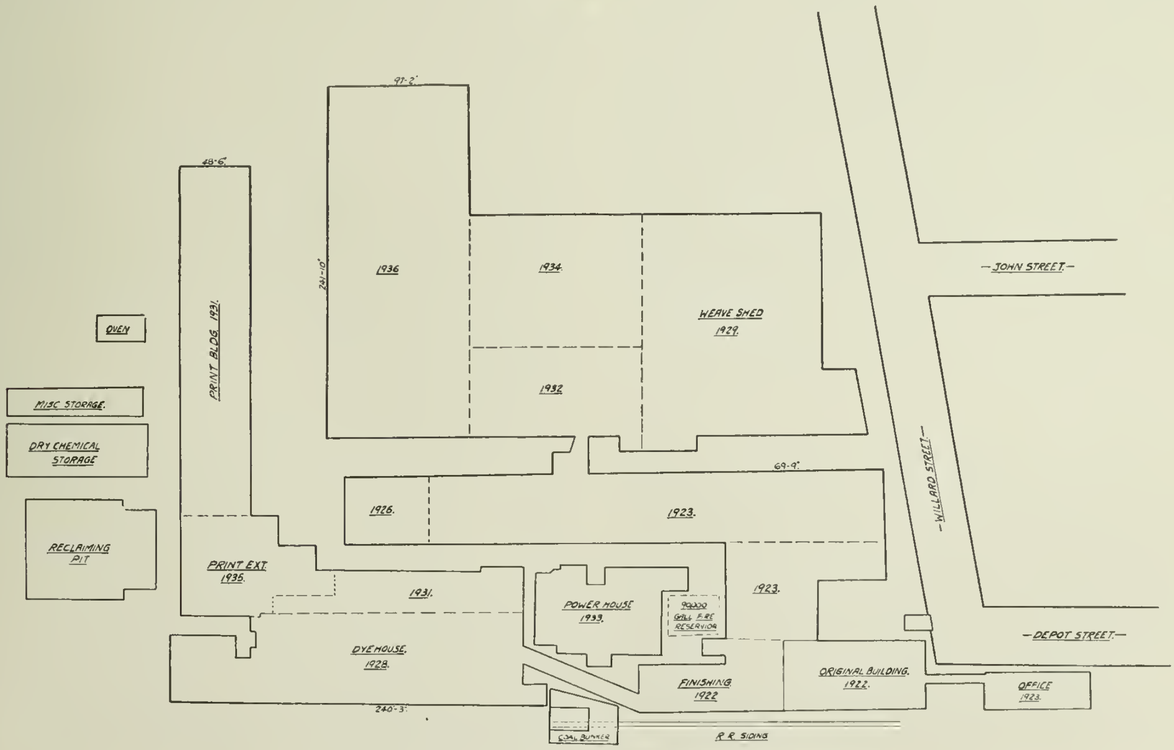


Fig. 1—General Layout Plant Bruck Silk Mills.

pounds per hour. Five compound high speed engines were installed, direct connected to 550-volt generators. One of these was a d.c. machine, and a 50-kw. motor generator served as a d.c. standby.

This installation was successful economically and also reduced the number of power interruptions, but it was soon apparent that more boiler capacity would be needed. A serious study of the situation indicated that with modern steam generating equipment in which efficiency can be brought to any point that justifies the expense, the variation in the cost of the fuel itself affords the best opportunity for savings. This point had been fully illustrated by the equipment already installed. The oil burning unit was easy to operate, and developed a high capacity in a small space, but the cost of steam was tied to the fuel oil market. The coal burning unit was equipped with a V-type overfeed stoker and it had been found that this stoker was rather particular about its fuel; a certain combination of coking qualities and clinkering tendencies was necessary to obtain the best results.

In view of this, pulverized fuel was seriously considered, since oil, or any grade of bituminous coal, could then be burned at will. On inquiry, however, it was found that a considerable tonnage of Welsh anthracite screenings was available at a very attractive price, and therefore further consideration was given to stokers.

This coal was high in heating value—14,600 B.t.u. per pound—and after working out suitable allowances for efficiency, maintenance costs, and capital costs for special combustion equipment, it still showed the lowest cost per B.t.u. delivered; it was therefore decided to use this fuel. It was found that the special equipment required could be converted, when necessary, to burn bituminous coal and a long term contract for Welsh screenings assured a sufficient supply to justify the extra initial cost.

This fuel had, however, a number of peculiar qualities. In the first place, it was very fine; 90 per cent was under $\frac{1}{8}$ inch, 60 per cent was under $\frac{1}{16}$ inch and there was even a good deal of 100 and 200 mesh dust. Since the plant was a silk mill, and had the finishing department located beside the coal dump and boiler house, flying dust would be fatal. Several visits were made to coal yards to observe the behaviour of screenings when handled, and it was seen that if the fuel was allowed to run smoothly by gravity without dumping or falling through space, no great amount of dust was liberated. Since it was necessary to dump from the railway cars into a 300-ton bunker under the track, a house was built to enclose a 60-ton centre dump car. From under this bunker a belt conveyor was run in a covered trench to inside the boiler room where the totally enclosed coal elevator is located. This elevator discharges to a dust-tight hopper at the front of the boiler, which has about 7 tons capacity. In following this procedure the coal slides by gravity, and wherever it is disturbed to a harmful extent it is fully enclosed. This arrangement has been quite successful in preventing any trouble from the dust in the factory.

The next point was the pressure of the boiler. The mill uses an average of about 33,000 pounds of steam per hour in the winter, and 20,000 pounds in the summer. The winter electrical load of 600 kw. can therefore be developed by any generating units with a water rate under 55 pounds per kilowatt hour. The summer load of 500 kw. would require a water rate of 40 pounds per kilowatt hour. It was therefore decided to adopt a moderate pressure of 200 pounds for present operation, since this could be used by the existing engines, and would be perfectly satisfactory for the bulk of the year's load. In order not to hamper future developments, the pressure parts of the boiler and superheater are built for 450 pounds.

The capacity of the new unit was determined by making assumptions of future growth of the mill, and an output of 30,000 pounds per hour seemed to meet the requirements. This has since been increased to 45,000 pounds per hour.

The extreme fineness of the fuel affected the selection and design of the combustion equipment and it was soon apparent that the best grate surface for this service was one with very fine and closely spaced air openings. This was necessary to reduce the amount of fuel sifting down through the grate. Moreover, since the fuel had no coking qualities whatever, to hold the particles in the fire, it was necessary in order to reduce the blowing of coal out of the fuel bed. To further reduce this action, a large stoker was selected, with a maximum burning rate of around 20 pounds of coal per square foot per hour.

Investigation showed, however, that even with these precautions, carry-over of fine fuel would be a serious matter, and special means were needed to deal with it. A rear arch type of furnace was used, in which the combustion gases rising from the fire travel forward over the front of the fuel bed, instead of passing straight to the boiler. The fine fuel in suspension is, to a considerable extent, dropped back on the fire, especially at the front of the grate, where the gases turn up to the boiler. In order to obtain the greatest benefit from this action, a relatively long and narrow stoker was selected, so that as much burning as possible would be done under the rear arch. To catch dust carried into the boiler, large soot hoppers were provided under the rear arch passes, discharging back into the furnace.

Another peculiarity of this fuel is the extremely low ash content, only 4 to 6 per cent being found even in the screenings. Practical experience indicated that this would mean rapid burning of the grate surface, so an attempt was made to counter this by ordering grates made from a heat resisting alloy.

One of the unexpected properties of this fuel was that although it contained 6 to 9 per cent of volatile matter, it was much slower burning than American anthracite with only 2 to 4 per cent volatile, so slow burning, in fact, that a heavy loss in carbon to the ashpit must be expected. After making due allowance for this, and for the loss in fine fuel blown out of the fire, it was found that efficiencies of 70 to 72 per cent could be obtained.

Having settled on the fuel burning equipment, a boiler was selected to suit it. The one purchased met the requirements very well. It provided a large, high furnace, with a long path for the flames sweeping out from under the rear arch and ample steam and water volume to meet a fluctuating load. Its arrangement facilitated deslagging of the first pass, through doors in the front wall. Hoppers could be conveniently arranged under the last pass.

Having settled all the details, a contract was signed in October 1933, and the unit was ready for operation on February 2nd, 1934. It was started up and put on the line the same day.

In spite of the rapid construction programme, the work had been successfully carried out, and no difficulties were encountered which necessitated stopping. The boiler room staff were without experience with travelling grate stokers, but adapted themselves very well to the new machine. In less than a week the firemen were thoroughly familiar with the operations necessary to maintain a load of about 20,000 pounds of steam per hour.

The first interesting development was the surprise of the staff in finding that by changing from oil to coal over $110 per day was being saved. The unit was found to be most sensitive and easy to control, and adjustment of the main forced draught damper and of the stoker speed, with the necessary correction of the boiler damper to maintain

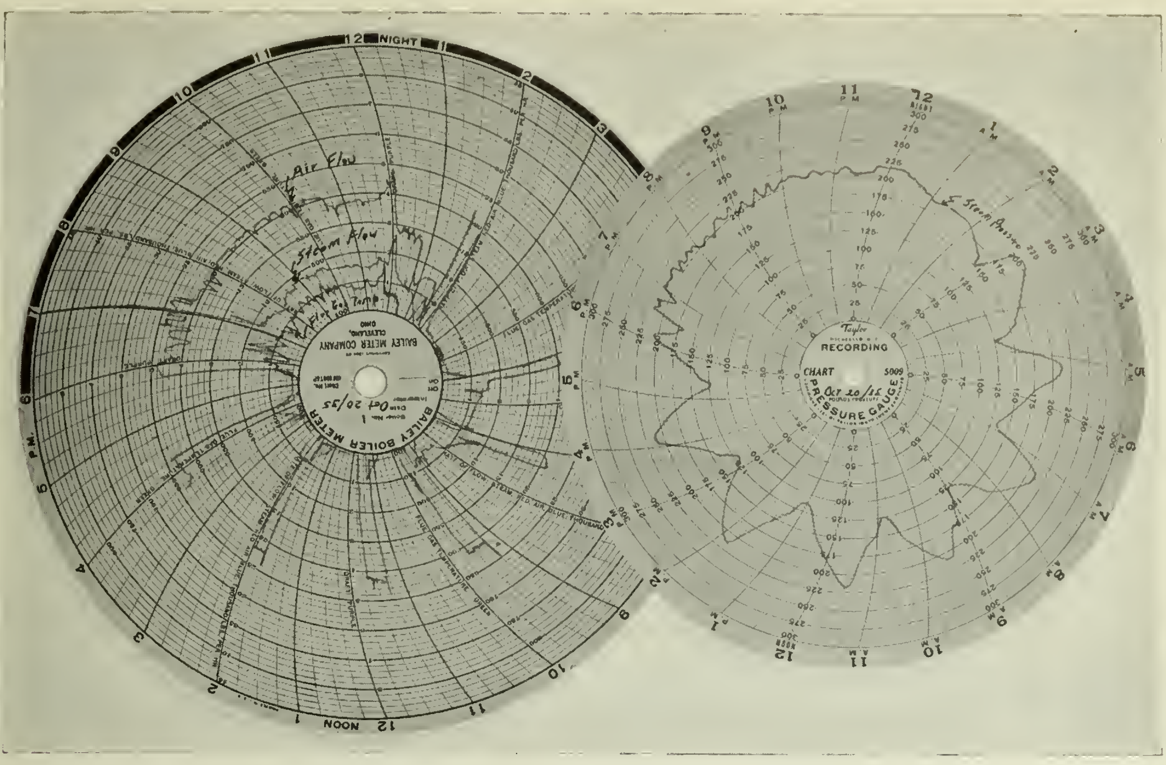


Fig. 2—Charts showing Week-end Conditions.

a suitable furnace suction, would suffice for 80 to 90 per cent of the unit's operation.

This, of course, would be the case only if the correct settings of the compartment dampers had been made. As has been mentioned previously, the full benefits of the rear arch are only realized if the fire is burned under it, and this means that instead of applying the maximum pressure in the first compartment, it is applied to one of the rear compartments, and air pressure then gets less towards the front instead of toward the rear of the grate. If full pressure is applied near the front, the fuel bed bubbles somewhat like porridge boiling, and this occurring under the throat of the furnace, results in a high percentage of fine fuel being blown up into the boiler. With very wet fuel this premature bubbling appears at the front, even with the correct low air pressure, but it is caused simply by steam being generated and puffing up through the bed, and this has no special effect.

After the normal load was being carried satisfactorily, the next problem was carrying the extremely low week-end load. From midnight Saturday to midnight Sunday the only load is the stoker engine, and a 50 kw. d.c. generator which supplies light and refrigeration. This amount of steam is so small that it does not record on the meters, and some doubt was felt about just what would happen. There were two conflicting dangers, that of burning the grate if the furnace was kept hot, and that of losing ignition if it were cooled off. The method of operation finally worked out overcame both of these, and consisted simply in intermittent firing. This method is not generally advocated by manufacturers, whose pride in their equipment leads them to attempt the almost impossible feat of running continuously at 2 to 3 pounds of coal per square foot. Actually it is a simple and practical method. About a 3½-inch fire was carried, and as may be seen on the chart (Fig. 2), the fire blown and the pressure raised every two or three hours for twenty minutes, then the unit was allowed to stand with all dampers shut. While the fire gets quite black it comes to life in a few minutes when air is supplied.

In summer it was necessary to go six or seven hours without starting the fans and it was found advisable to put a few shovels of soft coal across the rear edge of the fire. This was found to be entirely satisfactory, in fact the unit has stood under these conditions for over twelve hours, and, as may be noted from the chart, has then been put on the line in twenty minutes.

Attention was next turned to tuning up for maximum efficiency. It was mentioned previously that the fuel is slow burning, and a high loss of carbon to the ashpit was expected, but no great attention had been paid to the true meaning of this high percentage of carbon in the refuse. To visualize what was encountered it must be remembered that with a 4 per cent ash coal, 50 per cent carbon in the ashpit means only 4 per cent loss in the heat balance. Four per cent ashpit loss is not unduly high with a very refractory fuel, and the operating efficiency had been based on exceeding even this.

The result was that the ashes which were being used as fill around the unit preparatory to laying a new floor looked quite dark in colour, and showed possibilities. These possibilities were realized a few days later when a hitch occurred in the coal deliveries. In an effort to keep the unit on the line the entire floor fill was dug up, and put in the stoker hopper. To the great surprise of the staff the unit carried at least 70 per cent of the load which it had been carrying, and ran for over six hours on this refuse. This showed that the stoker and furnace were capable of burning a very low grade of fuel, and later test runs with coke breeze have proved this to be so.

This discovery that the ashpit refuse could be burned led to a more careful study, with the idea of developing a continuous method of handling it, of skimming out the clinker, and returning the fuel to the hopper. Although this idea was not, as far as the author knows, in use in the mechanical stoker field, it is really similar to the regenerative cycle used for reducing the steam to turbine condensers, and in other forms in other fields.

The final outcome of this may be seen in Fig. 3; it has been in operation for almost two years without giving

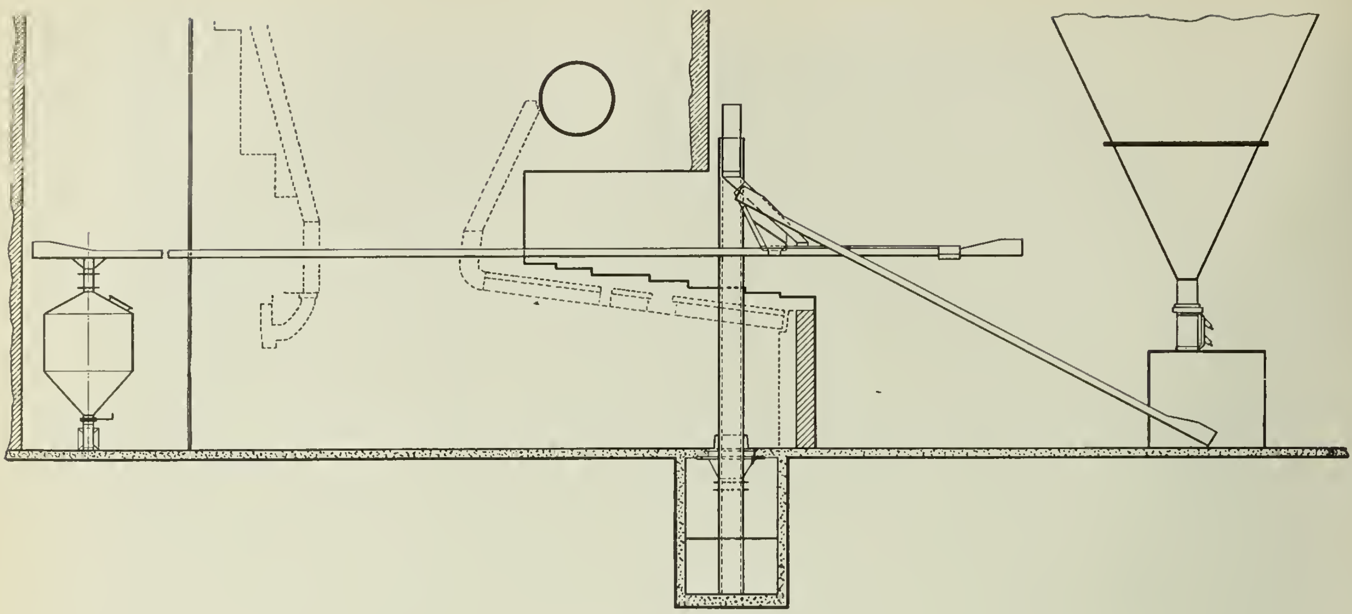


Fig. 3—Ash Reclaiming Device.

any trouble. Thanks should be given here to the various manufacturers who co-operated in the creation of this system.

First experiments included a light steel hopper built in the ashpit, with a provision for air circulation all around it. However it was found that ashes of this kind, being very small particles, cooled rapidly, and, unless a large pile was accumulated, the highest temperature did not exceed 700 degrees. This indicated that a mechanical conveyor, if properly arranged, would work satisfactorily, and one has been very successful in service. So far the only maintenance work has been the renewal of the conveyor chain pins; even this was more precautionary than necessary.

This conveyor system is timed to work with the coal handling equipment. About every four hours coal is taken in, and the ashpit cleared. First the coal elevator is started, then the belt delivering coal to this elevator, and then the ash conveyor. These are all electrically interlocked. When the coal is feeding freely to the elevator, the ashpit conveyor is started, and the refuse is elevated, dropped through the screen where clinker is removed, and the combustible refuse is then brought forward to mix with the coal where it is fed to the elevator.

With this arrangement, the coal and refuse are well mixed, being well shaken up together on entering and leaving the elevator.

The screen for skimming out the clinker is ¾-inch mesh, this size having been determined by experiment. If the openings are too small, good combustible is rejected with the clinker; if too large, clinker gets sent back to the hopper. In considering this whole arrangement, it will be seen that it depends on obtaining good separation of the clinker from the combustible, so the screen is the vital part.

After putting this ash handling system in service, operation was found to be much simpler. The extra ash in the incoming fuel, which increased the average ash in the fuel from 4 or 6 per cent to 7 or 9 per cent, helped protect the grate against burning. It almost eliminated one of the fireman's duties, since the amount of unburned coal going to the ashpit was no longer of any great importance.

Towards the end of 1934, owing to further large plant extensions, it was necessary to again increase the steam generating capacity, and several alternatives were considered. A new boiler could be installed, the oil burning unit could be revamped to burn coal, or the output of the existing unit could be increased. It appeared that this latter was the best alternative, since the extra 50 per cent of capacity required could be obtained by equipment that would also increase efficiency.

One of the main limits to high output was the carry-over of fine dust in the gases. This has been mentioned before, and it will be recalled that two large hoppers had been provided under the last passes to catch some of this dust. This arrangement proved very satisfactory, in fact, the operators used the dust for meeting sharp peaks. Feeding it into the furnace gave an instant increase in output without altering stoker or fan speeds. This carry-over reached serious proportions above 30,000 pounds per hour, but experience showed that it would be easy to collect, and would burn readily, so a dust collector offered one way of increasing capacity.

An induced draught fan was also needed, the chimney having no reserve of draught beyond that required by the boiler at 20,000 pounds per hour. An economizer was therefore included, since under these conditions it would be relatively inexpensive. The particular design selected was one which could not plug up, or collect dust on the heating surfaces. This surface consists of steel tubes with fins welded on in the same line as the gas flow, thus giving a large surface for heat transfer with low resistance to gas flow. The tubes are staggered so that while the fins do not obstruct the gas flow, it travels zig-zag, and the heat recovery is excellent. The same idea was adopted underneath the economizer as had been applied to the second pass of the boiler, thinking to again collect dust and return it to the furnace. This, however, turned out to be a total failure, as there is no deposit whatever at this point if the load goes over 30,000 pounds; and all the dust which passes the second pass hoppers goes to the collector, which proved to be very efficient.

The contract for this extension was placed in November 1934, to be completed in February 1935, and the work was satisfactorily carried out on time. Since then there have been excellent opportunities to observe the behaviour of the equipment, since the load reached and even slightly exceeded 45,000 pounds at various times. Operation has proved to be easy, for the two main worries of the fireman—carbon loss, and dry gas loss—have been almost eliminated. High carbon loss to the ashpit is impossible, since all the combustible is returned to the stoker hopper. High carbon loss in the form of carry-over is caught and returned. High excess air has much less effect than it would without the economizer. The result of this is that it has been possible to operate at efficiencies of 82 to 85 per cent for long periods, including the Sunday low load.

The return of extra ash in the dust from the collector has had a further beneficial effect on the grate surface, which now appears to have an indefinite life ahead of it. The only furnace deposit that has been found so far is a kind of spongy slag which builds up to from 2 to 8 inches thick all over the brickwork and then drops off at odd periods, and then the process begins all over again. This has the effect of protecting the brickwork, as it would appear that it builds up under normal conditions, and if some unusual temperature occurs it either runs or drops off without doing any harm. The ashpit conveyor is covered with a one inch square grid so that this cannot get into the chain, and the slag is removed from this grid by hand once a day.

To prevent burning of the furnace lining at the grate line a single clinker chill tube is fitted to each side of the furnace.

After two years' continuous operation, the upkeep charges of the complete unit have been less than $500. In this time the unit has evaporated 291,527,200 pounds of steam, and has burned 14,730 tons of coal. The total maintenance cost for all the equipment therefore amounts to about 3.4 cents per ton of coal.

Great care has, of course, been taken with the supply of feedwater. Fifty per cent of this is returned, and the makeup is zeolite treated. A continuous blowdown is fitted.

The feedwater to the boilers is first heated to about 212 degrees by the exhaust from the boiler feed pumps through a closed coil fitted in an open tank, 7 feet in diameter by 8 feet high, set 25 feet above the pumps, which acts as a surge tank. The makeup water is normally supplied by pumps from the river about 600 yards away, and in addition there is a direct connection from the town water. It is found that at odd times when the dye house is exceptionally busy the demand for water is so great that it lowers the pressure on the entire system. This is one of the minor things that had to be taken into consideration as it would have been uneconomical to install pumping equipment to take care of such high peaks, which only occur twice a day and last for ten to fifteen minutes. The overhead tank above the pumps has sufficient capacity to handle these peaks.

The closed heater using the feed pump exhaust prevents oil from that source entering the feedwater, and as a precaution against oil from the generators, the tank is overflowed once a shift and the overflow inspected. As an additional precaution, the tank from which the returns are pumped to the overhead tank is overflowed twice a day, and within 18 inches of the pump suction the feedwater should be reasonably safe against oil.

After the water leaves the overhead tank it is pumped through a high pressure heater, supplied with exhaust steam from the generators, which delivers it to the economizer at 230 degrees. Thus the water reaches it at a temperature well above 200 degrees, and is free from scale forming material or oil. These precautions have prevented any scaling or corrosion in the steel tube economizer to

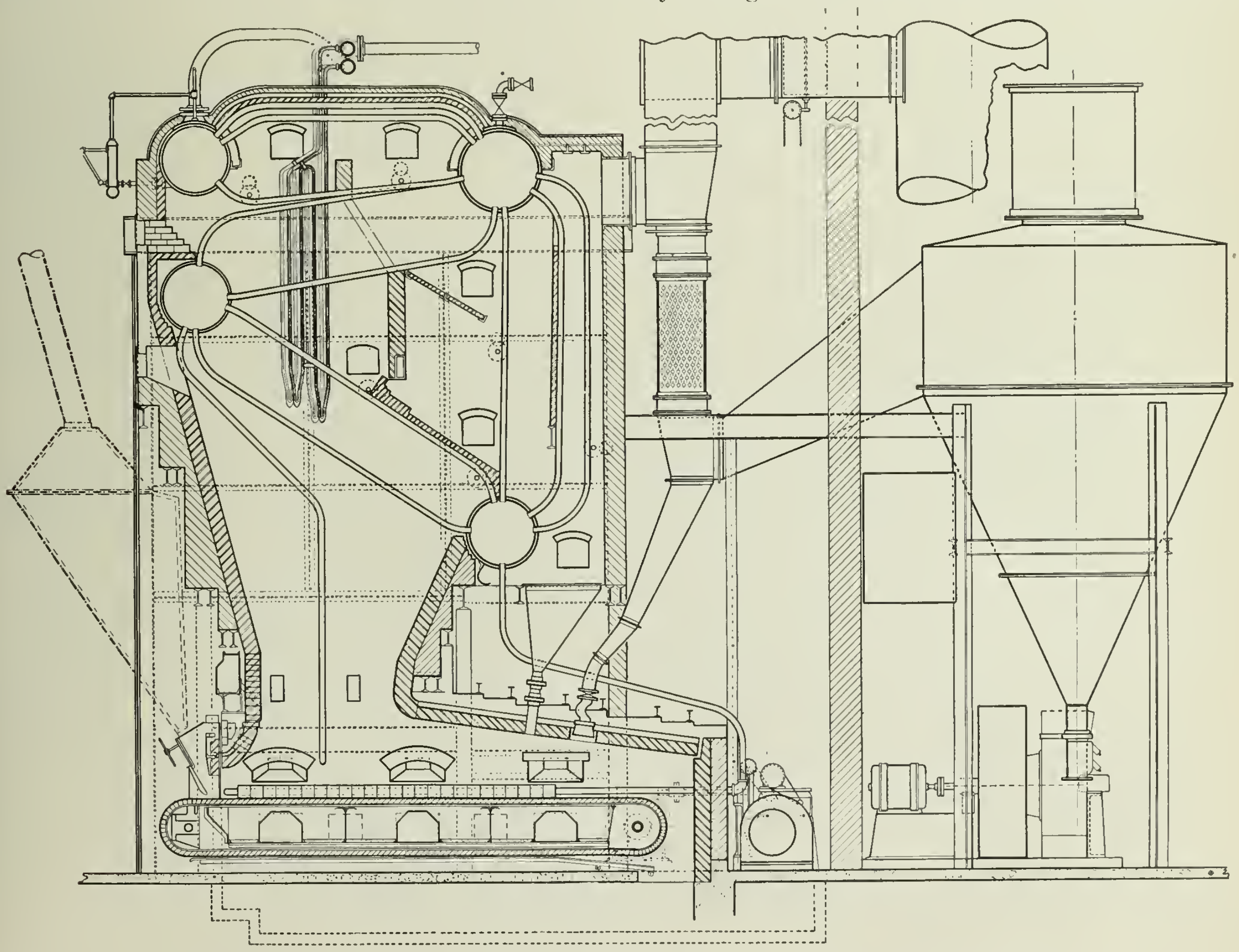


Fig. 4—Section Through Boiler Installation showing Dust Collector and Economizer.

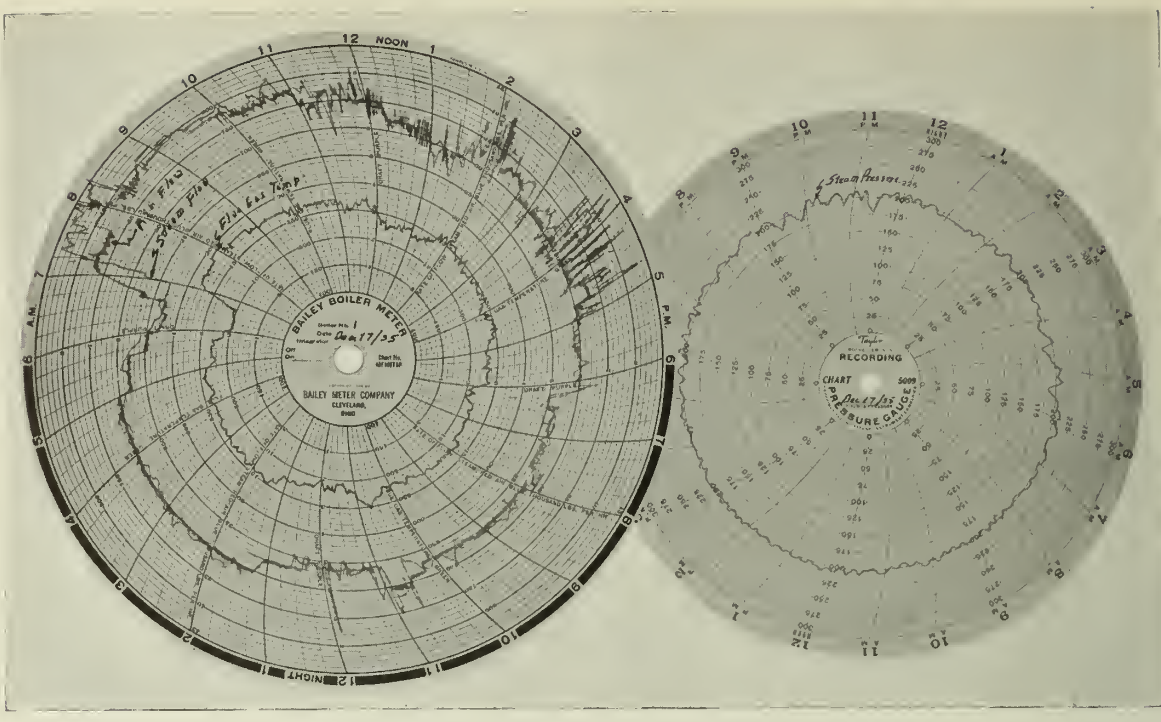


Fig. 5—Charts showing Load Increase and Pressure.

date. The water leaves the economizer at 280 to 300 degrees, and the flue gas, which enters at not over 560 degrees at 45,000 pounds per hour, leaves at about 360 degrees.

An oil separator of the latest type and of ample capacity prevents any cylinder oil passing into the exhaust mains.

Three hot water storage tanks of about 30,000 gallons total capacity have been installed to help even up the wide variation of steam demand, and these are heated at any period during the day when the factory steam demand gets below the generator steam output. During the night, when process work is light, these tanks are heated to 180 degrees, and at 7 o'clock a.m. the steam is shut off and the water is used for dyeing. This takes about two hours. This has eliminated the high peak that occurred each morning and it actually has the effect of increased boiler capacity.

To further balance the steam and electrical load during the summer one generator is run on back pressure, one condensing through a barometric condenser. This condenser gets its water from a 200,000-gallon reservoir which is located under the dye house, and from which the whole factory is supplied. Approximately 80 per cent of this water has to be heated in any event, so that the heat of the condensing water is put to work on this job. A further step taken is to exhaust at atmospheric pressure with one generator to the hot water heaters, and then if any surplus is left over it is blown directly into the large water reservoir.

In reviewing the experience with this installation, there are a number of points of interest. The rear arch furnace was a novelty in this district, but it has been found easy to handle, in spite of its operation being so entirely different from that of the front arch furnaces commonly used. The ignition of the coal is steady and uniform, even when wet. The fines carried out of the fire are deposited, to a great extent, on the front of the grate by the current of hot gases. The turbulence and mixing in the throat of the furnace is quite strong, as can be seen in the swirling of the flames. A certain proportion of the air for combustion is blown down through eight nozzles located just above the front arch in the throat of the furnace. These help the turbulence.

Due to the extreme fineness of the coal, it can carry a large percentage of moisture. If it is normal in size, this causes no trouble, even if it reaches 20 per cent; but it is found that if the two larger sizes, $\frac{3}{16}$ inch and $\frac{1}{8}$ inch, are left out it is almost impossible to run at high ratings with more than 10 per cent moisture. On the other hand, if the moisture is around 6 per cent no trouble is found in burning it, even if it is all fine. It has been found an ideal fuel for storage, as there is no tendency for it to heat and cause spontaneous combustion under any conditions.

There has been no difficulty of any kind with the superheater. This was primarily designed for operation at 450 pounds, and was adjusted for operation at lower pressure by leaving out several loops. A total steam temperature of 520 degrees is about all that it is thought advisable to use with the type of prime mover, and the staff available for operation.

The method of operating the boiler has been to run continuously from one annual inspection in August to the following August, and so far this has been entirely satisfactory, even if it does sound unusual. On opening the boiler no deposit has been found in any of the drums except the top front drum, where there was about an inch of scum or slush, which was washed out with an ordinary garden hose, and no further action was necessary. The blowdowns on the lower rear drum and the economizer are opened once a week to make sure they are clear.

A $\frac{1}{4}$-inch drain is fitted to the top of the economizer and this is piped to the floor where it can be opened once a day to blow out any possible accumulation of air. A similar drain is fitted on top of the high pressure feed heater.

The boiler has operated quite satisfactorily. The load is liable to sudden increases, and on these occasions the water in the front boiler drum will rise about $1\frac{1}{2}$ inches, due to the swelling of the water. The gauge glass and feed regulator are both fitted to this drum, as it materially helps the operator when getting a sudden demand for 12,000 pounds extra, to feel that he has lots of water, and the pumps do not get a chance to put in extra water before he has regulated his draughts to meet the additional load. The reverse of this is also found when load is dropped, and it is found that with the drop on load and the water dropping the feed pumps immediately get into action and the incoming water helps to absorb the surplus heat and prevent blowing of safety valves.

Some of the foregoing may appear to be of minor importance, but it has been found that it is such small items, added together, that mean the difference between good and bad results. The confidence of the operator in his equipment is of first importance, as the results in any plant are only equal to its method of operation.

From February 1st, 1932 to February 1st, 1933, 11,920,000 pounds of bituminous coal was burned giving an evaporation of 83,440,000 pounds steam, in addition to this an annual electrical bill was paid for a connected load of 750 h.p.

In 1933 for the same period 937,740 gallons of oil were consumed giving 122,109,650 pounds of steam and 2,220,000 kilowatt hours. A better explanation of what the actual electrical load meant would be to say that when the company's plant started at the end of 1932, 5,600 to 6,000 kilowatt hours were an average daily load. This has now increased to 12,000 kilowatt hours per day.

In 1934, 14,539,730 pounds of screenings were consumed giving 136,513,550 pounds of steam and 2,635,140 kilowatt hours. In 1935, 14,923,500 pounds of screenings were consumed giving 155,013,650 pounds of steam and 3,112,230 kilowatt hours, this representing an increase of 11 per cent on 1934 figures by adding the economizer and dust collector.

As the company made a long term contract for coal it would not be fair to state here the price of fuel, but the graph shown in Fig. 7 will give an approximate idea of the complete results of this installation.

The cost of this steam unit cannot be charged up entirely to the new scheme as an increase in steam capacity was inevitable. What should be charged to this account would be three shift engineers and one extra fireman and the investment in generators plus insurance and depreciation. Against this can be set the saving of time and improvement in production and quality of goods with reliable power, which cannot be calculated directly but is very evident.

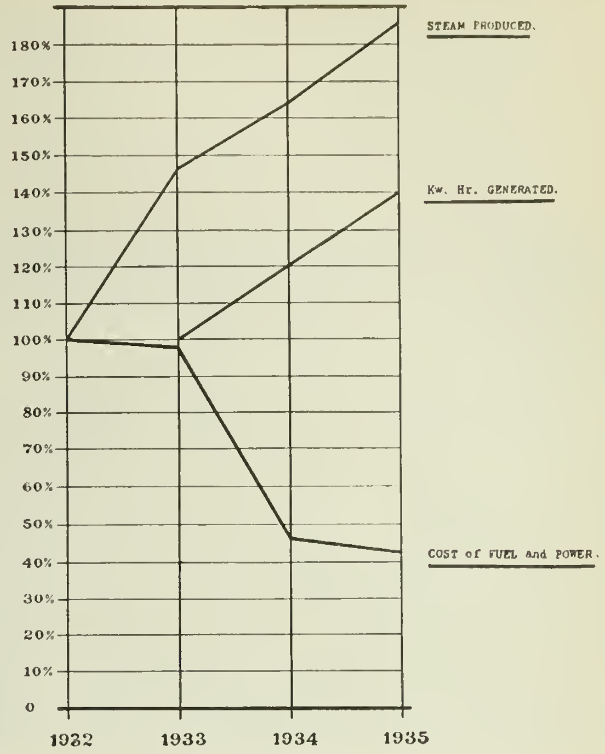


Fig. 7

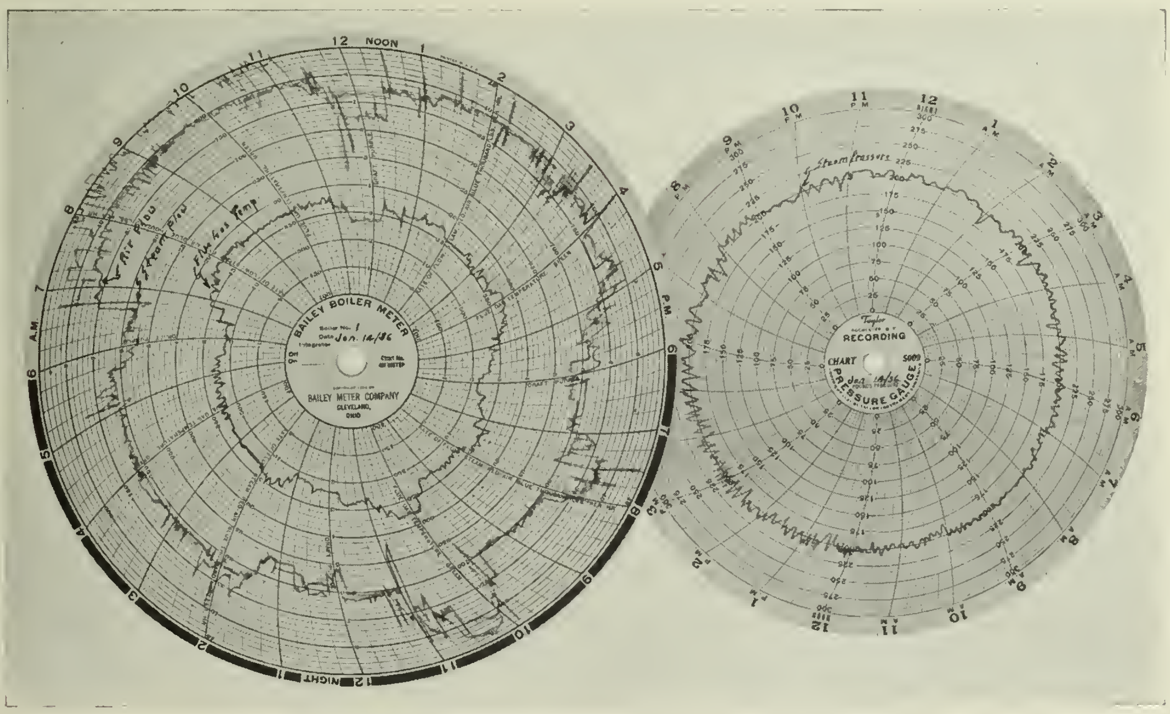


Fig. 6—Charts showing Load Increase and Pressure.

The Soya Bean

Its Growth, Processing and Uses

D. L. Calkin,
Dominion Soya Industries Limited, Montreal.

Paper presented before the Montreal Branch of The Engineering Institute of Canada, January 23rd, 1936.

SUMMARY—The author gives a brief account of the plant and its cultivation, the bean and the methods by which oil and meal are produced from it, and the many uses of these products for food and industrial purposes.

The soya bean has been called the "wonder seed" of the age, and a study of the literature on this plant and its many and varied uses will soon convince one that this cognomen is particularly apt.

The plant was cultivated and highly valued as a food in China and Japan for centuries before written records were kept. It is mentioned in the ancient "Materia Medica" of the Chinese Emperor Shen Nung, written almost five thousand years ago. In many parts of the East it provides practically the sole source of proteins in the daily diet of the people. Only 2 per cent of protein in Chinese diet is supplied by fish and meat, against 18 per cent in North American diet.

The first soya beans were brought to the United States by a New England clipper in 1804, but it has become a crop of importance only within the last twenty years. In 1915 about 500,000 acres were under soya beans in the States; last year there were over 5,000,000 acres and the crop, exclusive of those grown for hay, amounted to over 39½ million bushels.

In Canada the soya bean has been grown at the Ontario Agricultural College, Guelph, for approximately forty years, and is now being grown at other Government Experimental Stations and by farmers in several provinces, the largest acreage being in Ontario. In Canada there are now some 15,000 to 20,000 acres devoted to soya beans. It may be of interest to note that at the annual International Grain and Livestock Exposition at Chicago, Mr. Finlay, Northwood, Ont., recently won first prize for soya beans for the third consecutive year.

The following table, compiled from production figures for 1934, gives an idea of the magnitude of the world soya bean crop:—

Table I

Manchuria	173,160,000 bushels.
China	159,840,000 "
Japan and Korea	31,635,000 "
United States	17,762,000 "
Soviet Russia	3,330,000 "
Total	385,727,000 "

Soya beans are grown in many countries but the five listed are the largest producers.

Varieties

There are an almost infinite number of varieties of this plant and it has been found that the selection of the proper variety for each district is of the utmost importance; as beans which will grow and mature in one section may prove an absolute failure in another. An intensive study of this question has been made, both in Canada and in the United States, where some three hundred varieties have been tested in an endeavour to find strains suitable for different sections of the country.

Another important item is whether they are to be grown for seed or for forage purposes. If grown for the bean then the yellow varieties are most desirable, as when processed they yield lighter coloured products, and usually have a higher oil content. Unfortunately most of the yellow beans require a longer season to ripen. When grown for forage some of the brown, green or black strains, which mature more rapidly, are suitable.

To mention a few of the many varieties, there are:

Yellow Soya Beans.	Manchu, Mandarin, O.A.C. 211, Ito San, Illini, Mammoth Yellow and Greenfield.
Green Soya Beans.	Morse, Medium Green, or Guelph.
Black Soya Beans.	Wilson, Peking, Wisconsin Black and Tarheel.
Brown Soya Beans.	Virginia, Mammoth Brown, Early Brown and Manitoba Brown.

Fig. 1—Soya Bean Plant.

The soya bean is a legume, combining the advantages of a legume with those of an annual cash crop and an oil seed bearing plant. It grows from two to five feet high, has small white or purplish flowers and the seed pods are two to three inches in length, containing one to four seeds. The stems, leaves and pods are covered with fine, short hairs.

The average composition of the mature seed is:—

Table II

Oil	19 per cent
Protein	40 " "
Carbohydrates	20 " "
Crude fibre	4 " "
Ash	5 " "
Lecithin	2 " "
Moisture	10 " "
Starch	Traces only.

Of course analyses may show wide departures from the above and figures are dependent on the soil, climatic conditions and the variety of soya bean. The fat may fall below 14 per cent or may reach over 24 per cent, while the protein may range from 30 to 50 per cent.

Soil

Soya beans yield best on mellow fertile sandy and clay loams, although they will produce a fair yield on land too poor to grow good corn. The yield runs from 15 to as high as 38 or 40 bushels per acre.

The preparation of the soil is very important. The ground should be prepared by either fall or spring ploughing, followed by a thorough working in the spring with disc or harrow, to provide a fine, smooth seed bed and to overcome weed menace later in the season.

Seeding and Harvesting

Seeding should be done about the middle of May and unless the soil has borne a previous crop of legumes, the seeds should be inoculated; a special culture is provided for this purpose. Seeding may be done in rows or drilled solid like wheat or oats.

If harvesting for hay, cut when pods are about half filled out. In harvesting for seed, cutting is done after the leaves have dropped off. In the United States where large acreages are grown, the combine is used; for smaller tracts a grain binder or self-rake reaper.

The grain separator may be used to thresh the crop, provided a few minor adjustments are made to prevent splitting of the seed.

The storage of beans is important. To prevent heating and moulding they should never be bulked in large quantities if their moisture exceeds 15 per cent, but should be spread out where they can dry, or be put up in burlap sacks with air space between the bags. If the beans are to be used for seed, these precautions are doubly necessary, since their vitality drops rapidly when stored under unfavourable conditions. Soya beans are seldom attacked by weevils or other grain insects.

Methods of Processing the Soya Bean

These fall largely under four heads:

1. Hydraulic press method.
2. Expeller method.
3. Solvent extraction method.
4. Various patented processes by which a soya flour is produced with all the oil left in.

1. The most ancient method of extracting oil is the hydraulic press method, crude forms of it having been used in Manchuria for centuries. The cleaned beans are ground and cooked in steam-jacketed kettles at a temperature of approximately 150 degrees F., and are then fed into hydraulic presses to remove the oil. This process is not continuous and requires considerable hand labour for loading and unloading the presses. The press cake still retains 8 or 9 per cent of the oil.

2. In the expeller method the cleaned beans are crushed, dried to a moisture content of about 3 per cent and passed through a steam-jacketed trough, which heats the beans to about 150 degrees F. before they reach the pressing cage of the expeller. This treatment renders the product more mobile without injuring the resulting oil for use in the manufacture of varnishes, or impairing the digestibility of the nutrients in the meal. The expeller operates on the same principle as a household meat grinder and the ordinary working pressure is about 6 tons per square inch. The oil is pumped to filter presses on its way to storage, while the cake emerges in thin sheets that are broken up on a revolving cake breaker at the discharge end. The meal obtained by this method contains about 4 to 5 per cent of oil.

3. In the solvent process the carefully cleaned, and sometimes de-hulled beans, are ground or flaked, then treated with a fat solvent to remove the oil. The oil is obtained by distilling off the solvent, which is recovered and returned to the system. The oil is filtered or centrifuged and sent to storage. Oil obtained by this process possesses superior bleaching qualities and shows less refining loss. After the oil is extracted the meal is then

Fig. 2—Hydraulic Process Mill.

carefully dried to remove all traces of solvent. This meal has about 1 to 1½ per cent of oil.

The meal produced by this method has better adhesive qualities, is less susceptible to rancidity and is lighter in colour than that obtained by the previous processes. The meal may later be ground and bolted to produce soya flour.

There a number of extraction processes; for example, the Bollman, Fauth, Boehm, Hansa-Muehle and recently the Ford.

Figure 3 is a rough diagram of the oil extraction unit employed in the Bollman extraction process. In this process the crushed beans are fed through "C" and pass down into trays "B" which are simply perforated buckets forming an endless belt. The bean flakes are washed with solvent using the counter flow principle. Fresh solvent is sprayed in at "D," runs down through the flakes and collects in the base of chamber "A." It is pumped from there up to another spray at "E." The mixture of oil and solvent from the base of this section of "A" is then piped off through "G" to the stills, where they are separated. The oil is run into drums or further processed and the solvent re-enters system.

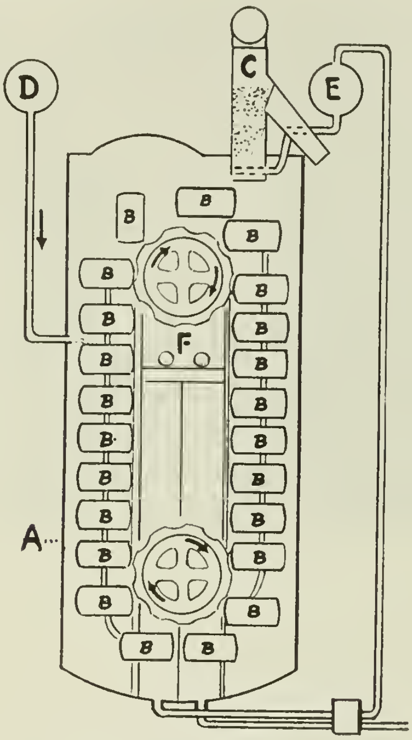
The trays "B" finally dump the extracted flakes into chamber "F" and from there they are removed by screw conveyors passing through drying chambers to remove the solvent.

A diagrammatic illustration of the Ford extraction unit is shown in Fig. 4. The cleaned and dehulled beans are fed into the hopper "A," from whence they pass through crushing rolls into the percolator, or extraction tube, "E," where a screw conveyer carries them through to the discharge end.

The solvent is introduced about half way up the percolator, flows down through the bean flakes, and is pumped out at "D," through a filter to remove any meal. The miscella (oil and meal) from "D" goes to the preheater and thence to the still where the oil and solvent are separated. The solvent is distilled off, recondensed, and sent back to system, after passing through a settling drum to get rid of any water. The oil is collected at "N" and is subsequently filtered and drummed for shipment.

The upper part of the percolator is steam-jacketed to dry the flakes and remove all traces of solvent. The dry flakes are discharged at the upper end, through a barrel valve, into container "J."

Figure 5 gives a flow sheet showing the various stages in an extraction process, from beans to finished products.



A.... EXTRACTION CHAMBER
B.... EXTRACTION BOXES
C.... FEEDING BOX
D.... CONTAINER FOR FRESH SOLVENT
E.... CONTAINER FOR DILUTE MISCELLA
F.... CHAMBER FOR EXTRACTED SOYA MEAL.

Fig. 3—Bollman Extraction Process.

Refining Soya Bean Oil

The oil obtained by the above methods is known as crude soya bean oil. For edible purposes it must be carefully refined and deodorized. For paint and varnish use it is usually partially refined, that is, the free fatty acids are neutralized and the oil clarified with activated earths.

The oil is first treated with an alkali, such as sodium hydroxide, to neutralize the free fatty acids. Alkali solution should not exceed 20 degrees Baumé. An excess of alkali is usually added and the excess removed by washing with 20 to 30 per cent water at 120 to 140 degrees F. This water must then be removed before bleaching. If the water does not separate readily a solution of common salt may be added to break down the emulsion. Centrifuging will effect a rapid and thorough separation of the oil and water.

The oil is then treated with a bleaching clay; highly activated earths are preferable for this purpose, although fuller's earth, mixtures of this with charcoal, bone char, etc., are also used. Bleaching is accomplished in about twenty minutes at 195 to 220 degrees F., followed by rapid passage through a filter press, to avoid re-absorption of colour.

Deodorizing is carried out in a 10 to 15 mm. vacuum at 390 to 570 degrees F., by blowing steam at 390 to 570 degrees F. through the oil. This usually takes from three to four hours, but this time may be doubled, depending on the efficiency of the vacuum.

Minimum refining losses run about 10 per cent.

4. There are numerous patented processes producing a whole oil flour. One of the first was the Berczeller. In this the beans are dried to about 2 per cent moisture, split or cracked, and subjected to a series of suction treatments to eliminate the hull or bran. The bean meats are then treated with saturated steam under a vacuum, after which they are finely ground and the flour is recovered through suction. Flour of this type cannot be bolted, due to the high oil content. The yield is about 85 per cent.

Products and Analyses

Soya bean oil has the following average chemical composition (Harvath):—

Table III

Glycerides of saturated fatty acids (palmitic, stearic, etc.)	14 per cent
" " linolenic acid	2 per cent
" " linolic "	53 per cent
" " oleic "	30 per cent
Unsaponifiable matter	1 per cent
	100 per cent
Average iodine number	130.
Saponification value	188-194

Analyses of soya flours vary with the method of their manufacture. The following table shows an analysis of a whole oil flour (*a*) and an extracted flour (*b*):—

Table IV

Constituents	(*a*) Whole oil Per cent	(*b*) Extracted flour Per cent
Moisture	8.80	8.51
Fat	20.20	1.30
Protein	42.90	53.75
N.F.E. (carbohydrates)	22.40	29.71
Crude fibre	1.30	1.71
Ash	4.40	6.02
	100.00	100.00
Lecithin Phosphoric acid	0.22 per cent	0.154 per cent

Comparison of protein and nitrogen-free extract (as distinguished from protein) content of various foods:—

Table V

Food	White Flour Per cent	Oat-meal Per cent	Eggs Per cent	Milk Per cent	Round Steak Per cent	Soya Flour
Protein	11.5	16.1	14.8	3.3	20.5	as
N.F.E.	75.3	66.6	....	5.0	....	above

To show the composition of the ash and nitrogen-free extract an analysis of each is shown in Table VI.

Table VI

Analysis of ash in (*b*)

Constituents	Per cent
Potassium	43.92
Phosphoric acid	39.64
Magnesia	7.04
Lime	6.12
Sulphuric acid	1.95
Soda	1.01
Chlorine	0.32
	100.00

Nitrogen-free extract in a whole meal (Street and Bailey)

Constituents	Per cent
Pentosans	4.94
Galactans	4.86
Sucrose	3.31
Dextrin	3.14
Cellulose	3.29
Organic acids (as citric)	1.44
Raffinose	1.13
Starch	0.50
Invert sugar	0.07
Waxes, colour, etc.	8.64
Total nitrogen-free extract	31.32

The analysis of meal varies with the method of producing it but approximates that of the flour, slightly lower in protein and higher in fibre.

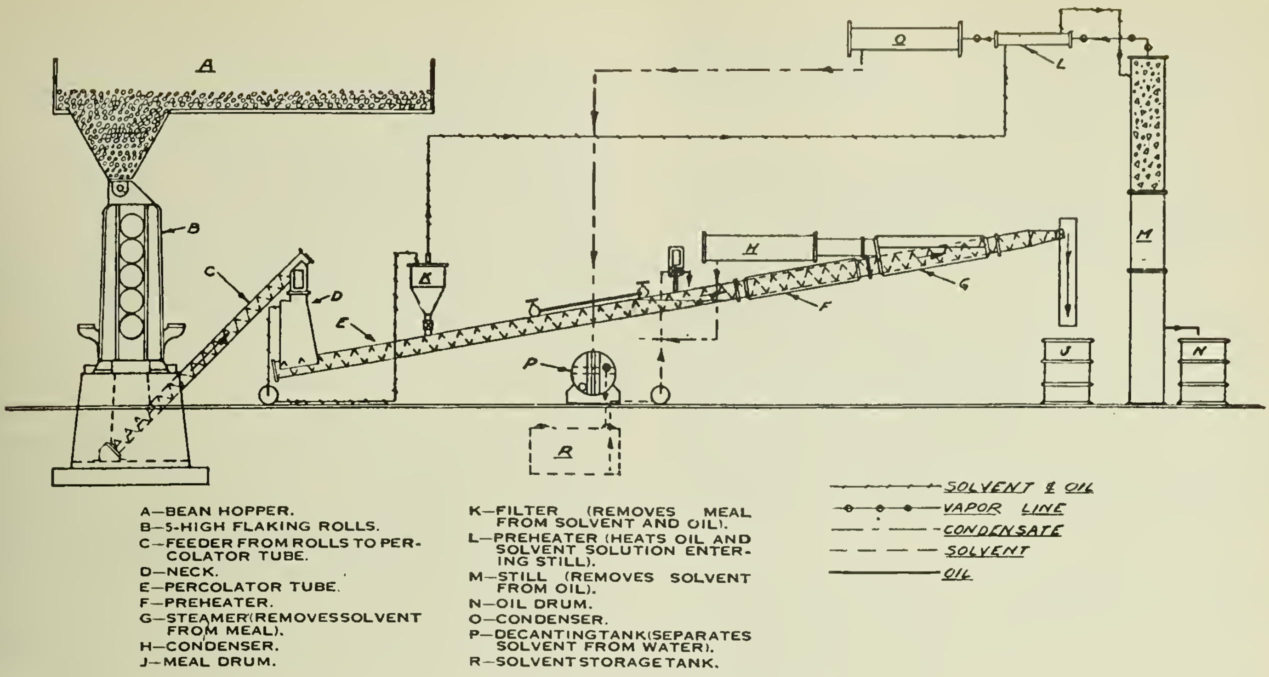


Fig. 4—The Ford Extraction Process.

The Food Value of Soya Bean Products

It has already been noted that the soya bean has a high protein content, but it might be well to point out that, while the protein content of a food is important, the nature of these proteins is even more so. It has been found that about twenty substances, all falling into a class called amino-acids, are linked together in some manner to make the substance called protein.

Not all of these twenty are found in a single protein and not all are necessary for animal or human nutrition. However, four of them, lysine, cystine, histidine and tryptophane, are essential to normal growth and development and must be supplied in foods as they cannot be built up in the body. Soya protein contains all these essential amino-acids and is a complete protein. The navy bean for instance is lacking in cystine, wheat is lacking in lysine and corn meal in two of the essential amino-acids.

Research has shown that the yield of protein, pound for pound, is twice that of beefsteak, four times that of eggs, wheat and cereals and twice that of navy beans.

The Application of Soya Products as Foods for Man and Animals

Soya flour is ideal to mix with other flours in the manufacture of bread, cake, pastry, pan cakes, macaroni, etc. It has also a wide and useful application in the manufacture of sausages, meat pies, cocoa, chocolate, baby foods, and various special foods.

In the baking trade and also in the packing industry (sausages, etc.) it is used not only for its food value but also to keep the products fresh and palatable for a longer period.

It has been found that, due to its anti-oxygenic properties, it will inhibit rancidity in lard to a very marked degree. (Sydney Musher.)

Refined soya bean oil is used in the food industry in the manufacture of oleomargarine, vegetable shortenings, cooking oil, mayonnaise and in the fish packing industry.

Soya bean meal, or as it is commonly called by the trade, soya bean oil meal, is used as a protein "concentrate" in the feeding of all livestock and poultry; and is rapidly winning approval for this purpose.

There has been considerable controversy as to the desirability of feeding the soya bean to hogs and dairy cattle, as it produces soft pork and soft butter. Authorities apparently now agree, however, that the soya meal with a low oil content overcomes this objection and is a desirable protein "concentrate."

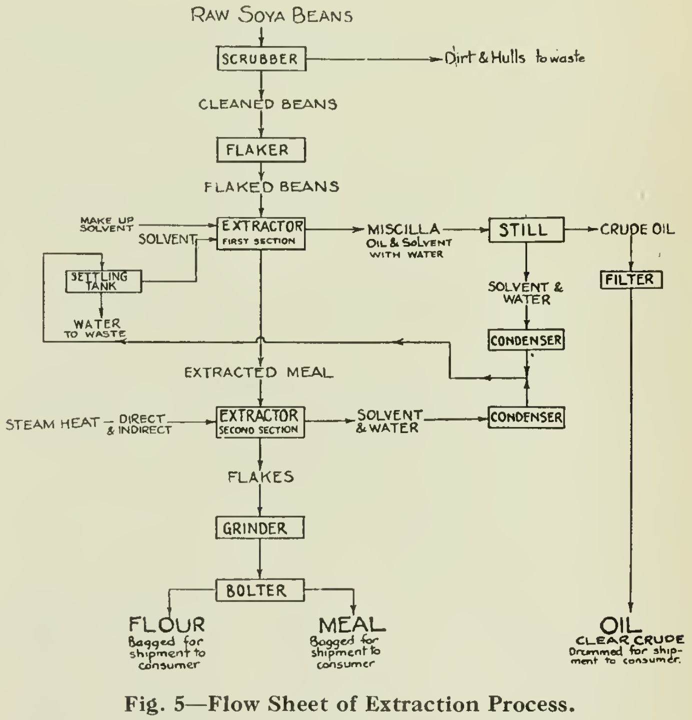


Fig. 5—Flow Sheet of Extraction Process.

The digestibility of the proteins and carbohydrates of this meal is very high. Below is a comparison with other well known protein feeds:—

Table VII

	Digestibility of Protein	Digestibility of Carbohydrates
Soya bean oil meal	92 per cent	100 per cent
Linseed oil meal	89 per cent	78 per cent
Cottonseed oil meal	84 per cent	75 per cent
Tankage	70 per cent	50 per cent (4 per cent N.F.E.)

Its value per unit of protein is unsurpassed and when used to supplement the various farm grains such as corn, barley, wheat, rye, sorghum seed and others, together with the necessary minerals, provides a feed of outstanding nutritional and economic value.

Industrial Uses

The soya bean, however, is not only of interest as an outstanding food; its products can be utilized advantageously by a large number of industries.

Oil.

The oil is used in the manufacture of paints, enamels and lacquers. Soya bean oil has certain properties which make it more valuable in the paint and varnish industry than it would be as a mere diluent for linseed oil. For instance, it is particularly well adapted for grinding pastes: the pastes never skim over and they hold their original tints remarkably well. Soya bean oil moreover has the property of mitigating the after-yellowing of a white paint or enamel. It increases the elasticity and pliability of the film and makes it more lustrous.

Both soya bean oil and its acids are used quite extensively in the manufacture of artificial resins of the alkyd type, which are known under different trade names such as Glyptal, Rezyl, Dulux, Duraplex and Backsol.

The artificial resins of the Glyptal type have marked insulating properties and are employed in practically all the varnish factories and in large quantities in the nitrocellulose lacquer industry. The Ford Company employs soya bean oil in the production of glycerine used in the manufacture of the Glyptal resin and as an oil modifier in the finished enamel of their cars. Linseed oil has been replaced 100 per cent.

It can be used in making rubber substitutes (factis) by a treatment with nitric acid or by adding sulphur, or sulphur chloride to the bean oil. These substitutes are excellent when used in mixtures with natural rubber, they fill up the pores thus reducing decomposition by light and air.

The Japanese have made an artificial petroleum from soya oil and the engineering staff of the state railways of Manchukuo claim to have carried out successful experiments with a foreign car and that these tests indicate the possibility of Manchukuo obtaining an independent supply of fuel oil and at the same time a new market for its staple product, the soya bean.

Blown soya oil can be mixed with petroleum oils as a lubricant. Japanese chemists have obtained a mixed oil that withstands low temperatures and is very suitable for greasing the axles of the Manchurian Railway cars.

An efficient waterproofing substance can be manufactured from the saponified oil.

Glycerine (or glycerol) is present in the soya bean to the extent of 10.2 per cent.

Soya bean oil is used as a soap making material and as such stands midway between linseed and cottonseed oils. In the manufacture of soft soaps it serves as an almost complete substitute for linseed. In the manufacture of hard soap it can replace cottonseed to some extent only as the soap is softer than one made from cottonseed oil. Soya oil has a high froth generating power little affected by the hardness of water. Both raw oil and hydrogenated oil are used.

The oil is also used in making printers' ink, linoleum, celluloid and candles.

Investigations of Casberg and Schubert, of the University of Illinois, show that raw soya bean oil produces core oils with an average tensile strength that compares favourably with the core oils now on the market. Henry Ford uses it in his foundry as a core and dry bond. That is, it becomes the bond after the core is baked.

By oxidation of the refined oil a good agent for stablizing emulsions of water or milk in oil can be obtained.

Recently a United States patent has been issued for the use of soya oil in the case hardening and heat treating of blue carbon steel.

An important by-product of the soya bean, obtained with the oil by using special solvents and later reclaimed, is lecithin. Chocolate manufacturers use it to produce a gloss; gumdrop makers put a drop in to prevent the product from becoming hard in storage; cotton textile plants use lecithin to produce a soft supple finish; tanneries use it to assist chrome leathers to take up the necessary grease.

Meal and Flour.

Soya meal and flour are used in large quantities in the United States in the manufacture of a water-proof glue and practically all of the plywood manufacturers of the Pacific coast have adopted this glue. All the outside walls and floors in the Hall of Science at the International Exposition in Chicago, 1933-34, were made of three-ply sheets joined with soya glue. This glue is now being manufactured in Canada.

Soya flour can be used in the textile industries, especially in lighter weight materials, and gives a soft glove-like finish.

Dr. Phillips, of McGill University, investigated the use of an extracted soya flour in the sizing and coating of papers. Bleached sulphite pulp and soya powder were treated in a beater and then standard sheets prepared on the British sheet machine. He found that this powder

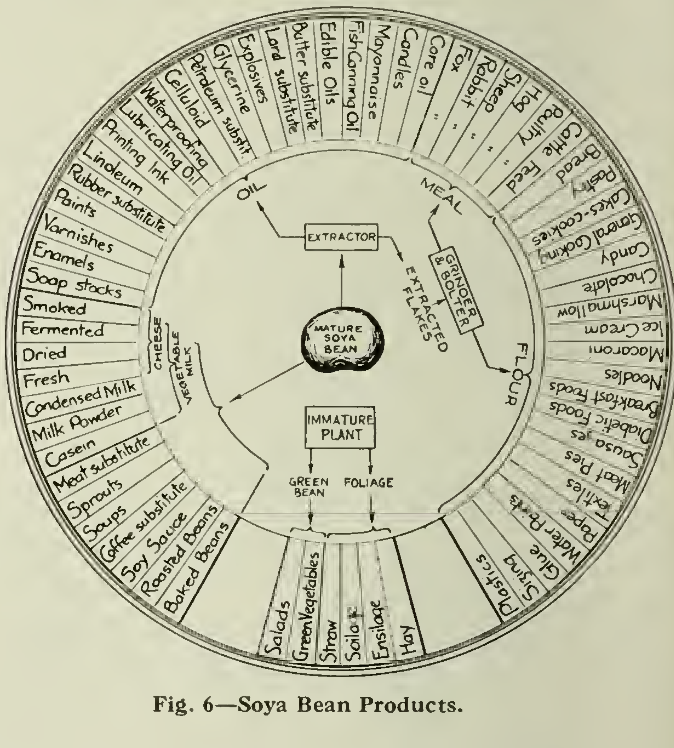


Fig. 6—Soya Bean Products.

seemed to have excellent possibilities as a filler or size for paper. The opacity of the paper was increased somewhat and it had no marked effect on the colour of the paper. When these sheets were exposed to sunlight no discoloration occurred.

In testing the soya powder as a substitute for casein in the coating of papers it was used in dissolved form, together with clay, blanc fixe, etc. The dissolving agents used were ammonia, sodium carbonate, sodium hydroxide, borax and trisodium phosphate. The coatings appeared to be applicable to a variety of papers and indicated that soya powder made a suitable adhesive for coated papers and does not discolour or decompose.

The Ford Motor Company is now completing a factory, estimated to cost $5,000,000, for the manufacture of automobile accessories out of moulded soya plastics. They are using extracted soya meal to make push-buttons, knobs for the gear shift, switch handles, distributor covers, timing gears, dash boards, window frames, etc. Chemists are also studying the manufacture of car bodies with laminated steel sheets and soya plastics.

The production of plastics from soya flour is based on the property of the proteins to react with formaldehyde to give a plastic basis. When great resistance to moisture and a high dielectric constant are required, resins are used, produced by the simultaneous condensation of the soya bean proteins and phenol, or urea, with formaldehyde in the presence of cellulose and carbohydrates.

Recently soya flakes have found application in the brewery business to give a better body to beer. Such beer contains 1.12 per cent protein and the persistence of the froth and richness of flavour are improved.

In the hydrolysis of the soya cake either by fermentation (eastern method) or by chemical reagents (western method), a dark brown liquid called "soya sauce" is obtained which forms the basis of Worcester sauce.

Conclusion

It seems increasingly evident that with the present utilization of the soya bean and the new uses which are being discovered almost daily, this bean is destined to play a leading role in the agricultural and industrial life of this continent.

BIBLIOGRAPHY

"Soybeans," by F. Dimmock. Pamphlet No. 155, New Series, Dominion of Canada Department of Agriculture.

"The Soybean," by Charles V. Piper and William J. Morse.

"The Soybean Industry in the United States," by A. A. Horvath, Ph.D. Reprinted from Journal of Chemical Education, Vol. 10, No. 1. January 1933.

"Continuous Extractors for Soybean Oil," A. A. Horvath, Ph.D., Oil Paint and Drug Reporter, April 22, 1935.

"Recent Developments in the Utilization of Soybean Oil in Paint," W. L. Burlison. Circular 438. University of Illinois, Agricultural Experiment Station and Extension Service.

"The Soybean Oil of China and its Manifold Uses," A. A. Horvath, Ph.D. The Bureau of Industrial and Commercial Information, Ministry of Industry, Commerce and Labour, National Government of the Republic of China, Customs Building, Shanghai, China.

"Supply and Marketing of Soybeans and Soybean Products," Bulletin No. 386, University of Illinois, Agricultural Experiment Station.

"Soybean Seed Production in Michigan," The Edison Institute of Technology, Dearborn, Mich.

"La Utilizacion Industrial de la Soja en los Estados Unidos," A. A. Horvath, Ph.D. Revista de la As. Quemica Argentina, Ano 1, no. 2, Pag 33 y sig. 1935.

"Soybean Oil Meal," by Dr. John M. Evvard.

British Voltage Regulating Transformers

R. J. Spencer Phillips,
Bepco Canada Limited, Montreal, Que.

Paper presented before the Montreal Branch of The Engineering Institute of Canada, April 9th, 1936.

SUMMARY.—British practice in voltage regulation employs booster regulators or depends on tap changing on the main transformers. Various arrangements and modifications of the two methods are discussed with their suitability for various duties.

It is not the intention to make this a technical paper but rather to give a general outline of the methods at present used for maintaining or endeavouring to maintain constant voltage in an a.c. network such as exists in any large city.

If left to itself a large a.c. network would not remain at a constant voltage at all points owing to the nature and variation of the load. Hence it is necessary to have voltage control equipment not only to give complete control of the load on that network, but to ensure a constant voltage supply at the consumer's terminals.

In all cases, fortunately, transformers are a necessary part of any large network and afford the means for controlling the voltage. Tappings are usually fitted to the high voltage winding of the transformer and arranged either to compensate for variations in the supply or to vary the voltage of the secondary. In isolated cases where the load can be disconnected, these taps may be changed by means of links inside the transformer tank or by means of an "off load" tapping switch mechanically coupled to an operating handle conveniently located. The tapping switch is, of course, preferable especially where the transformer is required for outdoor service.

In cases where the load cannot be disconnected, which is the majority of cases, apparatus is necessary by which the voltage ratio can be varied without interrupting the circuit. Such apparatus may be situated at the transformer or at any convenient point on the system. For many years induction regulators have been used for this purpose, but owing to their high cost they are being gradually displaced by voltage regulating transformers. The very earliest type of voltage regulating transformer consisted of a direct tapped transformer fitted with a hand operated switch of the battery regulator type, with main and pilot brushes to avoid short circuiting the winding sections when changing from one tapping to another. Its use was limited to small, low voltage feeders where the voltage per step was sufficiently low to prevent excessive arcing on the switch contacts. With the increase in size and operating voltage of supply systems, the need became apparent for regulating transformers which could be used in all stages of transmission from the generating to the distributing centres and this led to the development of the following methods:—Firstly, the booster regulator, and secondly, tap changing on the main transformer. It will be realized of course that "connection" or "tap" changes have to be made with both systems, but with the booster regulator system, these changes are made on a transformer entirely separate from the main transformer, whereas with the so-called tap changing system, these changes are made actually on the main transformer. These two methods are therefore similar in that they both depend upon switchgear suitable for transferring the load from one transformer tapping to another without interrupting the circuit.

The booster regulator, the first of the two methods to be developed, consists of an arrangement in which a regulating transformer connected across the lines is used to excite a booster transformer, the secondary windings of which are connected direct into the main lines to be regulated.

In the case of tap changing on the main transformer, the necessary adjusting tappings are taken by means of insulated leads direct from the main transformer windings to suitable switchgear and this switchgear thus becomes essentially a part of the main transformer and has to be insulated to suit the voltage to be controlled.

The advantages and disadvantages of these two methods may be briefly summarized as follows.

In the case of the booster regulator, this is entirely separate from the main transformers and therefore can be designed for use at any point in an existing circuit. The main transformers remain as simple as possible, no tappings being necessary. The switchgear usually operates in a low voltage circuit although the equipment may be for use in a high voltage circuit. The equipment is self-contained and can be easily isolated from the circuit in which it is operating without interrupting the supply by the addition of a simple arrangement of isolating switches. Considerable floor space, however, is required for the equipment, and it is more expensive and less efficient due to losses in the auxiliary transformers. The chief application of the booster regulator at the present time is when voltage control is required in an existing circuit at a point remote from the transforming station.

In the case of tap changing on the main transformer, regulation can only be obtained at a transforming station. The main transformer is complicated by the large number of tappings and auxiliary apparatus. The floor space of the main transformer, however, is only slightly increased and this method is cheaper and more efficient.

The rapid development of high tension switchgear for direct connection to a transformer has made it possible to provide at reasonable cost "on load" voltage control for a large range of capacities, and switchgear for tap changers has been standardized up to 66 kv. for use on insulated systems and up to 132 kv. for use on earthed systems.

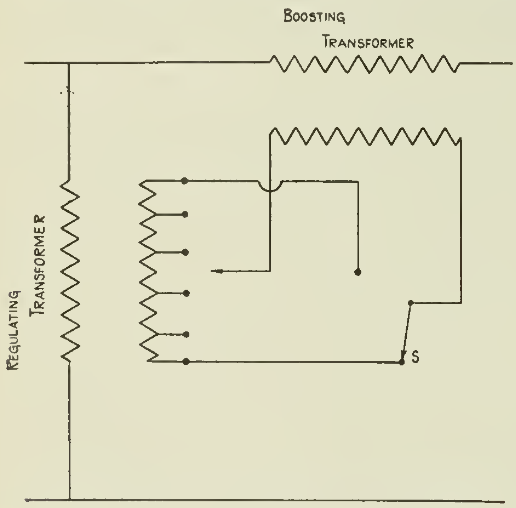


Fig. 1—Diagram for Single-Phase Circuit.

The fundamental principle underlying this switchgear is that two parallel circuits are provided during transition, one circuit carries the load current, whilst the other is being changed to the next tapping and when this new connection is made the parallel circuit which was carrying the current is broken and the current is diverted to the new tapping.

Numerous schemes have been devised following the above principles and an attempt will be made to give a description of those more commonly used.

Taking the case of the booster regulator, the fundamental feature is that the switching is done in an isolated circuit which may be designed for any required pressure, hence it is possible to use low voltage switchgear. The capacity of the switchgear is dependent upon the kv.a. of the main circuit and the amount of regulation required and the number of steps required. Booster regulators may be designed for single or polyphase circuits. Figure 1 shows the diagram for a single phase circuit.

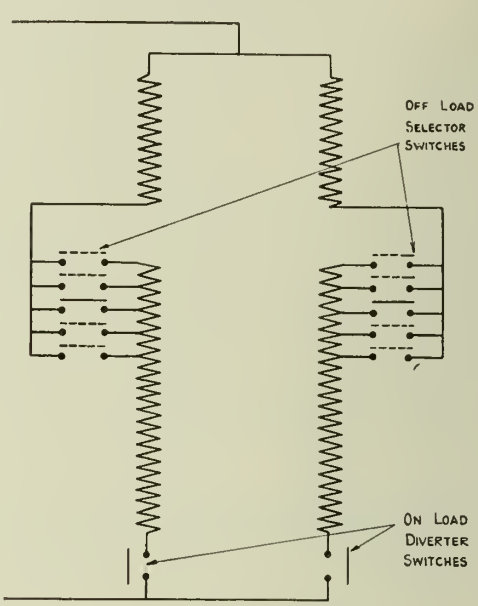


Fig. 2—Split Winding.

The regulating transformer excited from the lines is provided with a secondary winding tapped at equal intervals. This will enable an adjustable pressure to be applied to the primary of the boosting transformer, the secondary of which is in series with the line. Thus, by means of a suitable selector switch the voltage in the line may be boosted in equal steps above the normal value. It should be noted that on normal voltage the primary of the boosting transformer becomes short circuited. This will set up a circulating current to counterbalance the load current flowing in the series winding. The function of switch "*S*" is to reverse the polarity of the primary windings of the boosting transformer thus giving a corresponding buck in the line. In cases where the required variations are not equal above or below normal position, it is usual to introduce an additional winding in series with the line to give a permanent boost or buck, as the case may be. When required, this additional series winding is placed on the core of the regulating transformer and is independent of the switchgear circuit.

The regulating and boosting transformers are mounted in a common tank to which is attached the switchgear casing. Connections are through suitable bushings in the tank side by means of insulated cables. The tank and switchgear casing are mounted on a common base, hence the apparatus may be handled as a complete unit.

Switchgear of this type can be made for three phase equipments up to 5,000 kv.a. capacity with a plus and minus 10 per cent range of regulation and it is probably the most common type that is used for booster regulators. For larger equipments the choice of gear is very wide and usually involves the use of oil immersed switches such as used for main transformer tap changers with the addition of a reversing switch to give the variations in two directions.

Now to consider the system of tap changing on the main transformer. Many methods have been used to effect the change in voltage from one tapping to the next, in general the various schemes of operation may be classified in the following sections:—

(1) The split winding method
(2) The use of a resistor
(3) The use of a reactor
(4) The use of an induction regulator
(5) The use of an auto-transformer

In the first section the main winding of the transformer is split into two parallel portions each similarly

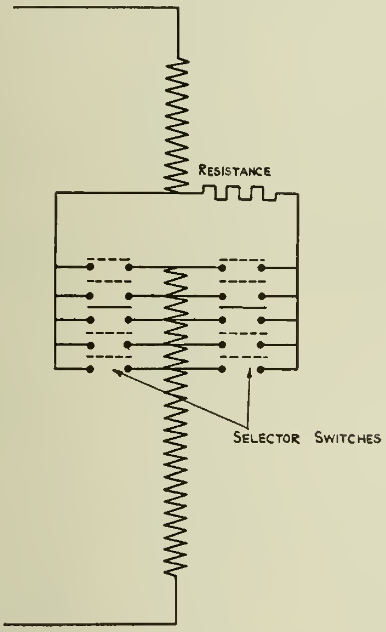


Fig. 3—Use of Resistor.

tapped as shown in Fig. 2, these tappings being connected to suitable off-load selector switches. The ends of the windings are connected directly at one end and through two diverter switches at the other. The two portions of the windings are so disposed relatively to one another that the reactance between them will limit the current which will circulate when the selector switches are on different tappings. In the running position the two diverter switches are closed. To change a tapping the sequence of operation is as follows:—

One of the diverter switches is opened and the selector switch of that half winding is moved to the next position, after which the diverter switch is closed. There is now a circulating current round the two windings. The switching operation is repeated for the other half winding and the tap change is then completed.

No choke coils or resistances are required for this scheme and it is fairly cheap in cost, but possesses disadvantages in that the main transformer has to be specially designed to accommodate the regulating gear and that a large number of tapping leads have to be brought out. A further criticism is that during transition the whole of the load current is carried by half the winding only and if for any reason the operating mechanism should stick during a tap change, this winding would become overheated unless specially designed to carry full load current.

Next there is the system using resistors, these follow the old principle in which a buffer resistance is used to bridge a section of winding during the process of a tap change. They may be designed in the form of a faceplate switch of the dial type, a sliding brush type with linear movement or in the form of a drum controller. In all cases current is broken on the main switch and consequently the contacts must be designed to withstand the arcing which will take place.

Figure 3 shows the sequence of operations. In any running position the main and auxiliary contacts of the switch are closed. To change a tapping the main contact opens, transferring the current via the resistance. The main contact is then made on the next tapping giving rise to a circulating current through the resistance and changing the voltage to the next tapping. Finally the auxiliary contact moves to the next position and the operation is completed.

It should be noted that with certain types of apparatus such as a drum controller the auxiliary contact need not necessarily be closed in a running position. The resistance is usually designed to pass a circulating current equal to the full load current and so will limit the voltage variation during a tap change to a value not greater than that between two tappings. When the apparatus is required to be operated by a motor, the fact that the resistance is not continuously rated constitutes a disadvantage for the reason that if the apparatus should stick during a tap change, the switchgear casing will become overheated. It is, therefore, desirable to provide an alarm circuit. This circuit might consist of a lamp or buzzer connected to an auxiliary supply which may be closed by means of a bi-metal strip or other form of thermostat situated in the switchgear casing.

A modified form of the resistor method of main transformer tap changing consists of an arrangement in which the resistance is tapped at suitable intervals in order to give smoother regulation from tap to tap. This arrangement necessitates the use of separate selector switches, also a resistance changeover switch; hence it is more costly and occupies more space.

This resistor method may be used for a large range of transformer capacities. Generally speaking it is used for three phase transformers or single phase banks from 100 kv.a. to 10,000 kv.a. although in certain cases its use may be extended beyond these limits.

Next there is the main transformer tap changing utilizing reactance, this method functions much in the same manner

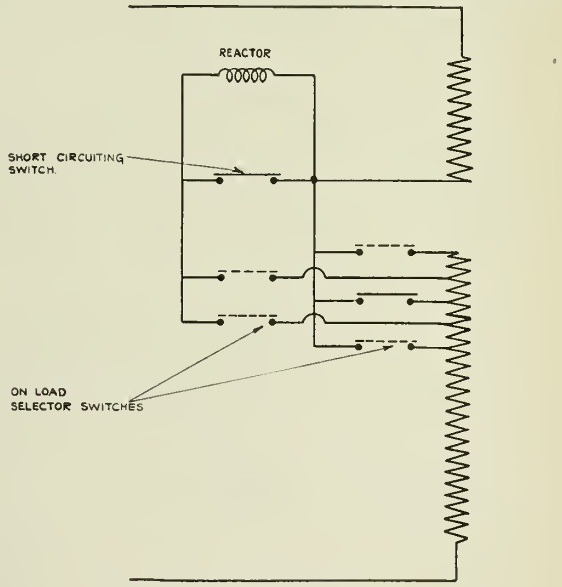


Fig. 4—Use of Reactor.

as has just been described, the only difference being that a reactor or choke coil is substituted for the resistance. The objection is that the voltage induced across the windings of the reactor due to the load current tends to maintain the arc across the selector switch contacts and increases the duty on the switch.

The general principle employed for larger capacities is shown in Fig. 4. Tappings are alternately connected to two busbars across which is placed the choke coil together with a short circuiting switch. The running position is, with the selector switch contacts closed across the appropriate busbars for the required tapping; and the choke coil short circuited. To change to an adjacent tapping, the short circuiting switch is opened and the selector contacts

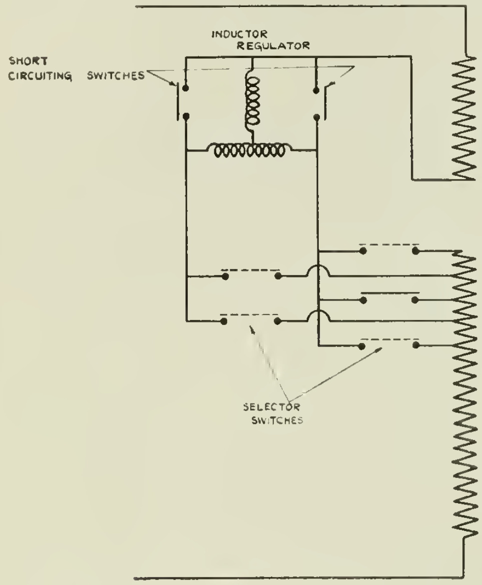


Fig. 5—Use of Induction Regulator.

of the next tapping closed. This introduces the reactor across two tappings. The operation is completed by opening the selector contacts for the tapping recently in use and finally closing the short circuiting switch. The choke coil may be continuously rated or intermittently rated. In the latter case it is preferable to place it in a compartment separate from the main transformer tank.

Figure 5 shows a diagram for a scheme in which the choke coil just described is replaced by an induction regulator designed to deal with the step kv.a. between two

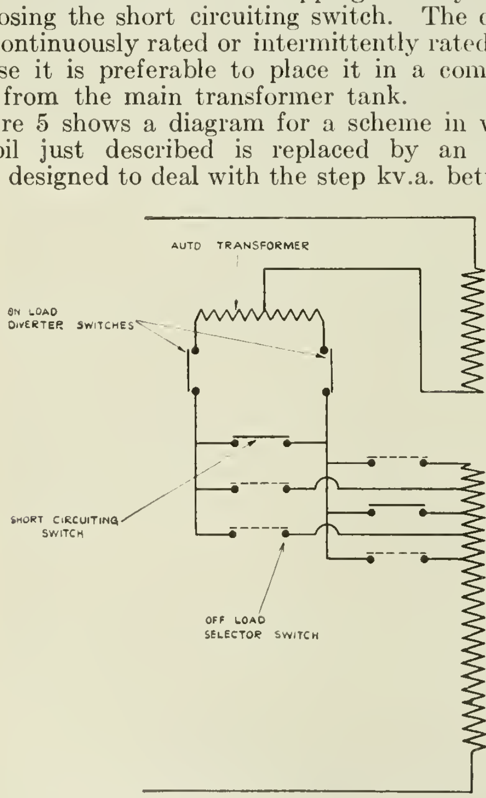


Fig. 6—Use of Auto Transformer.

tappings. With this arrangement the selector switch operates on much the same principle as previously described but two short circuiting switches are necessary.

The sequence of operations is as follows:—In a running position the selector contacts for the appropriate tapping and the short-circuiting switch on the same busbar are closed. To change to the next position the selector contacts of the adjacent tapping are closed, thus energizing the induction regulator. The short circuiting switch on the original circuit then opens. The regulator is then rotated to adjust the voltage to that of the new tapping. This is followed by the closing of the short-circuit switch for the new circuit and the opening of the original selector switch contacts. Thus the selector switches are the first and last to move, intermediate operations being performed by the short circuiting switches and the induction regulator.

Some of the more important features of this scheme are:

(*a*) The selector switches have only to break the exciting current of the induction regulator.
(*b*) The voltage change is gradual.
(*c*) If the induction regulator is designed with a continuous rating, the apparatus can be left in any position.

This apparatus is somewhat clumsy and expensive, but it is particularly suitable for use on heavy current circuits.

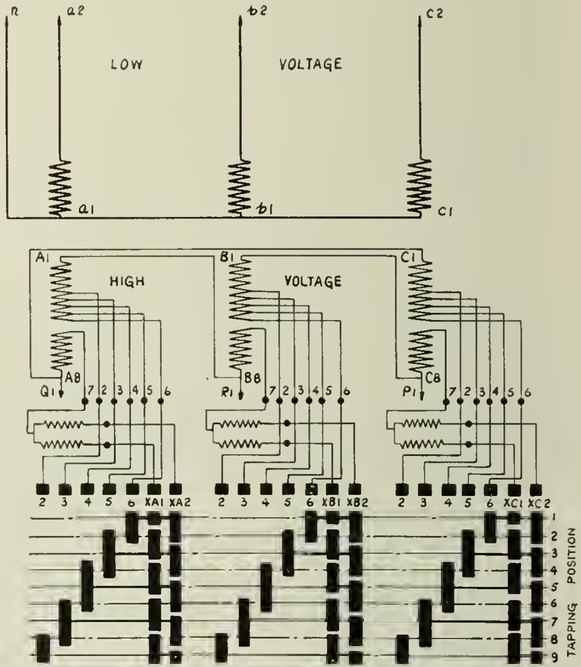


Fig. 7—Drum Type Tap-changing Controller.

The last method, namely the use of the auto transformer, also bears a similarity to the choke coil method. The choke coil in this case is replaced by an auto transformer the middle point of which is connected to the load. The sequence of operations is also similar, but the intermediate positions when the short circuiting switch remains open and the selector contacts of the next tapping are closed, constitutes a permanent running position. Thus, for the same number of tapping leads from the main windings it is possible to obtain double the number of steps. Figure 6 shows the arrangement and it will be noticed that on-load diverter switches and off-load selector switches are shown. On small equipments where the step voltages and the current to be broken are relatively small, diverter switches are not necessary, but when the combination of step voltage and current give a large step kv.a., it is expedient that the current should be broken by means of suitable diverter switches and to design the selector and short-circuiting switches to work off load.

It will thus be seen that the choice of a scheme depends upon many factors, some of which have already been mentioned and every application naturally has to be considered with a view to its special requirements.

The main diagram for a 500-kv.a., 3-phase, 11,000-volt transformer using the auto-transformer principle is illustrated in Fig. 7. The whole of the switching operations in this case are performed by revolving a simple drum controller. It will be noted that there are no "on load" diverter switches.

One of the more recent developments of a means to regulate the voltage in a power supply system or a distribution circuit is the moving coil voltage regulator.

With reference to Fig. 8, the essential features of the regulator comprise a two-legged core as used in transformer construction with coils "*a*" and "*b*" mounted respectively at the top and bottom of one leg, and a short circuited coil "*s*" which is free to move up and down the leg between coils "*a*" and "*b*." The moving coil "*s*" is entirely isolated electrically, so that no flexible connections, sliprings, or sliding contacts are required. If a voltage be applied to coil "*a*" only, the resulting current will depend upon the impedance of this coil, which is determined by the position of the moving coil "*s*." This coil may be looked upon as a gate preventing the passage of magnetic flux through it, and thus nullifying the effect of the coil immediately adjacent. The closer the moving coil is to coil "*a*" the greater its short circuiting effect and, therefore, the lower the effective impedance of coil "*a*." Hence, with the moving coil in the position shown in Fig. 8a, the impedance of coil "*a*" will be small and of coil "*b*" large. If a voltage be applied across these two coils connected in series, then the greater part of the voltage will appear across coil "*b*" and a small part only across coil "*a*," as shown in the figure. With the moving coil at the bottom

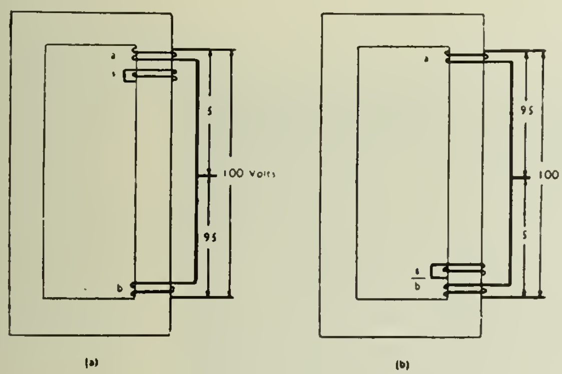


Fig. 8—Principle of Moving Coil Voltage Regulator.

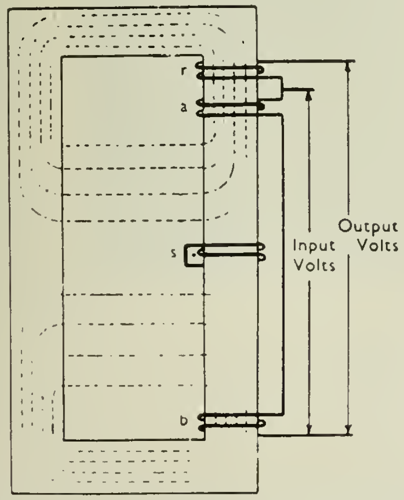


Fig. 9—Principle of Boosting with Moving Coil Voltage Regulator.

of the leg, as in Fig. 8b, the respective impedances of coils "*a*" and "*b*" are reversed, and the greater voltage will now appear across coil "*a*."

With the values assumed in the figures, and an impedance variation of 20/1, it will be seen that the voltage across coil "*b*" can be varied smoothly and uniformly from 5-95 volts by varying the position of the moving coil.

It is, however, only in testing transformers and the like that such a wide range of voltage variation is required.

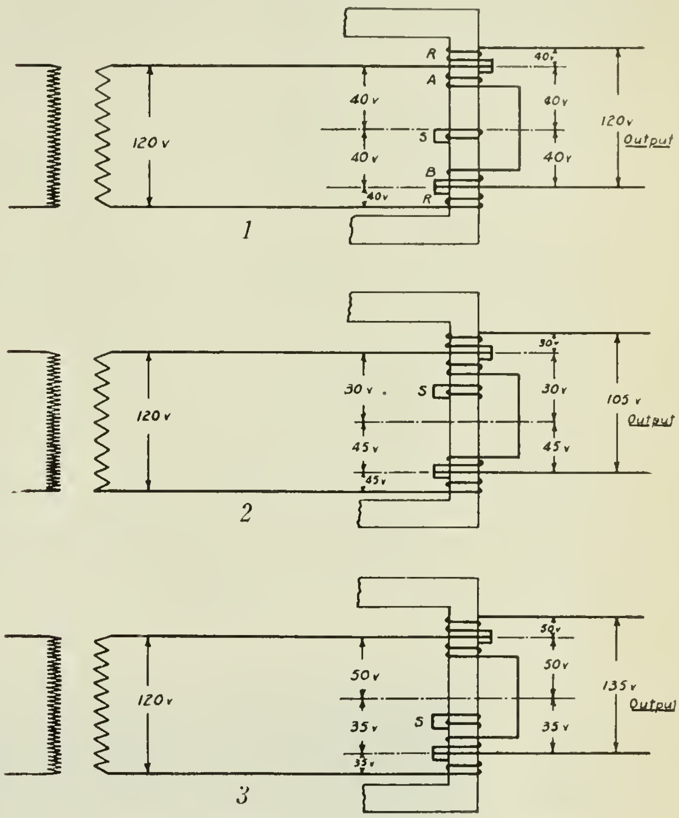


Fig. 10—Schematic Diagram of Moving Coil Voltage Regulator.

In transmission and distribution circuits, voltage variations of 10 to 20 per cent are usually sufficient.

The arrangement shown in Fig. 9 will give a boost, the voltage across the boosting coil "*r*" being a constant function of the voltage across the adjacent coil "*a*," depending upon the turn ratio of these two coils. As the coil "*s*" is moved nearer to coil "*b*" the amount of the boost will be increased.

If both increases and decreases in voltage are desired, that is both buck and boost, a coil similar to "*r*" is mounted at the bottom of the leg close to coil "*b*."

Figure 10 illustrates a diagrammatic arrangement of such a regulator. The first figure shows the sliding coil "*s*" in the centre, the boosting coil is at the top and the bucking coil is at the bottom. With the sliding coil in the centre, the coils "*a*" and "*b*" have an equal effect and the output voltage 120 which is just chosen for example remains at its normal value.

The second figure shows coil "*s*" moved upwards and thus nullifying the effect of the booster coil with the result that the net effective output voltage is lowered to 105 volts.

The bottom figure shows coil "*s*" moved downwards nullifying the effect of the bucking coil so that the resultant output voltage is now 135.

Thus, with the value chosen one is able to get a buck or boost of approximately 12 per cent with a perfectly smooth change and no transformer tappings or switches.

So far as the question of moving the coil is concerned, this is done by means of a small eddy current motor completely immersed in the oil so that the whole equipment is completely enclosed in a tank.

The moving coil regulator is built in general on the same lines as ordinary static transformers.

All switchgear for use, either with booster regulators, or main transformer tap changers, can be motor operated and can be arranged either for "push button" or automatic control. These conditions, of course, necessitate the use of certain mechanical devices and a number of auxiliary switches.

The supply for the motor and control gear is usually taken from the transformer with which it is operated. If taken from an auxiliary supply, there is always the chance that the auxiliary supply may fail at a critical moment.

The question of automatic control might well be the subject of a separate paper and is really a study in itself with the necessary arrangements to obtain the required degree of compounding with supply lines of varying resistance and reactance drop, to say nothing of varying power factor, and it is not proposed to enter into the question. It is feasible, however, to obtain automatic regulation over a wide range.

CITY OF VANCOUVER, B.C.

FIFTIETH ANNIVERSARY OF CITY'S INCORPORATION

Celebrations June to September 1936.

Vancouver City and Harbour.

Institute Committees for 1936

FINANCE

P. L. Pratley, *Chairman*
J. B. Challies
A. Duperron
F. Newell
J. L. Busfield

LIBRARY AND HOUSE

E. A. Ryan, *Chairman*
J. L. Clarke
W. G. Hunt
J. H. Landry
H. W. Lea

LEGISLATION

R. E. Smythe, *Chairman*
F. R. Faulkner
S. Young

PAPERS

R. L. DOBBIN, *Chairman*

PUBLICATION

H. Cimon, *Chairman*
J. A. Duchastel
A. A. MacDiarmid
P. L. Pratley
H. L. Trotter

PAST-PRESIDENTS' PRIZE

C. N. Monsarrat, *Chairman*
D. E. Blair
J. M. R. Fairbairn
J. A. Heaman
J. A. Wilson

GZOWSKI MEDAL

W. P. Copp, *Chairman*
A. F. Baird
A. R. Chambers
F. R. Faulkner
I. P. MacNab

LEONARD MEDAL

A. O. Dufresne, *Chairman*

DUGGAN MEDAL AND PRIZE

C. M. Goodrich, *Chairman*
W. A. Duff
C. R. Young

PLUMMER MEDAL

A. G. Fleming, *Chairman*
L. M. Arkley
W. L. Malcolm
N. C. Sherman

STUDENTS' AND JUNIORS' PRIZES

Zone A (Western Provinces)

H. N. Ruttan Prize

E. V. Caton, *Chairman*
H. J. McLean
S. Young

Zone B (Province of Ontario)

John Galbraith Prize

R. L. Dobbin, *Chairman*
F. Smallwood
J. A. Vance

Zone C (Province of Quebec)

Phelps Johnson Prize

(English) P. L. Pratley, *Chairman*
F. Newell
E. A. Ryan

Ernest Marceau Prize (Province of Quebec)

(French) A. B. Normandin, *Chairman*
H. Cimon
B. Grandmont

Zone D (Maritime Provinces)

Martin Murphy Prize

H. W. McKiel, *Chairman*
H. S. Johnston
G. A. Vandervoort

CONSOLIDATION OF ENGINEERING PROFESSION

G. McL. Pitts, *Chairman*
J. B. Challies
A. B. Crealock
A. R. Decary
G. J. Desbarats
O. O. Lefebvre
F. A. Gaby
R. E. Jamieson
C. C. Kirby
R. F. Legget, *Secretary*

BOARD OF EXAMINERS AND EDUCATION

H. M. White, *Chairman*
E. P. Fetherstonhaugh
J. N. Finlayson
N. M. Hall
J. W. Sanger
W. Walkden

HONOUR ROLL AND WAR TROPHIES

Col. A. E. Dubuc, *Chairman*
Fraser S. Keith
Brig.-Gen. G. E. McCuaig

RELATIONS WITH NATIONAL SOCIETIES

John Murphy, *Chairman*
R. W. Angus
A. B. Cooper
A. B. Crealock
J. M. R. Fairbairn
H. J. Roast

COMMUNICATIONS

G. A. Wallace, *Chairman*
J. L. Clarke
S. T. Fisher
W. A. Steel
J. H. Thompson
H. J. Vennes

WESTERN WATER PROBLEMS

G. A. Gaherty, *Chairman*
C. H. Attwood
Charles Camsell
L. C. Charlesworth
T. H. Hogg
O. O. Lefebvre
C. J. Mackenzie
S. G. Porter

PUBLICITY

J. M. Fairbairn, *Chairman*

DETERIORATION OF CONCRETE STRUCTURES

R. B. Young, *Chairman*
O. O. Lefebvre
J. A. McCrory
E. Viens
C. N. Simpson

THE

ENGINEERING JOURNAL

THE JOURNAL OF
THE ENGINEERING INSTITUTE
OF CANADA

VOLUME XIX JUNE 1936 No. 6

Vancouver's Fiftieth Birthday

Among the navigators of the eighteenth century Captain George Vancouver has an honoured place. In 1791, when he commenced his eventful four years voyage to the Pacific coast of North America, his instructions included a direction to seek an eastward passage to the Great Lakes. With this as one of his objects, after sighting the coast of what is now California in April 1792, he proceeded northward, surveying the inlets and harbours, discovering the Gulf of Georgia, and circumnavigating the island which has been named after him. Thus he was exploring Burrard Inlet at the time when representative government had just been granted to Upper and Lower Canada. Water communication between the Pacific coast and the Great Lakes did not prove to be feasible, but he did find a splendid harbour which was to become Canada's main outlet to the Pacific.

Some sixty years after Vancouver's visit, there was a small settlement in the forest on the south shore of that harbour, known as Granville, which even possessed a mill. It grew gradually, and since its location was the most favourable for shipping and port facilities, when W. C. Van Horne visited the locality in 1884 it was finally chosen as the ocean terminus of the Canadian Pacific Railway, whose construction work in British Columbia had commenced at Port Moody the previous year. It was also decided to change the name of the little town to Vancouver, in honour of the early explorer who first surveyed its harbour.

The city was incorporated on April 6th, 1886; now, on its fiftieth birthday the congratulations of the rest of Canada are being heartily extended to our great Pacific seaport.

During the past fifty years the city's growth has been phenomenal and its history remarkably eventful. Two months after its incorporation the new city was destroyed by fire. In an hour only a few buildings were left standing, and the disaster was accompanied by considerable loss of life. Nothing daunted, the citizens set to work to rebuild; they have been building ever since. Two days after the fire twenty new buildings were going up. Twelve years later throngs of gold seekers came to Vancouver on their way to the Klondike. When the South African war came the city furnished a strong contingent of volunteers. In 1901 the city was honoured by a visit from His Late Majesty King George V and Queen Mary (then the Duke and Duchess of York), and their steps were followed by many other illustrious visitors, including the King, when Prince of Wales.

At the beginning of the century mining began to develop in British Columbia, and the city's world-trade grew. Its commercial relations with the Orient became important; the problem of oriental immigration arose. The years 1905 to 1910 saw an extraordinary real estate boom, during which the population passed the 100,000 mark. The commencement of traffic through the Panama Canal in 1915 made a great change in the position of Vancouver as a seaport, since it brought the city some 6,000 miles nearer Europe by the sea route. The war period followed and was one in which the city's industrial growth began. In spite of the time of uncertainty which followed the conflict, the city's development continued. The facilities of the port were built up, and its overseas trade increased until it is now served by more than fifty steamship lines, with a total tonnage of over 6,000,000 per annum. An increasing proportion of our wheat finds its way through the western outlet, as much as 100,000,000 bushels having been shipped at Vancouver in one year.

The city's prosperity and growth have not been exclusively along commercial and industrial lines. Vancouver is an important educational centre. The University of British Columbia, developed from the earlier University College of British Columbia, was established by provincial enactment in 1908, and was formally opened in 1915, removing to its permanent home at Point Grey in 1925. An excellent school system; a public library; an art gallery and museum, make it clear that the citizens do not neglect the cultural side of life. The scenic and climatic advantages of the city and surroundings afford wonderful facilities for those who love the out-of-doors, and the city has made admirable use of the natural beauty of its many park sites and recreation grounds.

No small part of Vancouver's remarkable development has been due to the work of the engineer. Without his aid in the construction of railways, terminals, port facilities, bridges, highways, power developments, and provision for water supply and sanitation, the city's present aspect would have been very different.

No Canadian should consider his education complete until he has seen something of the wonderful country bordering on the Pacific, and the great city which is its commercial and industrial capital. We are apt to assume that the requirements and aspirations of all Canadians are similar to those current in our own province or locality. Travel in a province like British Columbia, which contrasts in so many respects with the provinces to the east of the mountains, cannot fail to correct erroneous ideas of this kind, even if they have survived the holder's first crossing of the Rockies. Eastern visitors to Vancouver will receive a hearty welcome from fellow citizens who yield to no other Canadians in their hospitality, energy and enterprise.

The celebrations to be held in Vancouver this year thus afford an opportunity, which should not be missed, to take part in the programme of civic rejoicings, to meet the British Columbians, and to see something of the forests, mines, fisheries, and fruit lands which are characteristic of their beautiful province.

OBITUARIES

Alexander Bell Ross, M.E.I.C.

Deep regret is expressed in placing on record the death at Toronto, Ontario, on December 6th, 1935, of Alexander Bell Ross, M.E.I.C., a member of The Institute of many years standing.

Mr. Ross was born at Goderich, Ontario, on April 12th, 1860, and was among the earliest students to enroll at the Royal Military College, Kingston, graduating from that institution in 1880. In 1881-1883 he was assistant engineer in connection with the improvement of the Missouri river at Nebraska City, Nebraska, and from 1883 until 1887 was with the Burlington and Missouri River Railway. During 1888 Mr. Ross was with the late C. H. Keefer, M.E.I.C., on the Trenton water power survey for the Belleville Bridge and Development Company at Toronto, and in 1889 he returned to Omaha and was assistant engineer on improvement works on the Missouri river, having charge of surveys and construction. In 1891-1893 Mr. Ross was engineer for the East Omaha Land Company of Omaha, being in charge of improvements, such as grading and paving of streets and the construction of an electric street railway. In 1893-1895 he was resident engineer of the Omaha Bridge and Terminal Railway Company. In 1895 Mr. Ross became engineer in charge of the construction of dykes on improvement works on the Missouri river at Omaha, and later was resident engineer in charge of the construction of the Jefferson City bridge across the Missouri river. During 1896 he made a reconnaissance for a proposed railway between Omaha and St. Paul. Mr. Ross engaged in railroad work in the Yukon, and for fifteen years was in charge of the construction of railways in Mexico as resident engineer for the Missouri Valley Bridge and Iron Company.

Mr. Ross joined The Institute (then the Canadian Society of Civil Engineers) as an Associate Member on February 14th, 1889, and became a Member on December 9th, 1897. On March 15th, 1927, he was made a life member.

Abel Seneca Weekes, A.M.E.I.C.

Regret is expressed in placing on record the death at Winnipeg, Man., on April 25th, 1936, of Abel Seneca Weekes, A.M.E.I.C.

Mr. Weekes was born at Glencoe, Ontario, on February 17th, 1866, and during the years 1887-1890 served his apprenticeship with Messrs. Coad and Robertson, surveyors and engineers, during which time he was employed as chainman, rodman and later as leveller on many drainage works in western Ontario. During the years 1890, 1891 and 1892, Mr. Weekes was township engineer for several townships in Huron county, Ontario, and was also engineer for the town of Clinton, Ont. In 1893 he was engaged on land survey work. From 1894 until 1902 Mr. Weekes was in private practice in Alberta, and the Yukon, and also did some mining engineering. In 1903-1904 he was engaged on Dominion government surveys. In November 1904 Mr. Weekes entered the engineering department of the Canadian Northern Railway, and on the formation of the Canadian National Railways in 1919 he was made chief land surveyor for western Canada. He had previously lived in Edmonton, but in that year he took up residence in Winnipeg. Mr. Weekes retired on February 17th, 1931.

Mr. Weekes was a member of the Dominion Land Surveyors' Association and the Ontario Land Surveyors' Association. He was a member of the executive of the Alberta Land Surveyors' Association and president of the Saskatchewan Land Surveyors' Association.

He became an Associate Member of The Engineering Institute on November 25th, 1919, and on October 18th, 1932, was made a Life Member.

PERSONALS

F. Bowman, A.M.E.I.C., who was formerly on the staff of the Dominion Bridge Company Limited, Montreal, is now connected with Evans, Deacon, Hornibrook Construction Pty. Limited, in Brisbane, Australia.

Professor Edgar Stansfield, M.E.I.C., was elected chairman of the Edmonton Branch of The Institute at a meeting held recently. Professor Stansfield is chief chemical engineer of the Research Council of Alberta.

J. N. Swartz, S.E.I.C., who is with the Pulp and Paper Research Institute, Montreal, has been awarded a $500 bursary in cellulose chemistry at McGill University. Mr. Swartz graduated from McGill University in 1934 with the degree of B.Eng.

J. H. Tuck, S.E.I.C., has joined the staff of the International Nickel Company Ltd., at Port Colborne, Ontario. Mr. Tuck, who graduated from Queen's University in 1932 with the degree of B.Sc., was formerly industrial engineer with the Campbell Soup Company, New Toronto, Ontario.

Adam Cunningham, A.M.E.I.C., is now on the staff of the Ontario Paper Company at Thorold, Ontario. Mr. Cunningham, who is a graduate of the University of Edinburgh of the year 1923, was formerly with Price Brothers and Company Limited, at Kenogami, Que.

A. E. Hyde, S.E.I.C., of Hamilton, an engineering student at Queen's University, has been awarded the Kenneth B. Carruthers scholarship (value One Hundred and Ten Dollars) in metallurgical engineering for outstanding work in the recent session.

E. F. Brown, S.E.I.C., has resigned from the engineering staff of the Northern Foundry and Machine Company Ltd., Sault Ste. Marie, Ont., and is now connected with the Dominion Bridge Company, Montreal. Mr. Brown graduated from McGill University in 1935 with the degree of B.Eng.

M. A. Phelan, S.E.I.C., formerly with the Canadian Fairbanks Morse Company at Rouyn and Noranda, Que., is now on the staff of Peacock Brothers Limited, as sales engineer. Mr. Phelan graduated from Queens' University in 1929 with the degree of B.Sc.

Advices from London announce that no less than three engineers were elected Fellows of the Royal Society on May 7th, 1936, and the list included a distinguished member of The Engineering Institute of Canada, Sir Alexander Gibb, G.B.E., C.B., M.Inst.C.E., F.R.S.E., M.E.I.C. Announcement is also made of Sir Alexander's election as President of the Institution of Civil Engineers for the forthcoming year.

Sir Alexander is the senior partner of Sir Alexander Gibb and Partners, the well-known consulting engineers. As chairman of Easton, Gibb and Son, Limited, he acted as contractor to the government for the construction of Rosyth dockyard, and other public works, and later was Civil Engineer-in-Chief at the Admiralty and Director General of Civil Engineering at the Ministry of Transport. Turning to consulting work, he acted for the British Admiralty for the Singapore naval base and for the Dean and Chapter of St. Paul's Cathedral, as well as for other important works in England and abroad. During the war, Sir Alexander was Chief Engineer, Ports Construction and Deputy-Director of Docks in France and Belgium. In 1931-1932 he carried out a survey of the National Ports of Canada for the Dominion Government.

O. Holden, A.M.E.I.C., assistant hydraulic engineer of the Hydro-Electric Power Commission of Ontario, was elected chairman of the Toronto Branch of The Institute at the annual meeting held recently. Mr. Holden graduated from the University of Toronto with the degree of B.A.Sc. in 1913, and shortly afterwards joined the staff of the Hydro-Electric Power Commission, with which organization he still remains.

E. A. Cleveland, LL.D., M.E.I.C.

E. A. Cleveland, M.E.I.C., President of The Institute, Chief Commissioner of the Greater Vancouver Water District and Chairman of the Vancouver and Districts Joint Sewerage and Drainage Board, received the honorary degree of Doctor of Laws from the University of British Columbia at a special congregation held on May 6th, on the occasion of the celebration of the twenty-first anniversary of the founding of that institution.

P. L. Pratley, M.E.I.C., a vice-president of The Engineering Institute, and member of the firm of Monsarrat and Pratley, Montreal, has been elected a Member of Council resident in Canada of the Institution of Civil Engineers for a third year of office.

J. J. White, M.E.I.C., Building Inspector for the city of Regina, Sask., has been appointed Secretary-Treasurer of the Saskatchewan Branch of The Institute, and Registrar of the Association of Professional Engineers of the Province of Saskatchewan. Mr. White, who graduated from the University of Saskatchewan in 1925, has been an active member of both societies, having served on the Executive Committee of the Saskatchewan Branch of The Institute, and on the Council of the Association. He was chairman of the Membership Committee of the Saskatchewan Branch in 1935, during which year an active membership campaign was successfully carried out.

Elections and Transfers

At the meeting of Council held on May 8th, 1936, the following elections and transfers were effected:—

Members

ANDERSON, Oscar Victor, E.E., (Univ. of Minn.), field engr., Toronto Hydro-Electric System, Toronto, Ont.

FLOOK, Samuel Evert, LL.B., B.A.Sc., (Univ. of Toronto), O.L.S., D.L.S., city engineer, Port Arthur, Ont.

Associate Members

JOHNSTONE, James Cameron, (Glasgow and West of Scot. Tech. Coll.), engr. i/c projects 55 and 73, Trans-Canada Highway, Hope, B.C.

LUMB, William Ewart, B.Sc., (Queen's Univ.), O.L.S., D.L.S., promotion engr., Canada Cement Company, Moncton, N.B.

MUIR, Harvey James, B.A.Sc., (Univ. of Toronto), sales-service engr., Bailey Meter Co. Ltd., Winnipeg, Man.

STEVENS GUILLE, Henry LeMarchant, B.Sc., (Univ. of Birmingham), chem. engr., Royalite Oil Co. Ltd., Turner Valley, Alta.

Juniors

COOPER, John Sidney, B.A.Sc., (Univ. of Toronto), civil engr., Sutcliffe Co. Ltd., New Liskeard, Ont.

PINCHBECK, George Reginald, B.Sc., (Univ. of Alta.), 43 Kensington Apts., Edmonton, Alta.

SUITOR, Warren Douglas, B.Sc., (Univ. of Alta.), engrg. dept., Imperial Oil Refineries Ltd., Calgary, Alta.

Affiliate

MOLD, Robert Charles, manager, H. G. Vogel Co. (Canada) Ltd., Montreal, Que.

Transferred from the class of Associate Member to that of Member

BISHOP, Arthur Leonard, Colonel, (R.M.C.), president, The Coniagas Mines Ltd., 320 Bay St., Toronto, Ont.

DUNCAN, Wilfrid Eben Pinkerton, B.Sc., (Glasgow Univ.), engr. of structures, Toronto Transportation Commission, Toronto, Ont.

FRANCIS, Thomas Frederick, (McGill Univ.), engr. of constrn., Dept. of Northern Development, Toronto, Ont.

HARRISON, Ronald, B.A.Sc., (Univ. of Toronto), mgr., supt., and sec.-treas., Scarborough Public Utilities Commission, Toronto, Ont.

HAY, Adam, (Robert Gordon's Coll., Aberdeen), chief dftsman., Dept. of Highways Ontario, Toronto, Ont.

LOVELL, William Edward, B.Sc., (Univ. of Man.), professor of elect'l. engrg., University of Saskatchewan, Saskatoon, Sask.

TATE, Harry William, B.A.Sc., (Univ. of Toronto), O.L.S., D.L.S., asst. mgr., Toronto Transportation Commission, Toronto, Ont.

WIREN, Robert Nicholas Rudolph Charles, B.A.Sc., (Univ. of Toronto), lecturer in mech'l. engrg., University of Toronto, Toronto, Ont.

Transferred from the class of Junior to that of Associate Member

MORRISON, Carson F., B.E., (Univ. of Sask.), M.Sc., (McGill Univ.), lecturer in civil engrg., University of Toronto, Toronto, Ont.

McFARLAND, Walter Irving, B.Sc., (Univ. of Alta.), Havelock, N.B.

McMILLAN, Ralph Edwin, B.Sc., (McGill Univ.), plant engr., The British Rubber Co. of Canada Ltd., St. Laurent, Que.

Transferred from the class of Student to that of Associate Member

DOHERTY, Thomas Hugh, B.Sc., (McGill Univ.), junior research engr., National Research Council of Canada, Ottawa, Ont.

HUGHES, Philip Bernard, B.Sc., (McGill Univ.), sales engr., The Plessisville Foundry, 714 St. James St. West, Montreal, Que.

Transferred from the class of Student to that of Junior

DEXTER, Joseph Dimock, B.Eng., (McGill Univ.), dftsman., Mersey Paper Company, Brooklyn, N.S.

Students Admitted

ALEXANDER, William Ronald, B.A.Sc., (Univ. of Toronto), 285 Heath St. East, Toronto, Ont.

BILLINGS, George Michael, (Grad., R.M.C.), (Queen's Univ.), Kingston, Ont.

BROSSARD, Leo, (Ecole Polytechnique, Montreal), Brosseau Station, Que.

CANDLISH, Fairlie, (McGill Univ.), 10703 Grande Allee Ave., Montreal, Que.

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

KERFOOT, John Grenville, (Queen's Univ.), P.O. Box 473, Prescott, Ont.

L'HEUREUX, Paul Emile, (Ecole Polytechnique, Montreal), 6316 St. Denis St., Montreal, Que.

McCOLEMAN, Hugh Alexander, (Univ. of Alta.), Claybank, Sask.

NADEAU, Leopold Maurice, (Ecole Polytechnique, Montreal), 5257 Durocher Ave., Outremont, Que.

NASON, Edward McKinney, (Univ. of N.B.), Welsford, N.B.

STIERROTTE, Alfred, B.Sc., (Univ. of Alta.), Turner Valley, Alta.

WARNICK, William Maurice, (Queen's Univ.), 133 Stinson St., Hamilton, Ont.

YOUNG, Angus Francis, (N.S. Tech. Coll.), 1369 Victoria Road, Sydney, N.S.

Committee on Consolidation

Report for May 1936

In the reports of the Committee for the months of March and April, reference was made to a "Memorandum" which summarized the results of the discussions at the joint meeting of the Dominion Council, representatives of the Provincial Professional Associations, and the Committee on Consolidation, held in Hamilton on February 7th, 1936. The Committee now publishes this "Memorandum" for your information.

"Memorandum of Informal Conference

Between Representatives of the Provincial Professional Associations in Canada and of The Engineering Institute, prepared for the purpose of discussion only and without prejudice to the action by any member present at this Meeting, Held at Hamilton, February 7th, 1936.

We record with satisfaction and appreciation the opportunity afforded in Hamilton, this day for the first time for accredited representatives of all Provincial Professional Associations in Canada (The Associations' Dominion Council) and also of The Engineering Institute (The Committee on Consolidation) to confer for the common good of the engineering profession.

We feel the opportunity thus afforded to be of such great moment to the engineering profession in Canada that it must be taken full advantage of. Therefore, we desire to place on record the following preliminary conclusions as a basis for definite progress.

1. General principles only should now be asserted. Constitutional details and precise methods of procedure to accomplish the general principles could be left in abeyance for the time being.
2. The Provincial Professional Associations must continue to function in their present capacities and for the purposes set out in their respective acts, and the E.I.C. should continue to function.
3. There should be a national engineering body for Canada, comprising within its membership all the qualified engineers of Canada.
4. The Engineering Institute of Canada can be the basis for such a national engineering body, and it is desirable that it should be.
5. To accomplish the purpose set out herein, we suggest for the consideration of the Provincial Professional Associations and of The Engineering Institute the following specific recommendations:

(*a*) That The Engineering Institute agree to consolidate its two classes of corporate membership into one class.

(*b*) That The Engineering Institute agree to admit to corporate membership only those applicants who are members of a Provincial Professional Association.

(*c*) That The Engineering Institute agree to grant a special non-voting membership, without payment of either entrance fee or annual dues and without right to hold office, to those members of the Provincial Professional Associations who may not for the time being desire to apply for corporate membership in The Engineering Institute.

(*d*) That The Engineering Institute agree to enlarge its Council to permit each Provincial Professional Association to be represented directly by an accredited representative.

(*e*) That the Provincial Professional Associations continue their Dominion Council until such time as the purposes of the negotiations connoted by this memorandum are accomplished.

(*f*) That the Provincial Professional Associations consider an acceptable plan by which the non-voting members referred to in paragraph '*c*' shall be encouraged to become corporate members of the national body.

In conclusion, it is the opinion of all assembled that the Provincial Professional Associations should encourage all their members to become corporate members of The Engineering Institute to the end that as soon as practicable there will be a real and a complete common membership as between the Provincial Professional Associations and the national engineering body."

As pointed out in the April report of the Committee, the Joint Conference gave careful consideration to the status of the proposed Class "C" or "Provincial Member," and during the discussion of Section 5, Subsection (*c*) by the Conference, the members of the Dominion Council agreed "that the Associations could not expect that The Institute should be put to any undue expense in the development of this scheme."

The following Resolution, passed by the Manitoba Joint Consolidation Committee on April 29th, 1936, will be of interest to the profession as indicating the progress being made by that Province:—

Whereas, this Committee adopted in June 1935, proposals forming a basis for consolidating the membership and activities of the E.I.C. and A.P.E.M. in Manitoba (see Journal, November 1935, page 510) and

Whereas, these proposals were approved almost unanimously by vote of the membership in November 1935, and

Whereas, this Committee feels that unless a basis of consolidation is adopted for Manitoba without further delay the favourable interest which a large number of our members have in this matter will be dissipated, and

Whereas, we feel that consolidation in Manitoba will not hinder the work of the E.I.C. Committee on Consolidation, nor delay Dominion-wide consolidation but will rather assist toward that end, and

Whereas, since the E.I.C. Committee on Consolidation was appointed by the last annual meeting of The Institute with instructions to report back to the next annual meeting, members of Council may not wish to take any action on our proposals without approval of that Committee,

Therefore, be it resolved that

The Chairman of this Committee write Mr. Pitts requesting the E.I.C. Committee on Consolidation to recommend to Council that they endeavour to take such steps as may be necessary to permit our plan to be put into effect at the earliest possible date, and

The Chairman write to the Secretary of The Institute for information as to the changes in The Institute By-laws which will be necessary in order to permit our plan to be put into effect.

The seventeenth meeting of the Committee on Consolidation was held on Saturday, May 30th, at 9 a.m., there being present Messrs. Challies, Crealock, Jamieson, Kirby, Lefebvre, Legget and Pitts.

The Committee again discussed and approved the above Memorandum of the Joint Conference. It also considered the Resolution of the Joint Consolidation Committee of the Province of Manitoba, and in a resolution expressed sympathy with the desires of this Province for early consolidation within the province coupled with the hope that the engineers of Manitoba would co-operate with the Committee to the extent of delaying action until such time as the proposed revisions to the By-laws had been approved and forwarded to them. It was felt that the suggestions of these By-laws might be of assistance to them.

Representations from British Columbia regarding simplified forms of admission to The Institute and from Ontario relative to the organization of the profession in that province and the question of entrance fee, also the matter of general publicity among non-Institute members of the profession, were considered. The tentative revisions to the By-laws of The Institute as prepared by Mr. C. C. Kirby which had been circulated to the members of the Council of The Institute and of the Committee on Consolidation, were reviewed.

At 2.30 the Committee met in joint conference with the Council of The Institute, and the memorandum above referred to was discussed and its approval was recommended, with the addition of the phrase, "who shall be a corporate member of the Institute," to Section 5 (*d*). This joint meeting also discussed the resolution of the Manitoba Joint Consolidation Committee as printed above, Mr. Kirby's suggested revisions to the By-laws, and other matters relative to consolidation in the several provinces.

The proposed revisions to the By-laws of The Institute are now under intensive study by the Committee on Consolidation.

Gordon McL. Pitts,
Chairman.

BOOK REVIEWS

An Introduction to the Metallurgy of Iron and Steel

By H. M. Boylston. John Wiley and Sons (Renouf Publishing Company, Montreal), New York. 1936. Second edition. 6 by 9¼ inches. 563 pages. $5.00.

Reviewed by C. R. Whittemore, A.M.E.I.C.*

The book presents a broad view of the present day metallurgy of iron and steel. It constitutes an excellent text for the college student and the engineer who has to do with the utilization of iron and steel. Naturally, detailed information required by the specialist must be omitted and the task of presenting a wide outlook is not easy. This, however, has been accomplished and the value of the book as a text established.

Professor Boylston has enhanced the value of his work by a fine collection of photographs and diagrams, well printed.

The author presents a brief historical review of the use of ferrous metals, following with the extraction of iron from its ore; its use in the foundry; the manufacture of steel; its shaping, heat-treatment and metallography.

Statistical data have been extended and new processes described. Of particular note is the account of the Bracklesberg melting furnace for the foundry, the Byers-Aston process for wrought iron, and the use of molybdenum-tungsten high speed steel. Trends in the electric furnace industry are outlined. Ingot practice is treated in an illuminating manner, but no mention is made of methods of controlling grain size and its practical application.

The book is one that every engineer who is connected with the iron and steel industry will find it profitable to read.

*Metallurgist, Dominion Bridge Company Limited, Montreal.

Mathematics of Modern Engineering

By R. E. Doherty and E. G. Keller. John Wiley and Sons (Renouf Publishing Company, Montreal), New York. 1936. 6 by 9¼ inches. 314 pages. $3.50.

Reviewed by Professor T. R. Loudon, M.E.I.C.*

This book is the result of the gradually increasing demand that mathematical works be written with clear explanations and practical problems as illustrations. The electrical engineer has always been well in advance of other engineers in mathematical training, but even he has been very departmental in his outlook as far as mathematics is concerned. The ability to recognize mathematical forms wherever found is the true basis of analysis; and gradually the demand for training along such basic lines has been growing. Any text which presents mathematical forms from this basic outlook is welcome—and this text does.

The book is well written and is published in that style which makes texts published in the United States so attractive.

There are four chapters in the book as follows:—

Chapter I—Mathematical Formulation of Engineering Problems.
Chapter II—Basic Engineering Mathematics.
Chapter III—Vector Analysis.
Chapter IV—Heaviside Operational Calculus.

Each chapter is subdivided into several sections. For instance, Chapter I deals with differential equations in a very clear and interesting manner which reminds one of Byerly's conciseness; determinants are well explained and the section on dimensional analysis is very complete. There is also a section on graphical and numerical methods of solving differential equations which is interesting.

Chapter III on Vector Analysis is also neatly and clearly laid out. Engineering students will find this chapter easy to follow.

Chapter IV on Heaviside's Operational Calculus is well and clearly written, the necessary preliminary theorems on line integrals in the complex plane being given in the text thus leading up to the Heaviside rules in a logical and concise manner.

There are many engineering problems worked out which lends a practical air to the book. Altogether, it is a pleasing addition to engineering mathematical literature.

*Professor of Applied Mechanics, University of Toronto, Toronto, Ont.

An Engineer's Recollections

By John F. Stevens. Reprinted from the Engineering-News Record, New York. 6½ by 9½ inches. $1.00.

This collection of Mr. John F. Stevens' reminiscences is well worthy of the attention of any engineer, and particularly of young engineers, as it gives an excellent idea in a sketchy way of the variety of work which any civil engineer may be called upon to do under pioneer conditions. In fact, these reminiscences with variations may be considered as exemplifying the life of many of our more prominent American engineers, though it is rarely given to any one man to have the same breadth of experience and hold such outstanding positions as have fallen to the lot of Mr. Stevens.

Doubtless many engineers have had similar opportunities, but Mr. Stevens' case is a shining example of what can be made of these opportunities by a man with the true spirit of an engineer, having the necessary ability, resourcefulness, courage and devotion to duty. Throughout his career his work has been outstanding in the engineering field and has won for him a most enviable position among his fellow craftsmen. His words of advice to the young engineers who must carry on are well worthy of careful study, and should prove to be an inspiration to any young man about to embrace engineering as his profession.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Electrical Supply Authority Engineers' Association of New Zealand: Transactions, 1935.

Canadian Institute of Mining and Metallurgy: Transactions 1935, Vol. 38.

Highway Research Board: Proceedings 15th Annual Meeting 1935.

University of Toronto Engineering Society: Transactions and Year Book 1936.

Reports, etc.

Quebec (Prov.): Statistical Year Book 1936.

League of Nations: Report by the Committee of Experts on Hydraulic and Road Questions in China.

British Columbia, Dept. of Lands, Lands and Survey Branches: Annual Report 1935.

Canada, National Research Council: 18th Annual Report, 1934-35.

Canada, Dept. of Mines, Mines Branch: Analyses of Canadian Crude Oils, Naphthas, Shale Oil and Bitumen.

City of Winnipeg Hydro-Electric System: Annual Report 1935.

Dominion Water Power and Hydrometric Bureau: Water Resources Paper No. 73, Atlantic Drainage south of St. Lawrence river.

American Institute of Mining and Metallurgical Engineers: List of Members, By-laws, etc. 1936.

Canada, Dept. of Labour: Labour Legislation in Canada, 1935.

Alberta, Dept. of Lands and Mines: Annual Report 1935.

Dominion Water Power and Hydrometric Bureau: Water Resources Paper No. 68, Arctic and Western Hudson Bay Drainage.

Canada, Geodetic Survey: Publication No. 60, Triangulation in Ontario and Quebec.

Technical Books, etc.

"Engineering" Directory, Engineering Limited, London, England. 81st edition. 1936.

Centrifugal Pumps, by R. L. Daugherty. (*McGraw-Hill, New York.*)

Sewerage, by A. P. Folwell. (*John Wiley and Sons, New York.*)

National University of Ireland, Calendar. 1935.

An Engineer's Recollections, J. F. Stevens. (*Engineering News-Record, New York.*)

BULLETINS

Pumps—The Pulsometer Engineering Company Ltd., London, England, have issued their list No. 0728, a 48-page booklet containing particulars of their various lines of pumps, which includes centrifugal, fire, turbine, hand, rotary and vacuum pumps.

Steam Specialties—Bulletin No. SS-12 C., a 56-page catalogue, has been received from Darling Brothers Limited, Montreal. This gives details regarding the company's various lines of steam specialties and Webster heating equipment. This includes control equipment, traps, valves, separators, expansion joints, etc.

Screw Threads—A 24-page booklet on how to cut screw threads in the lathe has been received from the South Bend Lathe Works, South Bend, Ind.

Cutter Bits—A 12-page booklet on how to grind lathe tool cutter bits has been issued by the South Bend Lathe Works, South Bend, Ind.

Paving Breakers—Canadian Ingersoll-Rand Company Ltd., Montreal, have issued a 12-page leaflet containing information on methods of application of various types of breakers and diggers manufactured by that company.

Propeller Pumps—An 8-page folder received from Canadian Fairbanks-Morse Company Ltd. gives information regarding the types of propeller pumps manufactured by that company for the efficient handling of large quantities of water at low heads.

Motor Reducers—A 28-page bulletin received from the Philadelphia Gear Works, Philadelphia, Pa., gives dimensions and details of motor reducer sets manufactured by the company, and also particulars regarding a number of installations.

Blowers—A 4-page pamphlet issued by Roots-Connersville Blower Corp., Connersville, Ind., contains particulars regarding positive displacement blowers for foundry cupolas.

Grabs—Priestman Brothers Limited, London, England, have issued a 6-page folder containing illustrations and applications of grabs for use on wharf cranes.

Pivoted Bearings—A 12-page booklet issued by Dominion Engineering Co. Ltd., Montreal, gives data on Michell pivoted bearings, outlining the principal uses, details of sizes manufactured, and possible applications.

BRANCH NEWS

Border Cities Branch

C. F. Davison, A.M.E.I.C., Secretary-Treasurer.
F. J. Ryder, S.E.I.C., Branch News Editor.

The regular monthly meeting and dinner of the Border Cities Branch was held at the Prince Edward hotel. After dinner, S. E. McGorman, M.E.I.C., gave a brief report of the annual meeting of The Institute at Hamilton. T. H. Jenkins, A.M.E.I.C., the chairman, then called upon Mr. McGorman to introduce the speaker, C. M. Goodrich, M.E.I.C., chief engineer of the Canadian Bridge Company Limited, who had recently returned from an extended tour of Portugal and discussed his experiences, and conditions in that country.

MAROONED IN PORTUGAL

The language of Portugal is the nearest to Latin of all the old languages, and is difficult to learn owing to the lack of unification. Different sections of the country find it hard and sometimes impossible to understand one another. Most Portuguese understand Spanish but the Spaniards are not able to understand Portuguese. In his dealings with engineering students, the speaker found they knew a great deal about engineering, but little about anything else, for they could not write their own observations, but had to have "editors" who did it for them.

The natives are very pleasant and a hard working people. The ordinary day's pay amounts to about twenty-three cents, which is sufficient for them to live on in the manner to which they have been accustomed.

Portugal has experienced several bloodless revolutions and at present seems to be progressing favourably. It has paid all its interest and foreign obligations in gold on the due date and its credit ranks high on the foreign exchange. The present prime minister is an economist and a former minister of finance. The government has recently repaired and restored all the public buildings and national monuments and has built schoolhouses and hospitals and undertaken a plan of reforestation, all out of current taxes. The importation of wheat has been reduced from two-thirds of the quantity consumed to nil. The government is encouraging the cultivation of rice, cork trees, olives, grapes and the sardine industry. Begging has been prohibited and all former beggars have been placed in concentration camps and are supported by a two per cent tax on earnings.

The future should be bright for Portugal; the natives excel in gold filigree work, wrought iron and stone work. There is a large field open for construction work, and modernization. The climate and conditions are ideal for resorts.

After a good deal of questioning which brought out further stories and incidents, a hearty vote of thanks was extended to Mr. Goodrich.

Edmonton Branch

M. L. Gale, A.M.E.I.C., Secretary-Treasurer.

The fourth dinner and meeting of the Branch for the year was held in Athabasca Hall, University of Alberta, on Wednesday, March 25th, 1936.

Election of officers for the 1936-37 session was held at this meeting and Professor Edgar Stansfield, M.E.I.C., was elected chairman.

Dr. H. J. McLeod, M.E.I.C., spoke briefly on the question of amalgamation, which was discussed at a recent joint meeting of the Association of Professional Engineers of Alberta and members of The Engineering Institute, in Calgary.

Following the adjournment of the meeting, the members were conducted on an inspection of the civil engineering laboratories and the power plant of the University of Alberta. Demonstrations were given in the hydraulics, mechanical engineering and strength of materials and soil testing laboratories, and displays were shown of fractures and modern surveying equipment.

A short Kodachrome motio picture of the university was shown at the close of the evening.

THE ODYSSEY OF THE NORTH

On Friday, April 24th, 1936, members of the Branch attended a dinner meeting at the Corona hotel, with their wives and friends as guests.

Ordinary business was dispensed with on this occasion and F. K. Beach, M.E.I.C., chairman, called upon C. E. Garnett, A.M.E.I.C., to introduce the speaker of the evening, Mr. John Blue, secretary-manager of the Edmonton Chamber of Commerce.

Mr. Blue chose as his subject "The Odyssey of the North."

Canada has its heroic age, its achievements of men who stand out as a record of courage. We find that history is repeating itself. Exploration and development of northern Canada has dominated the history of Canada, just as the pre-Cambrian shield dominates the landscape of our country. There is a re-awakening of interest in the north because of the mineral discoveries. The north is going to dominate our economic history. The farmer has made an essential contribution to our development, but he is not the only one. There is a flexibility to our economic structure. Today, export of our minerals is greater than our field crops.

For two hundred years, adventurers were concerned with developing the fur and timber trade of the north. Now the opening up of the great mineral wealth will energize the thinking of the nation.

Mr. Blue traced the history of the far north from the time of its earliest explorer, Hearne, who in 1769, was the first white man in the northland. He went on to relate the efforts to solve the mystery of the Franklin expedition lost in the Arctic in 1845.

Hamilton Branch

A. Love, M.E.I.C., Secretary-Treasurer.
A. B. Dove, Jr.E.I.C., Branch News Editor.

RECENT ELECTRICAL DEVELOPMENTS IN THE STEEL INDUSTRY

The Hamilton Branch of The Institute, and the Toronto Section of the American Institute of Electrical Engineers, held their annual joint meeting in the Canadian Westinghouse auditorium, Hamilton, on April 3rd, 1936, about two hundred being present.

H. B. Stuart, M.E.I.C., on behalf of The Engineering Institute, opened the meeting and turned it over to Mr. M. J. McHenry of the A.I.E.E. Mr. McHenry, after asking the meeting to join in a moment's silence in memory of the late H. U. Hart, M.E.I.C., vice-president of the Westinghouse Company, introduced the speaker, Mr. R. H. Wright, of the steel development division of the Westinghouse Company at Pittsburgh, Pa.

Mr. Wright stated that of late there has been increased activity and expenditure in the steel industry. This did not necessarily imply decreased unemployment, but rather permitted increased production of better quality material. Turret top automobile bodies and wide sheet requirements had increased the demand for larger mills; this with increased drawing characteristics had caused building of equipment worth from $8,000,000 to $20,000,000.

Sheet and tinplate development had progressed from the old two high rolls to two and four high mills, hand operated, and later to automatic reversing equipment. The most modern equipment, however, is a series of four high mills operating continuously under constant tension. This equipment is further enhanced by accurate pressure equipment, micrometer gauges actuated on electronic principles, with intricate signal devices and automatic tension and speed control. The power equipment was modern, controlled carefully to two per cent variation in speed at upper limits, and generally with a 1½ per cent variation at all speeds. Automatic screw-down equipment which actuated the roll screws has been so developed that manual operation is unnecessary. Only by the use of roller bearings had such equipment been made possible, although recent developments in babitted bearings had been most successful.

The speaker then discussed electrical steel mill apparatus including electrical precipitators for flue dust, and electrionic rectifiers. Such equipment has now been developed so that in spite of the normal delicate construction of such instruments, design has improved along rugged lines without loss of accuracy. Even the "beam" principle has now been used for operating soaking furnace doors from the overhead cranes without direct electrical connection.

A film was then shown which demonstrated strip mill equipment and its operation, after which the meeting was thrown open to discussion. Interesting discussion was carried on between members of the assembly, which included representatives of various steel mills, and Mr. Wright. The nature of the discussions readily demonstrated the interest shown by the meeting. The meeting adjourned for refreshments prepared by the Canadian Westinghouse Company, after the meeting had expressed its appreciation of the speaker's efforts and the kindness of the hosts, the Canadian Westinghouse.

Mr. Donnelly of the Algoma Steel Company, Sault Ste. Marie, was a visitor, and gave an interesting outline of the development at the Soo.

London Branch

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

At the kind invitation of J. A. Vance, A.M.E.I.C. (Councillor of the Branch), the regular monthly meeting was held at his residence in Woodstock, on Wednesday, April 22nd, 1936.

J. Ferguson, A.M.E.I.C., Branch chairman, presided.

The speaker was W. G. Ure, O.L.S., A.M.E.I.C., city engineer of Woodstock, and he was introduced to the meeting by the host of the evening, Mr. Vance.

The subject of Mr. Ure's talk was the proposed reforms of the calendar and the following is a brief summary of his remarks.

The ancient Jewish system was first described, under which the excess days over twelve lunar months was allowed to accumulate for several years, and then an intercalary month was added making that particular year have thirteen months. Then a step forward was the Egyptian system under which five or six intercalary days were put in at the end of each year. Then the system introduced by Julius Cæsar under which the days were added into the months as they went along, making the months alternately thirty-one and thirty days except February which had twenty-nine days in ordinary years and thirty days in leap year. Then Augustus Cæsar took a day from February and added it to August because that month was named after him, and also took a day from September and added it to October and a day from November and added it to December. This gave the Julian Calendar, and the one in use today with certain modifications made by Pope Gregory with regard to the rules for leap year.

The rules for obtaining the date of Easter were also given and the connection between Easter and the full moon pointed out.

Various schemes for making further improvements in the calendar were described, among them the proposal for fixing the date of Easter and making it independent of the Jewish calendar moon, the International Fixed Calendar having thirteen months of twenty-eight days each, and the World Calendar Association scheme for retaining the twelve month year but having months in the arrangement of two of thirty days and then one of thirty-one days.

The advantages and disadvantages of these schemes were given, and it was pointed out that any scheme for a perpetual calendar involves the disturbance of the continuity of the seven day week, and that our present calendar regards the maintenance of that continuity as more important than the perpetuity of the calendar.

A vote of thanks was proposed to the speaker for his interesting and instructive address by A. O. Wolff, A.M.E.I.C., seconded by F. C. Ball, A.M.E.I.C., and unanimously carried.

A lively discussion followed in which many of those present took part. W. C. Miller, M.E.I.C., gave a short description of the new "planetarium" which has recently been set up in New York. This machine visualizes all the planets in the constellation and could be set in motion showing the movement of these bodies and regulated in speed so that, say, a year's movement could be shown in a few minutes. The machine was so accurate that it showed the position of the planets at the birth of Christ after being set at the present formation and put in motion backwards to cover the elapsed 1936 years.

Mr. Vance mentioned the proposed establishment of a Transportation Committee at Headquarters and in view of his next visit to Montreal he asked if the members had any suggestions.

None were put forward but he was assured by the members of their co-operation in considering any measures proposed by that body.

A lunch was provided by Mrs. Vance and much appreciated by the members and guests, among the latter being several prominent Woodstock citizens. About twenty-five were present altogether.

The hospitality shown by the host and hostess was suitably marked by Mr. Ferguson and Mr. McKillop, who voiced the appreciation and thanks of the company.

Moncton Branch

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

A very instructive address on "National Problems for Research in Canada" was delivered before the Branch on March 20th, 1936, by Dr. H. E. Bigelow, Professor of Chemistry, Mount Allison University, Sackville, N.B.

H. B. Titus, A.M.E.I.C., chairman of the Branch, presided.

In opening his address, Dr. Bigelow briefly outlined the development of the National Research Council from its foundation in 1916 until the present time, and the development of the new laboratory in Ottawa. He then discussed the general problem of national research as seen in England, the United States, Russia and Japan. These countries are spending enormous sums on this field. The development has been particularly spectacular in Russia, which has built up a strong organization, spending nearly half a billion dollars yearly. Fifty years ago, there was no chemical industry in Canada. Today $750,000,000 is invested in chemical and allied industries which produce $500,000,000 worth of products annually. This compares with $7,000,000,000 in the United States.

Discussing some of the problems solved, the speaker stated that in 1935 the loss to Canadian wheat, due to rust, is estimated to have amounted to $100,000,000. This problem has been studied for twelve years and it is confidently declared to be solved by the development of a rust resistant wheat which will be distributed to farmers in 1937.

The codfish industry in Nova Scotia was handicapped by the discolouration of the fish on keeping. Canadian biologists working under support of the Council solved the problem, and also that of the lobster canning industry of New Brunswick.

Research on rubber has shown that the addition of fatty acids—obtained from animals—increases the wearing quality of rubber. About 12,000,000 pounds of this is used yearly and has increased the sale of fats. Pilchard oil from British Columbia may supply the fat.

Weed control is one of the great national problems and already much has been done. Barley for malting has been an imported product. A research on this subject is now in progress and shows promise. A large industry here is possible. Bleaching clays are imported to the value of $500,000 yearly. Several deposits in Canada have been studied and results show the possibility of utilizing Canadian material.

In moving a vote of thanks to the speaker, R. H. Findlater, M.E.I.C., congratulated Dr. Bigelow upon his appointment to the Council of Research, and, in speaking of research work, expressed the hope that one of the problems to be solved would be the liquefaction of natural gas for use as fuel in that form. The motion was seconded by G. C. Torrens, A.M.E.I.C.

Montreal Branch

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

JUNIOR SECTION

On Monday, April 20th, 1936, Mr. J. Alex. Edmison, a graduate in law of McGill University, and one of the leading public speaking instructors in Montreal, gave a most interesting talk before the Junior Section, his subject being "The So-called Problem of Public Speaking." P. E. Savage, S.E.I.C., was in the chair.

SMOKING CONCERT

The third smoking concert of the Montreal Branch was held in the Windsor Hall, Windsor hotel, on April 24th, three hundred and fifty members and friends being present. An unusually interesting and amusing programme was arranged. J. B. D'Aeth, M.E.I.C., chairman of the Branch, opened the proceedings, and R. H. Findlay, M.E.I.C., acted as master of ceremonies, being ably assisted by the members of the Entertainment committee, Messrs. F. S. B. Heward, A.M.E.I.C., A. Budden, A.M.E.I.C., E. R. Smallhorn, A.M.E.I.C., C. C. Lindsay, A.M.E.I.C., J. A. E. Gohier, M.E.I.C. and J. A. Lalonde, A.M.E.I.C. D. C. Tennant, M.E.I.C., who led the community singing, proved himself to be, as usual, an able conductor. R. F. Legget, A.M.E.I.C., gave an amusing talk illustrated by lantern slides.

Niagara Peninsula Branch

P. A. Dewey, A.M.E.I.C., Secretary-Treasurer.
C. G. Moon, A.M.E.I.C., Branch News Editor.

The annual meeting was held at the General Brock hotel on May 7th, 1936. Immediately before dinner the Executive committee met to receive the report of scrutineers and to elect officials for the coming year.

Under new by-laws the district is now divided into three divisions with three representatives from each, serving for a term of one year.

An impromptu experiment in lactology, submitted by Messrs. Harold Bucke, M.E.I.C., and George Wood, A.M.E.I.C., won approval and convinced the members that Pasteur had not grasped the full significance or possibilities of his research into the elimination of bacteria.

Past-president Alex. J. Grant, M.E.I.C., who has been wintering in Florida, said a few words in appreciation of the attendance at the meeting, and remarked upon the healthy appearance of the Branch.

Councillor E. P. Murphy, A.M.E.I.C., also reported progress and was instructed regarding an important matter to be discussed at the next meeting of Council.

The speaker of the evening was Professor Thomas R. Loudon, M.E.I.C., of Toronto, who told about his recent trip to Europe and pictured political and economic conditions with special reference to aircraft development. The speaker was presented by Lt.-Col. H. M. Campbell, A.M.E.I.C.

AIRCRAFT DEVELOPMENT IN EUROPE

Canada is air-minded, stated Professor Loudon, but her general equipment is now about five years behind the times. The greatest factor of safety in flying is a good metereological service and Canada is well supplied, provided facilities are expanded properly.

European air travel is increasing by leaps and bounds. England doubled her flying mileage in one year, 1934-35, while, from 1932-35, the mileage in Germany quadrupled. During four years—1931-35—two English planes alone carried 132,000 passengers without a mishap. Croydon airport is a hum of activity at all times, catering to about 3,600 passengers a week which, in the holiday season, increases tenfold. England has twenty-three municipal airports and many other privately owned. Every city in Canada with any pretensions to future greatness should follow suit or else be content to take a secondary place away from the main routes of travel.

The London to Paris flight is crowded. Seats must be purchased ahead of time. Everything is done for the comfort and convenience of passengers and visas and passports are checked before leaving; consequent delays are therefore less than in rail and boat travel.

The cost of flying, taking tips, meals and berths into consideration, is about 10 cents a mile as against 7 cents for the rail and boat route. There is but one class in the English planes but Germany has instituted a "popular" service in certain places at a rate comparable with third class rail travel.

Empire routes to Africa, India and Australia have three planes leaving each week which are always well filled. There is no night flying at present; but a new type of flying boat is predicted for 1937 which will allow twenty-four hour runs with consequent reduction in passage time.

Aeronautic research is being carried in a large way. Full scale and enclosed tunnels with interior pressures of 25 to 30 atmospheres contribute much valuable information but, of course, the final and conclusive tests must be made by actual flying.

Turning to the political aspects of Europe, Professor Loudon then sketched briefly the disturbances caused by the fact that dictatorships are sometimes forced to use harsh and spectacular measures in order to retain power. Both the Ethiopian drive and the Rhineland march were undertaken in this spirit.

Russia seems to be the subject of the greatest uncertainty and suspicion in Europe. She practically controls the Turkish army and constitutes a menace of which Germany, rightly or wrongly, is afraid. Russia has possibly the best trained and equipped air force in the world. The alliance with France has done nothing to quiet this uneasiness and Germany is turning towards Britain with the feeling that at least a desire for peace and fair play may be found there.

The British Empire is about the last and best stronghold of freedom that remains.

A lengthy discussion followed, Messrs. McQueen, Grant, Vollmer, Collinson, Little and others taking part. Chairman Paul Buss, A.M.E.I.C., was unfortunately away but vice-chairman George Woods presided. The vote of thanks was proposed by C. W. West, A.M.E.I.C.

Ottawa Branch

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

FIFTY YEARS OF SHIPBUILDING—A RETROSPECT

The problems of the shipbuilder and the remarkable advances in shipbuilding in the past half century were ably described at the noon luncheon at the Chateau Laurier on Thursday, April 2nd, by Fred. Bridges, M.I.N.A., M.E.I.C., Port Warden at Sorel, Quebec. Mr. Bridges' address was entitled "Fifty Years of Shipbuilding—a Retrospect" and and was illustrated with views of early and modern marine construction.

E. Viens, M.E.I.C., chairman of the local Branch of The Engineering Institute, presided at the luncheon and in addition head table guests included: Hon. Grote Stirling, M.E.I.C., E. Hawken, G. J. Desbarats, C.M.G., M.E.I.C., F. A. Willsher, Group Captain E. W. Stedman, M.E.I.C., L. L. Bolton, M.E.I.C., J. E. St. Laurent, M.E.I.C., F. H. Peters, M.E.I.C., F. McDonnell, M.E.I.C., J. G. Macphail, M.E.I.C., and T. A. McElhanney, A.M.E.I.C.

Mr. Bridges who in 1884 was apprenticed to a shipbuilding firm on the Thames in England, specializing in war vessels, and who subsequently served in other capacities connected with naval engineering both on land and sea, came to Canada in 1908 as chief draughtsman at the Government Shipyard at Sorel, Quebec. In 1918 he left to take charge of a private yard; he was appointed Steamship Inspector at Montreal in 1924; and Superintendent of the Sorel Shipyard in 1928, retiring under the age limit from that position in 1934. He was appointed to the position of Port Warden of Sorel in 1930.

The speaker successively traced the advances that had been made to date in the construction of battleships, battle cruisers, torpedo boats, destroyers, submarines, and commercial types of vessels of all kinds. The greatest advance in the past fifty years according to the speaker, has been in the marine engineering end of ship construction.

He deplored the fact that shipbuilding was not carried on to a greater extent in Canada and stated that it might be a good thing for the industry if some men would make a practice of sending their sons to England to learn the trade.

He stated that when at sea in 1893 and 1894 he saw Nova Scotian barques in Manila, Yokohama, and Hong Kong, five and six at a time. In fact, they were all through the Far East and also in the South American and Australian trade. It seemed extraordinary that such a trade should have disappeared.

At a largely attended noon luncheon held at the Chateau Laurier on April 16th, 1936, Sir Francis Floud, British High Commissioner in Canada, addressed the Ottawa Branch on "Housing in Great Britain." E. Viens, M.E.I.C., chairman, presided and additional head table guests included: Mayor Stanley Lewis, Alderman David McMillan, G. J. Desbarats, C.M.G., M.E.I.C., Group Captain E. W. Stedman, M.E.I.C., Colonel A. E. Dubuc, M.E.I.C., T. W. Fuller, J. Clark Reilly, C. A. McDonald, Dr. Charles Camsell, M.E.I.C., and Norman B. MacRostie, A.M.E.I.C.

Housing schemes have been among the main contributions to the material reduction of unemployment in England and Wales, declared Sir Francis, and the building trades industry is now the largest in the country, in point of employment. It is estimated that a further half million new houses will be required within the next few years.

At this luncheon meeting, after the address by Sir Francis Floud, Group Captain E. W. Stedman, as councillor, made the announcement that the Council of The Institute had unanimously conferred upon G. J. Desbarats, C.M.G., of Ottawa, honorary membership in The Institute. In the announcement, mention was made of the high place that Mr. Desbarats had occupied in the engineering life in Canada, and also of the important place that he had occupied in The Institute affairs.

NEW AIR SURVEY METHODS

At the noon luncheon at the Chateau Laurier on April 30th, Lt.-Col. E. L. M. Burns, O.B.E., M.C., gave an address on "New Air Survey Methods." E. Viens, M.E.I.C., chairman of the Ottawa Branch, presided and in addition head table guests included: Major General E. C. Ashton, Chief of the General Staff; Air Commodore G. M. Croil; G. J. Desbarats, C.M.G., M.E.I.C.; J. F. Fafard, M.P.; Dr. Charles Camsell, M.E.I.C.; J. M. Wardle, M.E.I.C.; F. H. Peters, M.E.I.C.; F. C. C. Lynch, A.M.E.I.C.; Group Captain E. W. Stedman, M.E.I.C.; J. A. Wilson, A.M.E.I.C.; W. H. Boyd; N. J. Ogilvie, M.E.I.C.; A. M. Narraway.

Lt.-Col. Burns, who is in charge of the Geographical Section, General Staff of the Department of National Defence, and convenor of the sub-committee on mapping methods organized under the National Research Council, gave an outline of air mapping methods in Canada and referred to some of the complicated and costly machines that were in use in other countries for the interpretation and the reduction to map form of the data on air photographs.

Only 17 per cent of Canada is accurately mapped at scales of four miles to the inch or greater and only 2 per cent at scales of one mile to the inch. Air photography has furnished a means of mapping areas in Canada that were particularly adapted to the methods used and to the scale of the mapping.

Before 1933 all survey departments were carrying on investigations into mapping methods, but none had money to spare for research, and little information was passed from one department to another. It was decided to remedy this state of affairs, so an Associate Committee of the National Research Council was set up for survey research. All branches interested in surveying were represented and sub-committees were arranged to deal with mapping methods, photographic aeroplanes and cameras, photographic materials and camera accessories, and infra-red photography.

The aim is to eliminate the defects of the air photograph, considered as a plan or map. The principal defects are: the scale is not constant over the whole picture nor are the angles true, there is no direct representation of relief, the relative positions of objects are not true in plan projections, and there are errors due to distortion in the lenses and in the photographic materials.

Some of the plotting machines used by foreign countries have been studied by the sub-committee from the point of view of theoretical accuracy, convenience of operation, output and hence economy, applicability to Canadian conditions, and cost. This committee came to the conclusion that the Fourcade Stereogoniometer seemed the most promising in principle, although it has not been brought to the same stage of development as some of the other machines. The Imperial Oil Company very generously placed at the disposal of the Committee a sum of money for the purchase of one as an aid to research in air photography in Canada. The design of the instrument which has been under revision is nearly complete, and they hope to have one in this country within a year.

Another apparatus, a Zeiss multiplex aeroprojector, the simplest air plotting apparatus developed in continental countries (see E.I.C. Journal, August 1934, pages 377 and 379), was recently acquired by the Department of National Defence. Results of a first experiment, for which the plotting was done in Germany, showed that with a limited amount of ground control—three points in 27.2 square miles—a map whose accuracy would be sufficient for the 1 inch to 1 mile work in undeveloped country could be made at the rate of about three man-hours per square mile.

The committee has also been investigating means of taking pictures more cheaply. For this purpose, cameras with wider angles of view are necessary, say 80 or 90 degrees. Until recently this problem was regarded as practically insoluble, but last year Zeiss brought out a wide angle lens and the committee have been considering acquiring one.

Another solution is to combine the photographs taken with several cameras into one composite which shall have the same characteristics as the vertical photograph. Several examples of these multiplex cameras exist, one type of which has been ordered by the R.C.A.F.

The wide angle obtainable with these composite photographs enables a great area to be covered at one exposure, with consequent reduction of the number of photographs which must be taken, and hence of flying and plotting time.

Canada, for the orderly development of whose natural resources survey is indispensable, should allot a proper proportion of the personnel and money spent on survey to research for better methods. A practical start has already been made and it is hoped that further steady progress will ensue.

STEEL PILING

Robert F. Legget, A.M.E.I.C., of Montreal, addressed the noon luncheon, May 14th, 1936, at the Chateau Laurier on the subject "Steel Piling." E. Viens, M.E.I.C., chairman of the Ottawa Branch, presided, and in addition head table guests included: J. B. Hunter, Lt.-Col. A. E. Dubuc, M.E.I.C., J. M. Wardle, M.E.I.C., D. Macpherson, T. V. Anderson, A.M.E.I.C., J. M. Somerville, W. A. Mattice, C. McL. Pitts, A.M.E.I.C., G. A. Stone, R. F. Howard, M.E.I.C., and W. T. Lucas.

Mr. Legget, at the commencement of his address, stated that one of the most important differences between engineering practice of two thousand years ago and the present day lay in the fact that the early engineers had no real knowledge of the use of materials in tension. For years the study of the detailed properties of materials had not received the attention it deserved.

The materials used for piling at the present time include: timber, reinforced and massed concrete, and steel. The speaker dealt with these in turn indicating the suitability or otherwise of each. Steel piling, he pointed out, had certain fundamental advantages, particularly for sheet piling construction. At the end of the nineteenth century it had come into use as an efficient and effective material for such structures, although cast iron interlocking piling had been used many years before that time.

Of the steel sheet piling used in this country during the past five years, less than ten per cent had been for temporary purposes and even half of that had been left in place.

Mr. Legget illustrated his talk with lantern slides showing piling structures in various parts of the world, including some Canadian examples where steel piling had been effectively used to replace old wooden piling, as on wharves and docks, that had deteriorated through the effects of time and storms.

Peterborough Branch

W. T. Fanjoy, A.M.E.I.C., Secretary-Treasurer.
E. J. Davies, A.M.E.I.C., Branch News Editor.

THE ANNUAL STUDENTS' AND JUNIORS' NIGHT

Wednesday, April 15th, was the annual Students' and Juniors' Night at which there were five speakers as follows:—

A. R. Jones, Jr.E.I.C.—"The Engineer in Social Life."
G. Levy—"Metal Radio Tubes."
R. S. Hull, S.E.I.C.—"Panic."
A. J. Girdwood, Jr.E.I.C.—"A Mathematical Problem."
W. S. McMullen—"The Modern Pipe Organ."

The meeting was under the chairmanship of D. Emery, Jr.E.I.C., who mentioned briefly the purposes of the Students' and Juniors' Night and in passing mentioned with regret the unavoidable illness of B. L. Barnes, M.E.I.C., who was instrumental in instituting this feature in this Branch.

Mr. Jones outlined some of the effects upon society of the achievements of engineers in the application of science in its transformation of industry, with particular reference to the displacement of men by the modern machine.

Sociological problems which are challenging the world to-day were only indirectly referred to by Mr. Jones, but he quoted a pertinent paragraph from an article in "Electrical Engineering," by William E. Wickenden, suggesting the opportunities in the service of mankind which require talents analagous to those which have placed engineering in command, at least as an indispensable first lieutenant, of this machine age. "The fundamental job of the engineer," Mr. Jones quoted, "is to take the guesswork out of economic life as rapidly as scientific knowledge will permit. So far, he has succeeded brilliantly with processes and products, and this success is opening new doors. His next job will be to take the guesswork out of the use of products and resources; out of their distribution as well as their production; also to take guesswork out of the use of capital and of manpower."

"Mass production may be considered the very heart of modern industry. The design of automatic machinery has put many a gadget, which would otherwise be a luxury, on the counters of the five and ten-cent stores. It has put the majority of automobiles in the class of $900 or under, instead of the $1,500 to $3,000 at which they started.

"Many a volume could be filled with instances of human distress caused by discovery and invention. So much of our social and economic maladjustment is obviously due to the march of invention against mob inertia that it is difficult to see why histories have not been written with the names of generals left out and scientists and inventors inserted."

Mr. Levy described very graphically the component parts and assembly of the all metal radio tubes and gave a comparison of the service expected of them as compared with the glass tubes.

Mr. Hull defined panic as a sudden fright without good cause. He related instances of heavy loss of life in public buildings resulting from mob hysteria often in circumstances such as the fear of fire which would easily have enabled every person to have escaped in safety. Never go into a building without due thought of safety precautions and observations of convenient exits. Careful inspection of public buildings and their provision for emergency exits was also recommended by Mr. Hull.

Mr. Girdwood presented his mathematical problem, which had to do with synchronous motors, in such a capable manner that most of the audience, although they were completely in the dark as to what it all meant, were quite willing to accept his statement as true.

Mr. McMullen explained in a very thorough and capable manner the mechanics of the modern pipe organ. His description of the various component parts and types of organs indicated the extent to which science has contributed to the ability of the pipe organ to reproduce the sounds of practically all other musical instruments. He mentioned the fact that Casavant Frères of Quebec are considered the world's best organ builders and that of the many organs they have built there is no duplication.

Quebec Branch

Jules Joyal, M.E.I.C., Secretary-Treasurer.

Il nous fait plaisir d'offrir à nos lecteurs un résumé d'une conférence faite, à une réunion des membres de la section de Québec, par M. Maurice Archambault, I.C., du Service Provincial des Mines, conférence intitulée:—

L'INDUSTRIE MINIERE DU QUEBEC ET LE GENIE

Au point de vue national, l'industrie minière est de nos jours plus importante que l'industrie agricole. Ce qui constitue depuis longtemps la richesse matérielle la plus convoitable et la plus convoitée d'un pays, ce sont ses mines et non pas ses ressources agricoles ou forestières, comme on le dit généralement et comme il n'est plus à propos de le dire.

Le véritable enjeu de la prochaine guerre sera un groupe de mines intéressantes, et non pas la possession d'un sol fertile ou boisé. Qu'on pense un peu à l'histoire des mines de sel de l'Alsace, aux graves incidents des mines de fer de La Sarre, et aux convoitises suscitées par les richesses minières de la Mandchourie et de l'Ethiopie.

Si l'industrie agricole est nécessaire pour sustenter notre pauvre corps animal, l'industrie minière est non moins indispensable à la sustentation des progrès de la civilisation. Civilisation veut dire industrialisation et Industrialisation veut dire mines. L'industrie minière est à la fois la mère et l'enfant de la civilisation. Sans elle, peu ou point de bons combustibles; sans elle, peu ou point d'engrais ou de correctifs pour fertiliser ou amender les sols fatigués de l'agriculture; sans elle, point de produits minéraux neutres, alcalins ou acides, indispensables aux industries chimiques ou pharmaceutiques et à l'industrie du bâtiment moderne; sans elle, point de métaux, donc adieu nos merveilles de mécanisme et de confort, aviation, radio télévision, etc.; sans l'industrie minière, ce serait le retour aux âges sombres de la préhistoire!

Cette industrie a ceci d'intéressant, c'est qu'elle permet tous les espoirs. Le désert le plus aride, le pays le plus sauvage et le plus lointain peut se peupler demain, si on y trouve de l'or, du diamant ou du pétrole.

Aux principaux chapitres de l'histoire minière du Canada, le conférencier a mentionné la découverte près de Sudbury, des plus gros gisements de nickel du monde entier; la découverte près de Cobalt, des plus fameux gisements d'argent et de cobalt; la découverte dans les cantons de l'est de notre province, de mines d'amiante, qui furent d'emblée et pendant longtemps les plus intéressantes de l'univers.

"Nous vivons sûrement, a-t-il dit, dans un pays privilégié. Si le sol de la province de Québec, grâce aux substances minérales qu'il contient est d'une grande fertilité, son sous-sol n'est pas moins riche, et il récèle en son sein plus de richesses minières insoupçonnées qu'il n'y en a de mises à jour".

Sait-on généralement que pas plus de 10% de la superficie de notre province est cultivable d'une façon profitable. Ceci laisse 90% de terrains non utilisés ou non utilisables par l'agriculture, c'est-à-dire une superficie trois fois supérieure à celle de la France entière, soit encore 630,000 milles carrés de surface précambrienne dont l'industrie la plus importante est ou sera l'industrie minière. Partout, la formation rocheuse précambrienne s'est avérée une des plus riches recéleuses de métaux précieux et autres minéraux utiles à l'industrie et à l'agiculture. Les cantons de l'est de la province, à eux seuls, ont produit à date, près de deux cents millions de piastres d'amiante brut, qui en "produits finis" valent environ deux milliards de piastres.

"N'est-ce pas, a-t-il dit, que ces chiffres sont éloquents? Et pourtant, le pays n'est pas encore prospecté. On n'est qu'au prélude. De nombreuses mines surgiront encore de terre; la géologie nous en est garante! De toutes les provinces du Canada, la nôtre a la plus grande étendue de terrains favorables à la découverte de gisements de minerai. Malheureusement, si nous ne manquons pas de ressources minières, nous manquons de prospecteurs.

"Nous, Québecois, a-t-il dit, nous sommes en train de forfaire à nos ancêtres, qui s'étaient créé une réputation mondiale comme pionniers, défricheurs, pionniers-colonisateurs, ou pionniers-découvreurs. Nos aïeux furent ici les pionniers de l'agriculture; nous devrions avoir à cœur d'être nous aussi des pionniers, soit les pionniers de l'industrie minière qui est l'industrie du progrès, l'industrie de l'avenir; il ne faudrait pas perdre notre renom de pionnier, ni faire mentir l'atavisme".

Le conférencier s'est ensuite attaché à démontrer que la profession du génie-minier assure à son homme, la santé physique, intellectuelle, morale et matérielle.

Vancouver Branch

T. V. Berry, A.M.E.I.C., Secretary-Treasurer.
J. B. Barclay, A.M.E.I.C., Branch News Editor.

At a meeting of the Vancouver Branch held on Tuesday, May 5th, 1936, eighty-five members of the Branch had the pleasure of listening to a very interesting address delivered by P. L. Pratley, M.E.I.C., Vice-President of The Institute, on the subject of the Isle d'Orleans bridge, opened for traffic July 6th, 1935.

Mr. Pratley's address, which was amply illustrated by a series of fine lantern slides, dealt in a very satisfactory manner with technical considerations which were responsible for the final choice of the suspension type of bridge for this location.

Many of the features of design, of detail and of construction of the substructure, towers, cables, trusses and roadway of the structure were explained, and at the close of the address there was much interesting discussion.

The speaker was accorded a hearty vote of thanks.

TRIP TO BRITISH PACIFIC PROPERTIES LTD., WEST VANCOUVER

About fifty members of the Vancouver Branch visited the Capilano Estates of the British Properties Ltd. on the North Shore of Burrard Inlet on Saturday, May 15th, 1936.

Developed from wild bush land at elevations varying from 250 to 1,500 feet above sea level, five hundred lots in areas from one to ten acres have been turned into beautiful homesites. When the new Lions Gate suspension bridge is completed across the First Narrows, this new subdivision will be but fifteen minutes auto drive from the centre of Vancouver.

Led by Mr. John Anderson, manager of the British Pacific Properties Ltd., and Mr. G. C. Conway, M.E.I.C., resident engineer, the visitors were shown over the estate.

Despite the steep topography of the ground, road grades have been kept down to 7 per cent maximum and all curves super-elevated.

Boulevards have been planted with trees and shrubs, and paving will be completed this summer. An eighteen hole golf course in one of the most beautiful settings in the world, overlooking English bay, the Fraser river delta and the Gulf of Georgia, has been laid out by Stanley Thompson, of Toronto. Other facilities for recreation are a polo field, tennis courts, bowling greens and athletic grounds.

A complete piping system for the sprinkling of greens and fairways has been installed and a five million gallon reservoir provided for ponding of water from a near-by creek.

Suitable provision for schools and parks has also been made.

After the inspection, members of the party were served with refreshments by the British Pacific Properties Ltd. Dr. E. A. Cleveland, M.E.I.C., President of the Engineering Institute, thanked the company for its courtesy in entertaining the party, and congratulated them on the development of one of the most beautiful homesites in the world.

Winnipeg Branch

J. F. Cunningham, A.M.E.I.C., Secretary-Treasurer.
H. L. Briggs, A.M.E.I.C., Branch News Editor.

On April 16th. 1936, A. E. Macdonald, A.M.E.I.C., Associate Professor of Civil Engineering, University of Manitoba, presented a paper before members of the Branch.

FOUNDATIONS ON UNSTABLE SOILS

During the last few years there has been considerable concern among many property owners in Greater Winnipeg upon discovering that their homes, some of which have stood many years without apparent signs of settlement, have suddenly developed cracks in plastered walls and large breaks in their foundations. This—coupled with frequent press reports of contracts let for underpinning foundations of such buildings as apartment blocks and houses—leads one to question the generally used method of foundation support, by means of shallowly placed spread footings, for such medium and light-weight structures.

The problem is by no means new and has been met with in many parts of the world since early times. Reference was made to the spectacular tipping, in 1914, of the million-bushel capacity storage annex of a Winnipeg grain elevator, which was built directly on clay and settled to nearly 57 degrees out of plumb before it was righted and underpinned.

Lake Agassiz at one time covered this western area with a great sheet of water, some 700 miles from north to south, and over 500 feet deep at the present site of the city of Winnipeg. Great masses of clay settled to the bottom of this lake. At an average depth of about 60 feet under the clay is limestone bedrock. For about 8 to 14 feet from the surface is a surface soil, brown clay and yellow clay. Then there are some 30 to 40 feet of fairly firm blue clay with hardpan beneath, the latter separated from bedrock by a thin stratum of shattered limestone. The relatively shallow yellow and brown clays especially have a variable supporting value, depending upon moisture content.

The speaker said that some of the old theories of foundations have to be revised, such as, that: uniform pressure intensities exist beneath footings when the latter are concentrically loaded; capacities of footings vary directly as their areas; capacities of pile footings vary directly as the number of piles; the bearing value of a pile may be correctly found from a pile formula based on the work of driving; skin friction of piles is always reliable even when weak strata exist below the piles. The formation of "bulbs of pressure" under spread footings and piles was described, and also Housel's work in which he found that the supporting capacity of soil depends upon (1) the bearing area and (2) the perimeter of the bearing surface. The results of loading tests, in Los Angeles and Pasadena, on cast-in-place short piles were described.

The paper concluded with a resumé of loading tests on 2-16 inch diameter cast-in-place reinforced concrete piles *constructed to hardpan* in the Canadian National Railways rail yards, Winnipeg, in 1934 and a description of their application to the underpinning of a 5-storey apartment block. Their application as a means of supporting satisfactorily foundation walls and columns of medium and light-weight buildings was suggested.

The paper was illustrated with lantern slides.

ISLAND OF ORLEANS BRIDGE

At a special meeting of the Branch on May 11th, 1936, P. L. Pratley, M.E.I.C., of Montreal, described the new Island of Orleans bridge.

This bridge was built partly as a relief measure and partly to make the Island accessible to residents of Quebec city. At the site, the St. Lawrence is tidal to the extent of 20 to 21 feet. At low tide, the width of the channel is 2,400 feet; at high tide, two mud flats are covered with water, bringing the width to 6,000 feet. The main bridge and the approaches total 2½ miles in length. Over the deepest part of the channel, a clear width of at least 600 feet was required for navigation purposes, and a clear height of 106 feet. By going to a central suspension span, a clear width of 1,059 feet was provided for navigation at a cost approximately the same as for a rigid fabricated structure providing 600 feet of clearance.

Mr. Pratley described the anchor piers, the main piers, and the main 10⅝ inch cables in considerable detail, which is not repeated here because of appearing elsewhere in current literature. A large number of slides made the presentation most interesting.

Housing in Great Britain

Abstract of address by Sir Francis Floud, British High Commissioner in Canada, before the Ottawa Branch of The Engineering Institute of Canada, April 16th, 1936.

At the end of the war, housing was one of the most serious problems Great Britain had to face. It was decided that the best way to solve the problem was by state subsidies to make up the difference between the rent the workers could pay and the economic rent on which homes could be built. To do this, the government decided to make use of the local administrations in cities, towns and counties.

The first scheme in 1919, under which the government undertook to pay all the losses, was expensive and instead of reducing costs, as the government had hoped, actually resulted in increases.

In 1923 a second scheme was brought in, under which the subsidy was $30 per home per year for thirty years, this being reduced later to $20. The result of this scheme was the building of many houses for sale but few for rental, the latter being the houses in main demand.

To remedy this situation the Labour government in 1924 gave a subsidy of $45 per house per year, when erected for rental, this subsidy later being reduced to $37.50. This resulted in an increase of the number of houses built for rental. In 1930 costs had been reduced to the point where the government decided to terminate subsidies for housing.

The effect of these schemes is that 2,800,000 new houses have been built since the war, rehousing about eleven million persons or one-quarter of the population. Of the houses built, 1,250,000 were subsidized, and 1,500,000 homes were put up without benefit of the subsidy. Of the total homes built, 830,000 were put up by local governments and the remainder by private enterprise.

Since the war the total cost of subsidies borne by the state amount to $648,000,000 while the local governments have subsidized building to the extent of $125,000,000.

In the housing problem private enterprise played an important part and the work done by the building societies of Great Britain was of particular value. These societies, which number about one thousand, do not build but provide opportunity for thrift or borrowing of money for purchasing or building homes. They have a membership of about two million and in 1934 advanced £124,000,000 sterling. The assets of the societies amounted to £554,000,000 in 1934.

These societies may receive deposits of not more than two-thirds of their mortgage assets and pay from 2½ to 3 per cent on deposits, free of income tax. Shares which form a stable investment also may be purchased and these pay interest of 3½ to 4 per cent, also free of income tax. Between 88 and 90 per cent of the funds of these societies are invested in mortgages and since the war £900,000,000 has been advanced on mortgages, the advances made last year being £124,000,000. Between 75 to 80 per cent of the value of a home is advanced on mortgage, the amount being repayable on a monthly basis, of both interest and principal, over a period of from five to twenty-five years. The interest on mortgages has generally been one per cent over the bank rate with a minimum of 5 per cent.

It may be said that the building societies borrow short and lend long. In theory this is true and if all the depositors wished to withdraw at one time the societies would be in difficulty. However, in practice this has not happened and the proportion of withdrawals from the societies has been going down. In 1933 about 13 per cent was withdrawn, the amount being about £27,000,000, while repayments and new shares and deposits amounted to £80,000,000.

The real security of the building societies was the personal covenant of the house purchaser and experience has shown it to be the best security to be found. Last year arrears of payments amounted to only 0.29 per cent of the total sums due, and the societies have a margin of 20 per cent on their mortgages. The average amount lent is $2,600 per home and the average monthly repayment is $21.50.

At the present time a three-bedroom house would cost $1,300 and the land $300. Interest and sinking fund, spread over a period of thirty-five years, would amount to $96 annually, repairs, management and insurance $26, and rates and water $36, a total of $158 a year or an average of about $13 a month in rent and repayment. This rate was higher than would be liked, which was a rate of about $2.50 a week. Comparing this cost for a home with the income of craftsmen employed building them, the average wage was $17 per week or $70 per month. On that basis rentals amounted to one-fifth of the total wages. In the types of houses referred to about twelve were built to the acre.

The housing scheme in Great Britain aimed at the elimination of slum areas over a five-year period. Much progress has been made, so much so that the work is in advance of the programme.

A total of one million three hundred thousand persons will have to be rehoused and to date more than two hundred and fifty thousand have new homes. Overcrowding is a serious problem and has not been settled yet. Some 25 per cent of the population live at a density of more than one to a room while one million live at a density of three to a room and more than three hundred thousand at a density of more than four to a room, conditions under which no decent living was possible. It is hoped that in the next five or six years some 500,000 additional houses will be erected to assist in the elimination of the overcrowding in certain areas in the country.

Alberta Petroleum and Natural Gas Developments

In Canada, the production of petroleum, which occurs chiefly in Alberta, has shown a steady increase in recent years, due to the development of a new field in the foothills of the Rocky Mountains. The history and exploitation of these Alberta fields has been described recently by W. Calder and R. M. S. Owen (Jr. Inst. Petr. Tech. 1935, 21, 753-773), from whose paper the following details were obtained.

The existence of gas in this area was known for many years, but the first attempts to exploit it were made in the Medicine Hat district after 1883, and in 1905 gas was tapped at two horizons, one at 600-700 feet, and the other at 1,000-1,100 feet. After a time surface water penetrated the gas horizon due to faulty drilling of the shallow wells, and the flow declined. Even the deeper drillings in recent years have evinced this trouble. Government engineers, however, proved the trouble to be due to corroded well casings rather than to an upward encroachment of water into the gas sands, and, after being relined and cemented, the wells again produced without interruption. On the basis of this experience three additional wells were drilled and yielded 2.9 to 3.7 million cubic feet of gas per day with an initial pressure of 500 pounds per square inch. There are now twenty-six wells producing gas for the street lighting system from the lower horizon in the town area, with an average pressure of 369 pounds per square inch and an average open flow of 1½ million cubic feet per day.

The success of the Medicine Hat venture stimulated prospecting in other areas, and in 1908, at Bow Island, 40 miles west of that town, sufficient gas was obtained to justify the construction of a 16-inch main to Calgary (168 miles). By 1922 this second field had passed its peak and was declining, when the Foremost structure was discovered further south and relieved the heavy withdrawal from the Bow Island field.

Immediately the surplus gas from the Turner Valley petroleum field became available, a thorough overhaul of the Bow Island field was made, many old wells being plugged, and in 1930 the area was repressured. A total of 7,259 million cubic feet has been forced into the depleted sands and the area pressure increased from 246 to 478 pounds per square inch.

In mid-northern Alberta natural gas is known to exist at several points, but the Viking district is the only one being drawn on, gas being sent by a 77-mile pipe line to Edmonton and intervening towns. Other known and partly developed gas areas include Redcliff, Cypress Hills, Brooks, Wetaskiwin, Fabyan, Wainwright and Ribstone.

Only three petroleum-producing fields have yet been developed in Alberta; i.e. Turner Valley, Red Coulee and Wainwright. The Turner Valley field was discovered in 1913 when a light crude oil of 0.770 sp. gr. was discharged from a well bored to about 2,400 feet. The Great War checked the work, which was not resumed until 1924, when the Royalite well No. 4 struck wet gas under high pressure, which caught fire. The conflagration was eventually extinguished, and a daily flow of 21½ million cubic feet of gas which yielded 500-600 barrels of naphtha was obtained. This well, which may be classed as one of the world's big producers, continued until 1929, and there are now ninety producing wells located over an area approximately one mile wide by 12 miles long.

The Turner Valley structure is a narrow overthrust fold running N.N.W.-S.S.E. with steeply dipping flanks. In the shallow wells the limestone formation which carries the oil was encountered at 3,450 feet, and in those located away from the coast greater depths had to be drilled. Water trouble has been confined to the upper strata and has been easily cemented off.

Wet gas is obtained from the wells, and after scrubbing to remove the naphtha, 30-40 million cubic feet in mild weather, and 50-70 million cubic feet daily over the remainder of the year are sold, the excess gas being destroyed. The crude oil, which is of high grade and ranges in gravity from 35 to 50 degrees Be., and which is encountered at 2,500 to 4,500 feet, has aroused little interest, possibly because it occurs in compact sandstones which do not readily permit an immediate free flow of oil.

In the Red Coulee area only five wells are producing and in 1934 yielded over 200,000 barrels. Other wells sunk encountered good inflows of oil at the rate of 50-70 barrels per day, but they were abandoned after being drilled into bottom water at some depth below the oil horizon.

At Wainwright although there is production from eleven wells distributed over a large area, operations have been erratic and the output small; at no well has the daily flow exceeded 35 barrels. Despite this, there are good indications that the productive life of the wells will be of long duration, two having been in production for six years and that if sufficient wells are drilled, at least six to each quarter section (160 acres) the returns, even at the low rate of 20 barrels per day, should prove remunerative.

At Pekisko, approximately 10 miles south of Turner Valley, a well drilled near the Prince of Wales' Range, encountered a promising horizon at depth, the crude oil rising nearly to the surface. The actual production rate is unknown, as no continued test has been made. A similar discovery has been made at Bragg Creek, north-west of the Valley.

To the north, at Athabaska Landing, a flow of heavy crude oil (12.1 degrees Be.) has been met recently at a depth of 1,650 feet, issuing from a sand 50 feet in thickness. Gas in quantity did not appear, and it is therefore improbable that any sensational daily outputs will be obtained from wells put down in this area. The prospects for small persistent wells, producing over many years, are encouraging, however, should the sand be continuous over a large area.

As an index of the progressive increase in crude oil production in Alberta, the following table gives the annual production in barrels of 35 Imperial gallons each.

1925	2,926	1930	119,805
1926	8,590	1931	109,506
1927	41,863	1932	63,506
1928	78,908	1933	60,155
1929	90,411	1934	55,174

The decline in the production since 1931 has been attributed to work being concentrated on drilling wells for wet gas production, a statement which is apparently supported by the increased output of naphtha alone, which rose from 854,116 barrels in 1932 to 952,885 barrels in 1933, and to 1,210,766 barrels in 1934.

The foothills extend for a distance of over 250 miles in Alberta, and all along this length favourable geological conditions and in many places, active oil-seepages, have been located. It is, therefore, likely that other oil-producing areas similar to the Turner Valley may be developed in the future.

—*Bulletin of the Imperial Institute.*

The Escape of Electricity from Metals

In a recent lecture before the Institute of Metals the speaker, Mr. C. C. Paterson, remarked that from the great discovery of Faraday in 1831, to the great discovery of J. J. Thomson in 1897, electricity was, except in arc lamps, handled and controlled in metal conductors. The metallurgist and engineer had conspired to perpetuate this state of affairs right up to the war, but the physicists had nursed the new art, until a race of engineers had grown up who could learn from them. To this school of engineers, the key to the position was that part of the circuit in which such conditions were brought about as enabled electricity—still under strict control—to leave the metal, follow a path through vacuum, gas or vapour, and rejoin the metal again at a predetermined point. During this passage through space the current could be increased or decreased millions of times per second. It could be reversed or stopped equally quickly, modulated in the most complicated ways and controlled, however large its amount. The devices generally employed for liberating these free electron streams were two: In one a portion of the circuit, such as a filament in a valve, was heated to such a temperature that the electrons emerged freely. In the other, which was used in photo-electric cells, the electrons were freed from a specially-sensitized cold surface of, say, caesium, by exposing it to the action of light. This new electrical engineering would scarcely have come into being had it not been for the fact that so much of what we saw and heard consisted of extremely rapid happenings. If it was desired to transmit sound or vision to a distance minute and high speed effects had to be imitated down to the smallest detail by the electron stream. The art of doing this was the basis of long-distance telephony, broadcasting, television and talking pictures. Electric lighting was the second great field in which the escape of electricity from metals was leading to revolutionary results. For, by facilitating this escape and guiding the stream through suitable gases, a number of highly-efficient lamps of two main types had been produced. Of these, the cold cathode tubes were mainly used for display purposes and required a high voltage for their operation. In the second, or hot-cathode tube, only a low voltage was required to yield some of the highest intrinsic brilliancies yet produced. This was a significant fact. For while incandescent solids imposed a limitation on the amount of light they emitted because this light was associated with their temperature and thus with their melting points or vapour pressures, with the electric discharge through gas and vapour molecules there was no such restriction.—*Engineering.*

Gasoline Standardization

Gasoline better suited to the needs of the car user, and a higher average mileage per gallon is the goal of a programme of specifications and tests for gasolines announced by the American Standards Association.

Work on this project is being carried out through the co-operation of all interested groups. The American Society for Testing Materials is taking leadership in the technical work. Other represented groups will include consumer and producer organizations, the government, scientists and automobile manufacturers.

The formulation of technical requirements has already been started, and tests are under way to determine their practical workability. Mr. T. A. Boyd, Head of the Fuel Section of General Motors, is chairman of the committee in charge of this work, and Mr. R. E. Hess, of the American Society for Testing Materials, its secretary.

The same committee is engaged in the development of specifications for lubricants, a subject of almost equal importance to the car owner.

EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada
2050 Mansfield Street, Montreal

Situations Vacant

MECHANICAL ENGINEER, with analytical mind to observe and study present methods in pulpwood operations. Will have to spend most of the time in woods. Must speak French. Give age, qualifications and experience to Box No. 1322-V.

MECHANICAL OR ELECTRICAL graduate as demonstrator in engineering drawing for a university in the Maritimes. Apply at once to Box No. 1326-V.

Situations Wanted

SALES ENGINEER, E.E.I.C.; B.SC. C.E., 1930 (Univ. N.B.), P.E.N.B. Age 28. Experience includes building inspection, structural detailing, road construction, and chemical operation. Interested in sales work on the sales staff of some manufacturing or wholesale concern. Apply to Box No. 225-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power houee equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and detaile. Good references. Present location Montreal. Apply to Box No. 329-W.

ENGINEER AND ACCOUNTANT, JR.E.I.C., (Capt. Can. Engrs., reserve). Age 35, Canadian. Experienced in mechanical and civil engineering, Diploma; general office, draughting and instrument work; assistant engineer erection Royal York hotel; assistant resident engineer T. & N.O. Ry. const. Desires position in Toronto where combination of technical and business experience will be of value, ae have been director and accountant last three yeare. Apply to Box No. 377-W.

ENGINEER, A.M.E.I.C. Age 30. Single. Employed. Civil and mining experience, capable of designing and superintending construction of timber, concrete and steel structures, rock crushing and ore plants. Would consider position with mining or engineering company designing and building mills. Apply to Box No. 431-W.

CIVIL ENGINEER, B.ec. '25, A.M.E.I.C., P.E.Q., single, experienced in pulp and paper mill construction and hydro-electric developments; also experienced in highway construction and topographical surveying. Available at once, location immaterial. Apply to Box No. 473-W.

MECHANICAL ENGINEER, B.SC. Age 31. Married. Last ten yeare includes:—Mechanical etructural and reinforced concrete design in pulp and paper mills, industrial plants, hydro-electric, mine, sewers and sewage disposal plant construction. My experience also includes ehop production, eteam plant combustion, fuel analyeing, inspecting, supervising and instrument work on industrial construction. Permanent position preferred. Apply to Box No. 521-W.

CONSTRUCTION ENGINEER, age 26, unmarried, graduate C.E. Experience includes hydro-electric, railroad, highway, and industrial plant construction, both field and office, including cost accounting, estimating, storee, layout, general engineering and supervision, as well as practical work in mechanical trades. Apply to Box No. 567-W.

DOMINION LAND SURVEYOR, and graduate engineer with exteneive experience on legal, topographic and plane-table surveye and field and office use of aerophotographe, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

Situations Wanted

ELECTRICAL ENGINEER, McGill '31, desires permanent position in engineering field. Experience includes draughting, designing and testing of induction motore, radio supervision and test, and some construction. Available immediately. Apply to Box No. 626-W.

ELECTRICAL ENGINEER, B.SC., 1926. One year maintenance, one year operating, large hydro-electric plant. Five years hydro-electric construction, as wireman aud foreman, on relay, metal, and remote control installations. Also conduit and switches. Three yeare mainteuance electrician, in pulp and paper mill. Also small power system. Desires position of responsibility. Sober, reliable and not afraid of work. Available at once. Excellent references. Apply to Box No. 636-W.

MECHANICAL ENGINEER, A.M E.I.C., Canadian, technically trained; six years drawing office experience including general design and plant layout. Also two years general shop work including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer, estimator. Available on short notice. Apply to Box No. 676-W.

ELECTRICAL AND RADIO ENGINEER, B.SC. '30. Variously engaged on receiver development work, testing, and transformer development, under direction. More recent experience includes tranemitter test room procedure and ehort wave beam transmission engineering. For further information apply to Box No. 680-W.

Employment Service Bureau

This bureau is maintained by The Engineering Institute of Canada for the benefit of members and organizations employing technically trained men.

An enquiry addressed to 2050 Mansfield Street, Montreal, will bring full information concerning the services offered. Details can also be obtained from Branch secretariee who are located in the larger centres throughout Canada.

Brief announcemente of men available and positione vacant will be published without charge in The Engineering Journal and the Bulletin. Replies addressed in care of the required box number will be forwarded to the advertiser without delay.

An additional service also offered those who are unemployed or wish to change their positions, is the opportunity of placing their names and records on file et 2050 Mansfield Street for consideration by employers wishing to employ engineers. This is of great assistance as many employers will not advertise or wish to locate a suitable man on short notice. If desired the information contained in these records can be kept confidential.

Forms for registration purposes may be obtained from The Institute Headquarters or Branch secretaries.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installatione, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing etructural eteel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.SC. Elec. '29, B.SC. Civil '33. JR.E.I.C. Age 29. Experience includes four months with Can. Gen. Elec. Co., approximately three years in engineering office of large electrical manufacturing company in Montreal, the last six months of which wae spent as commercial engineer. For the last year and a half employed in electricel repair shop. Best of references. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.SC., '27, JR.E.I.C. Four yeare maintenance of high epeed Diesel engine units, 200 to 1,300 h.p. Also maintenance of d.c. and a.c. electrical systeme and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special etudy of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

Situations Wanted

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert deeigner and draughtsman on modern eteem power plents. Experienced in publicity work. Well known throughout the weet. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.SC., University of N.B., '31. Experience includes three monthe field work with Saint John Harbour Reconetruction. Apply to Box No. 722-W.

CIVIL ENGINEER, B.ec. (Alta. '31), S.E.I.C. Experience includes three eeasone in charge of eurvey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.ec. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.SC., Univ. of B.C. '30. Single, age 24. Sixteen monthe with the Allis-Chalmere Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of eteam turbines, erection of hydreulic machinery, and testing texropes end centrifugal pumps. Location inmaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER, M.SC., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering. Read, write and talk French. Married. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

RADIO AND ELECTRICAL ENGINEER, B.Sc., '31, JR.E.I.C. Single. Age 29. One year and a half actual field experience in power and lighting equipment. Extensive work in telephone and radio layouts in switchboard and installation depts. Particularly interested and experienced in sales and traffic work in telephone and radio company. At present supervisor over sales and service of radio and electrical company. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, B.SC. '29, A.M.E.I.C. Married. One year building construction. One year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanieh. Apply to Box No. 744-W.

MANAFACTURERS' REPRESENTATIVE, at present doing business with leading industrial organizations in Canada, wishes to represent manufacturers of mechanical equipment. Such work as would involve technical data, and the preparation of plans where necessary, would be handled by an engineer whose experience with outstanding firms and projects, would be veluable to those seeking representation. Apply to Box No. 764-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

PLANT ENGINEER or SUPERINTENDENT, capable of supervising all phases of industrial plant operation, graduate electrical, eleven years diversified industrial experience including test course, four years on large Quebec industrial development, on construction and operation, also six years with prominent consulting firm supervising electrical and mechanical engineering projects. Age 31, single. Apply to Box No. 795-W.

CIVIL ENGINEER, E.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assietent on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), E.E.I.C. Single. Experience in city street improvement; eewer and water extensione. Good draughtsman. Referencee. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.A.ec., D.L.e., O.L.e., A.M.E.I.C., age 46, married. Twelve yeare experience in charge of legal field eurveye. Owne own eurveying equipment. Eight yeare on technical, administrative, and editorial office work. Experienced in writing. Desires position on eurvey work, assieting in or in charge of preparation of house organ, on etaff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, S.E.I.C., B.SC. '32 (Univ. of N.B.). Age 25. Married Two years experience in power line construction and maintenance; one year of highway construction; one eummer surveying for power plant eite, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

Situations Wanted

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.Sc. '32, E.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

SALES ENGINEER, A.M.E.I.C., graduate engineer, age 34, practical experience in the manufacture of power plant equipment, thoroughly conversant with Canadian power plant practice and equipment for the metal working industries. Available on short notice. Apply to Box No. 860-W.

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 32, married. Two years in pulp mills draughting and designing additions, maintenance and plant layout. Three and a half years in the Toronto Building Department, checking and designing for steel, reinforced concrete and ordinary structures. One and a half years as transitman and draughtsman on road location and maintenance work. Available at once. Location immaterial. Apply to Box No. 899-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

CIVIL ENGINEER, B.Sc., C.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

CIVIL ENGINEER, B.Sc. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, E.E.I.C., B.Sc., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No. 1010-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.Sc. (Queen's, '14), A.M.E.I.C., Dominion Land Surveyor, 5 months special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply to Box No. 1035-W.

ENGINEER, Jr.E.I.C., E.E. '29, is very interested in applying electrical methods to cement testing and research work. Apply to Box No. 1062-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.Sc. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

ELECTRICAL ENGINEER, B.Sc.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

MECHANICAL ENGINEER, B.A.Sc. (Univ. of B.C. '29); M.S. Age 27. Single. Four years experience in research work in applied mechanics and materials testing. Desires position involving analytical work in design, development or testing. Available on short notice. Apply to Box No. 1123-W.

PETROLEUM CHEMIST, B.Sc. in Chem. Eng. Age 25. Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

CIVIL ENGINEER, B.A.Sc., E.E.I.C., age 26, single. Experience includes one year in bridge construction, plain and reinforced concrete, pneumatic caissons and surveying. Available at once. Any location. Apply to Box No. 1204-W.

PHYSICIST ENGINEER, B.Sc.Mech. (Queen's 1913), M.Sc., Ph.D.Physics (McGill 1929, '30). Experience in municipal engineering, producer gas installation and operation, university plant maintenance. Experienced teacher of college physics. Industrial and pure physical research experience. Age 42. Married. Apply to Box No. 1207-W.

MECHANICAL ENGINEER, B.Sc. (Queen's Univ. '28), age 36, married, desires position of trust and responsibility. Experience includes fitting and assembly of machine tools, production, draughting, and maintenance. Five years teaching draughting and mathematics. Available on reasonable notice. Location immaterial. Apply to Box No. 1210-W.

CIVIL ENGINEER, B.A., B.A.Sc., S.E.I.C., Canadian, age 27, single. Experience includes eighteen months in general building construction. Writes and speaks both French and English fluently. Available at once for any suitable position in general engineering. Apply to Box No. 1211-W.

ENGINEER, with twenty years experience in industrial, pulp and paper mill, and general engineering and design. Age 41. Last five years chief engineer of paper mill making newsprint specialties and toilet tissues. Apply to Box No. 1246-W.

ELECTRICAL ENGINEER, B.Sc. '34 (Univ. of N.B.), S.E.I.C. Age 21, single. Desires any kind of electrical work. Will consider any location. Apply to Box No. 1262-W.

CIVIL ENGINEER, B.A.Sc. (Toronto '33), S.E.I.C., age 25. Married. One year as instrumentman with provincial highways dept. Experience in concrete and retread construction, draughting, estimating and accounting. One year with department of National Defence on grading and reinforced concrete construction. Apply to Box No. 1265-W.

ELECTRICAL GRADUATE, S.E.I.C., B.Sc. '32, M.Sc. '34. Experience includes four years as part time operator and announcer for a radio broadcast station. At present employed in radio repair dept. of a large wholesale firm. Apply to Box No. 1283-W.

ELECTRICAL ENGINEER, B.Sc., E.E., A.M.E.I.C. University of Manitoba '28. Age 32. Married. Experience one year power line construction, five years resident and assistant district engineer on highway construction; two years highway traffic regulation in charge of district office. Good connections in Manitoba and Saskatchewan. Excellent references. Available at once and will go anywhere. Located in Winnipeg. Apply to Box No. 1316-W.

ENGINEER AND DRAUGHTSMAN, Jr.E.I.C., age 33, married. Diplomas from Mtl Tech. Inst. in R.C. and Structural Design. 11½ years experience in civil engineering, draughting and instrument work. This includes 7 years with M.L.H. & P. Cons. as field engineer on construction and maintenance of gas mains. Present location Montreal. Available at once. Apply to Box No. 1326-W.

GRADUATE ENGINEER, (McGill), in responsible charge of design, construction and operation of hydro-electric plants. Also power design and mechanical maintenance of industrial plants. Apply to Box No. 1328-W.

MECHANICAL ENGINEER, recent grad. University of Toronto, B.A.Sc. in mech. engrg, 24 years old, S.E.I.C., now managing a chain store, desires engineering work. Present location So. Ontario. Location immaterial. Best of references. Apply to Box No. 1348-W.

CIVIL ENGINEER, A.M.E.I.C. Married. Age 38. Twenty years experience in organization, design and estimating, and cost accounting. Active service in France. Apply to Box No. 1367-W.

FIRE PROTECTION AND SAFETY ENGINEER, A.M.E.I.C., B.Sc. '24 (Mech. Engrg.). Age 33. Bilingual. Ten years experience with insurance underwriters inspection bureau covering phases of field work. Thoroughly familiar with insurance requirements. Position desired industrial or other concern maintaining self insurance or relative departments. Location Montreal or vicinity preferred. Apply to Box No. 1395-W.

ENGINEER SUPERINTENDENT, A.M.E.I.C., R.P.E., Que. and Alta. Age 47. Married. Twenty years experience as engineer and superintendent in charge of hydro-electric, industrial, railroad, and irrigation construction. Specialized in rock excavation and suction dredging. Intimate knowledge of costs, estimating and organizing. Available immediately. Apply to Box No. 1411-W.

1935 GRADUATE IN CIVIL ENGINEERING, B.Sc. (Queen's Univ.), E.E.I.C. Experience includes eleven months summer work as county engineer's assistant in charge of the surveying party, and two months as surveyor's assistant during construction of concrete formwork and installation of machinery. Keenly interested in graphical analysis, draughting, design, organization and report writing. Now available for any location. Apply to Box No. 1415-W.

CIVIL AND ELECTRICAL ENGINEER, Univ. of Man. '35 and '36. S.E.I.C. Experience in irrigation and mapping. Available at once. Location immaterial. Box No. 1418-W.

THE ENGINEERING JOURNAL

THE JOURNAL OF THE ENGINEERING INSTITUTE OF CANADA

Published monthly at 2050 Mansfield Street, Montreal, by The Engineering Institute of Canada, Incorporated in 1887 as The Canadian Society of Civil Engineers.

ENTERED AT THE POST OFFICE, MONTREAL, AS SECOND CLASS MATTER.

"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."

July, 1936 **Volume XIX, No. 7**

CONTENTS

Price 50 cents a copy, $3.00 a year, in Canada, British Possessions, United States and Mexico. $4.50 a year in Foreign Countries.
To Members and Affiliates, 25 cents a copy, $2.00 a year.

Published Monthly at 2050 Mansfield St., Montreal

THE ENGINEERING INSTITUTE OF CANADA

Incorporated in 1887 as The Canadian Society of Civil Engineers

BRANCHES:

Halifax Branch, Halifax, N.S.
Cape Breton Branch, Sydney, Cape Breton.
Moncton, Branch, Moncton, N.B.
Saint John Branch, Saint John, N.B.
Saguenay Branch, Kenogami, Que.
Quebec Branch, Quebec, Que.
St. Maurice Valley Branch, Three Rivers, Que.
Montreal Branch, Montreal, Que.
Ottawa Branch, Ottawa, Ont.
Kingston Branch, Kingston, Ont.
Peterborough Branch, Peterborough, Ont.
Toronto Branch, Toronto, Ont.
Hamilton Branch, Hamilton, Ont.
Niagara Peninsula Branch, Niagara Falls, Ont.
London Branch, London, Ont.
Border Cities Branch, Windsor, Ont.
Sault Ste. Marie Branch, Sault Ste. Marie, Ont.
Lakehead Branch, Port Arthur, Ont.
Winnipeg Branch, Winnipeg, Man.
Saskatchewan Branch, Regina, Sask.
Lethbridge Branch, Lethbridge, Alta.
Edmonton Branch, Edmonton, Alta.
Calgary Branch, Calgary, Alta.
Vancouver Branch, Vancouver, B.C.
Victoria Branch, Victoria, B.C.

Members of Council 1936

PRESIDENT
E. A. CLEVELAND, Vancouver, B.C.

VICE-PRESIDENTS

*E. V. CATON, Winnipeg, Man.
†R. L. DOBBIN, Peterborough, Ont.
†H. W. McKIEL, Sackville, N.B.
†A. B. NORMANDIN, Quebec, Que.
*P. L. PRATLEY, Montreal, Que.

PAST-PRESIDENTS

F. A. GABY, Toronto, Ont.
O. O. LEFEBVRE, Montreal, Que.
F. P. SHEARWOOD, Montreal, Que.

COUNCILLORS

*C. G. R. ARMSTRONG, Windsor, Ont.
†Y. C. BARRINGTON, Sydney Mines, N.S.
*C. B. BROWN, Montreal, Que.
†G. S. BROWN, Lethbridge, Alta.
*G. H. BURBIDGE, Port Arthur, Ont.
†H. CIMON, Quebec, Que.
*A. COUSINEAU, Montreal, Que.
†A. B CREALOCK, Toronto, Ont.
†T. H. DICKSON, Moncton, N.B.
†A. FRIGON, Montreal, Que.
†A. B. GATES, Peterborough, Ont.
*For 1936

*L. F. GOODWIN, Kingston, Ont.
*B. GRANDMONT, Three Rivers, Que.
†A. K. HAY, Ottawa, Ont.
‡F. S. B. HEWARD, Montreal, Que.
*G. H. KIRBY, Riverbend, Que.
*H. S. JOHNSTON, Halifax, N.S.
†T. C. MAIN, Winnipeg, Man.
†E. P. MUNTZ, Hamilton, Ont.
†E. P. MURPHY, Port Colborne, Ont.
†H. J. McLEAN, Calgary, Alta.
‡F. NEWELL, Montreal, Que.
†For 1936-37

†E. A. RYAN, Montreal, Que.
†F. SMALLWOOD, Sault Ste Marie, Ont.
*R. E. SMYTHE, Toronto, Ont.
*E. W. STEDMAN, Ottawa, Ont.
†H. L. SWAN, Victoria, B.C.
*J. A. VANCE, Woodstock, Ont.
*G. A. VANDERVOORT, Saint John, N.B.
*H. R. WEBB, Edmonton, Alta.
*A. S. WOOTTON, Vancouver, B.C.
*S. YOUNG, Regina, Sask.
‡For 1936-37-38

TREASURER
J. B. CHALLIES, Montreal, Que.

SECRETARY
R. J. DURLEY, Montreal, Que.

OFFICERS OF BRANCHES

HALIFAX
Chairman, C. S. BENNETT
Vice-Chair., C. SCRYMGEOUR
Sec.-Treas., R. R. MURRAY, 87 Cambridge St., Halifax, N.S.
Executive, J. R. KAYE, I. P. MACNAB, J. D. FRASER, J. F. F. MACKENZIE, W. H. NOONAN, J. W. McLEOD, J. B. HAYES
(Ex-Officio) H. FELLOWS, H. S. JOHNSTON

CAPE BRETON
Chairman, W. E. BOWN
Sec.-Treas., SYDNEY C. MIFFLEN, 60 Whitney Ave., Sydney, N.S.
Executive, M. R. CHAPPELL, W. S. WILSON, C. M. ANSON, W. E. CLARKE
(Ex-Officio) Y. C. BARRINGTON

SAINT JOHN
Chairman, J. R. FREEMAN
Vice-Chair., G. H. THURBER
Sec.-Treas., F. A. PATRIQUEN, P.O. Box 24, Saint John, N.B.
Executive, T. C. MACNABB, T. MOFFAT, S. HOGG
(Ex-Officio) V. S. CHESNUT, G. A. VANDERVOORT

MONCTON
Chairman, G. L. DICKSON
Vice-Chair., E. B. MARTIN
Sec.-Treas., V. C. BLACKETT, Engrg. Dept., C.N.R., Moncton, N.B.
Executive, F. O. CONDON, C. S. G. ROGERS, R. H. EMMERSON, F. L. WEST, A. S. GUNN, G. C. TORRENS
(Ex-Officio) T. H. DICKSON, H. B. TITUS, H. W. McKIEL

SAGUENAY
Chairman, J. SHANLY
Vice-Chair., S. J. FISHER
Sec.-Treas., L. R. BEATH, P.O. Box 211, Kenogami, Que.
Executive, W. L. YACK, E. LAVOIE, H. B. PELLETIER, M. G. SAUNDERS
(Ex-Officio) G. E. LAMOTHE, J. W. WARD, G. H. KIRBY

QUEBEC
Hon. Chair., A. R. DECARY
Chairman, ALEX. LARIVIERE
Vice-Chair., J. T. F. KING
Sec.-Treas., J. JOYAL, Quebec Public Service Comm., Court House, Quebec, Que.
Executive, R. WOOD, L. P. METHE, M. BOURGET, A. O. DUFRESNE, J. G. O'DONNELL, A. ROBERGE
(Ex-Officio) A. B. NORMANDIN, HECTOR CIMON

ST. MAURICE VALLEY
Chairman, B. GRANDMONT
Vice-Chair., J. E. FLEURY
Sec.-Treas., J. A. HAMEL, 642 Notre Dame St., Three Rivers, Que.
Executive, F. W. BRADSHAW, C. L. ARCAND, H. J. WARD

MONTREAL
Chairman, J. B. D'AETH
Vice-Chair., H. MASSUE
Sec.-Treas., C. K. McLEOD, 1440 St. Catherine St. W., Montreal, Que.
Executive, R. H. FINDLAY, C. C. LINDSAY, B. R. PERRY, T. C. THOMPSON, J. A. LALONDE, J. A. E. GOHIER
(Ex-Officio) F. S. B. HEWARD, A. COUSINEAU, C. B. BROWN, P. L. PRATLEY, O. O. LEFEBVRE, E. A. RYAN, F. NEWELL, A. FRIGON, F. P. SHEARWOOD

OTTAWA
Chairman, E. VIENS
Sec.-Treas., F. C. C. LYNCH, Dept. of Mines, Victoria Memorial Museum, Ottawa, Ont.
Executive, E. M. DENNIS, T. A. McELHANNEY, N. B. MACROSTIE, G. R. TURNER, B. F. HAANEL
(Ex-Officio) E. W. STEDMAN, R. W. BOYLE, A. K. HAY

PETERBOROUGH
Chairman, H. R. SILLS
Sec.-Treas., W. T. FANJOY, 223 Crescent St., Peterborough, Ont.
Executive, V. R. CURRIE, A. L. KILLALY, E. J. DAVIES, W. M. CRUTHERS
(Ex-Officio) A. L. DICKIESON, A. B. GATES, R. L. DOBBIN

KINGSTON
Chairman. R. A. LOW
Vice-Chair., Lt.-Col. N. C. SHERMAN
Sec.-Treas., Major L. F. GRANT, Royal Military College, Kingston, Ont.
Executive, G. G. CARR-HARRIS, S. STEPHENSON, J. E. GOODMAN
(Ex-Officio) W. CASEY, L. F. GOODWIN

TORONTO
Chairman, O. HOLDEN
Vice-Chair., A. U. SANDERSON
Sec.-Treas., W. S. WILSON, Mining Bldg., University of Toronto, Toronto, Ont.
Executive, W. P. DOBSON, N. MACNICOL, W. E. P. DUNCAN, A. M. REID, D. D. WHITSON, C. E. SISSON
(Ex-Officio) W. E. BONN, A. B. CREALOCK, R. E. SMYTHE, F. A. GABY

HAMILTON
Chairman, W. HOLLINGWORTH
Vice-Chair., E. G. MACKAY
Sec.-Treas., A. LOVE, 40 Paisley Ave. S., Hamilton, Ont.
Executive, W. J. W. REID, A. R. HANNAFORD, V. S. THOMPSON, D. W. CALLANDER
(Ex-Officio) E. P. MUNTZ

LONDON
Chairman, JAS. FERGUSON
Vice-Chair., A. O. WOLFF
Sec.-Treas., D. S. SCRYMGEOUR, London Structural Steel Co. Ltd., London, Ont.
Executive, E. V. BUCHANAN, W. C. MILLER, J. R. ROSTRON, H. A. McKAY, W. M. VEITCH
(Ex-Officio) S. W. ARCHIBALD, S. G. JOHRE, J. A. VANCE

NIAGARA PENINSULA
Chairman, G. H. WOOD
Vice-Chair., L. C. McMURTRY
Sec.-Treas., P. A. DEWEY, 1224 Ontario Ave., Niagara Falls, Ont.
Executive, S. HAIRSINE, W. D. BRACKEN, M. H. JONES, C. S. BOYD, R. A. BRADLEY, C. G. MOON, A. W. F. McQUEEN
(Ex-Officio) P. E. BUSS, E. P. MURPHY

BORDER CITIES
Chairman, T. H. JENKINS
Vice-Chair., C. F. DAVISON,
Sec.-Treas., BOYD CANDLISH, 170 Rankin Blvd., Sandwich, Ont.
Executive, E. M. KREBSER, D. T. ALEXANDER, C. G. WALTON
(Ex-Officio) C. G. R. ARMSTRONG, H. J. COULTER

SAULT STE. MARIE
Chairman, J. L. LANG
Vice-Chair., W. SEYMOUR
Sec.-Treas., N. C. COWIE, 15 Hearst St., Sault Ste. Marie, Ont.
Executive, H. O. BROWN, C. W. HOLMAN, T. FOULKES, H. W. SUTCLIFFE
(Ex-Officio) F. SMALLWOOD, A. E. PICKERING

LAKEHEAD
Chairman, F. C. GRAHAM
Vice-Chair., G. R. DUNCAN
Sec.-Treas., G. R. McLENNAN, 80 North High St., Port Arthur, Ont.
Executive: H. G. O'LEARY, J. M. FLEMING, K. A. DUNPHY, E. A. KELLY, E. L. GOODALL, W. J. BISHOP
(Ex-Officio) G. H. BURBIDGE, R. J. ASKIN

WINNIPEG
Chairman, G. E. COLE
Vice-Chair., A. E. MACDONALD
Sec.-Treas., J. F. CUNNINGHAM, 918 Somerset Ave., Fort Garry, Man.
Executive, F. W. ALEXANDER, H. L. BRIGGS, W. D. HURST, R. W. McKINNON, W. F. RIDDELL
(Ex-Officio) E. V. CATON, F. V. SEIBERT, T. C. MAIN

SASKATCHEWAN
Chairman, W. E. LOVELL
Vice-Chair., STEWART YOUNG
Sec.-Treas., J. J. WHITE, City Hall, Regina, Sask.
Executive, A. R. GREIG, J. W. D. FARRELL, J. McD. PATTON, H. S. CARPENTER, H. J. BYRD, S. R. MUIRHEAD
(Ex-Officio) A. P. LINTON

LETHBRIDGE
Chairman, P. M. SAUDER
Vice-Chair., R. F. P. BOWMAN
Sec.-Treas., E. A. LAWRENCE, 207-7th St. S., Lethbridge, Alta.
Executive, J. M. CAMPBELL, J. B. DEHART, W. MELDRUM
(Ex-Officio) W. L. McKENZIE, G. S. BROWN, C. S. CLENDENING

EDMONTON
Chairman, E. STANSFIELD
Vice-Chair., A. RITCHIE
Sec.-Treas., M. L. GALE, 9914-111 St., Edmonton Alta.
Executive, J. D. BAKER, W. E. CORNISH, C. E. GARNETT, A. J. GAYFER, E. NELSON
(Ex-Officio) F. K. BEACH, H. R. WEBB

CALGARY
Chairman, JOHN DOW
Vice-Chair., H. W. TOOKER
Sec.-Treas., JAS. McMILLAN, 506 Insurance Exchange Bldg., Calgary, Alta.
Executive, J. J. HANNA, W. T. McFARLANE, H. J. McEWEN
(Ex-Officio) J. HADDIN, F. M. STEEL, H. J. McLEAN

VANCOUVER
Chairman, JAS. ROBERTSON
Vice-Chair., H. N. MACPHERSON
Sec.-Treas., T. V. BERRY, 3007-36th Ave. W., Vancouver, B.C.
Executive, E. C. THRUPP, P. SANDWELL, G. L. BOOKER, J. P. MACKENZIE, P. H. BUCHAN, C. P. HAMILTON, F. O. MILLS
(Ex-Officio) G. M. GILBERT, E. A. CLEVELAND, A. S. WOOTTON

VICTORIA
Chairman, I. C. BARLTROP
Vice-Chair., J. C. MACDONALD
Sec.-Treas., KENNETH REID, 1336 Carnsew St., Victoria, B.C.
Executive, G. M. DUNCAN, G. M. IRWIN, G. M. TRIPP, C. D. SCHULTZ
(Ex-Officio) D. MACBRIDE, H. L. SWAN

THE

ENGINEERING JOURNAL

The Institute as a body is not responsible either for the statements made or for the opinions expressed in the following pages.

Volume XIX | Montreal, July, 1936 | Number 7

Fire and Explosion Hazards from Industrial Products

J. R. Donald, M.E.I.C.,
J. T. Donald and Company, Limited, Montreal, Que.

Paper presented before the Montreal Branch of The Engineering Institute of Canada, February 20th, 1936

SUMMARY:—Modern technical developments have given rise to fire and explosion hazards in our daily life. The industrial products involved in this situation are described. The domestic and industrial hazards and the necessary safeguards are discussed as regards use, distribution and transportation by water, rail and road.

The subject discussed in this paper is the fire and explosion hazards arising from industrial products. In recent years the author has had occasion to devote a good deal of attention to various phases of the subject, particularly the investigation of the causes of fires and explosions, the study of methods of prevention and control and the preparation of technical data and advice in connection with legal proceedings arising from these causes.

When solids or liquids burn, heat is generated, and the products of combustion are gases such as steam, carbon monoxide and carbon dioxide. The conversion of solids and liquids to gases brings about a very large increase in volume which is further increased by the expansion of the gases by the heat produced. When gases burn the increase in volume is mainly due to the heat factor.

It is these sudden changes of volume which produce the pressures resulting in the explosions discussed in this paper. It is not proposed to deal with the type of explosion resulting from the failure of containers under pressure, for example, tanks of compressed gases, or steam boilers.

All explosions arising from the rapid combustion or burning of inflammable material are fires, but on the other hand not all fires are explosions. Whether there is a fire and an explosion, or a fire only, depends entirely upon whether in the course of combustion an explosive pressure is developed. The pressure developed in turn depends upon the speed of burning and the conditions that exist for developing pressure. The speed of burning is dependent upon the nature of the inflammable material and the proportions of the mixture of air and the inflammable material.

If for example a pint of gasoline were thrown on the floor of a large lecture room and ignited it would burn rapidly, and might even cause a small explosion. But if the same quantity were poured into a small room say 6 feet by 6 feet by 8 feet, and allowed to evaporate in the room, so as to mix the gasoline vapour with the air thoroughly, an explosive mixture would be formed, and any cause of ignition would certainly result in a very violent explosion.

Combustion reactions such as those just described are gas reactions. If the substance which burns is a solid or a liquid it must be converted to a gas before the combustion actually takes place.

The wax of a candle vaporizes from the heat of the flame. It is the vapour burning which produces the flame. That it is the vapours which burn and not the liquid or solid is well illustrated by a lubricating oil which at ordinary temperatures fails to ignite if exposed to a flame. If however it is heated, a temperature will soon be reached at which the oil will give off vapours which will mix with the air and form an explosive mixture above the surface of the oil. If a flame is applied the vapour proceeds to burn. The temperature of the oil at which sufficient vapour is given off to cause a small explosion or flash is known as the flash point. The temperature at which sufficient vapour is given off so that if ignited the oil continues to burn is known as the fire point. The flash and fire points are important indices, as below these temperatures the material is practically non-inflammable. When the fire point is at room temperature or lower the substance falls into the class of highly inflammable materials.

For combustion to take place it has been pointed out that there must be a mixture of air or oxygen with the inflammable vapour, but it does not follow that all such mixtures are inflammable. This is well illustrated by the operation of a motor car. If a mixture of gasoline vapour and air is too lean or too rich no burning or explosion takes place and it is only within a fairly narrow range that the maximum explosive force is produced. The limits of proportion of vapour to air within which combustion will take place are known as the explosive limits and these have been determined accurately for most common inflammable substances.

Combustion within the explosive range proceeds more or less rapidly and more or less completely according to conditions and there is a certain narrow range within the explosive limits within which complete and very rapid combustion and maximum pressure occurs.

Finally it is of course obvious that to have fire or explosion a source of ignition must exist. Any flame, electric spark or spark produced by friction may cause ignition. Once ignition takes place, the spread of the flame proceeds slowly or rapidly through the various explosive mixtures encountered, depending chiefly upon the proportions in which they exist. The rate of propagation, while fairly rapid, can be measured and varies for different materials and different mixtures.

Principal Materials Causing Explosion Risk

The following tables give a list of common industrial products, all of which are combustible and form explosive mixtures with air.

Table I

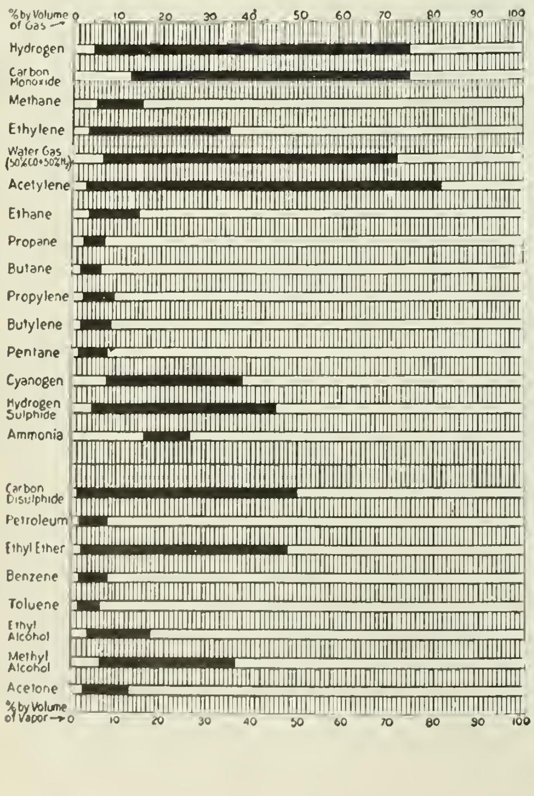
Explosive Limits and Heats of Combustion

High Range

	Explosive Limit per cent in Air	Heat of Combustion B.t.u. per lb.
Acetylene	2.6–82	21,600
Carbon monoxide	12.5–75	4,370
Carbon disulphide	1–50	5,840
Ether	2–48	16,040
Hydrogen	4.1–75	52,050
Water gas	6.5–72	7,550
Intermediate Range		
Cyanogen	7.5–38	17,850
Coal gas	5.5–31	16,300
Ethylene	3–35	21,350
Ethyl alcohol	3–18	12,820
Hydrogen sulphide	4–44	6,700
Methyl alcohol	6–36	9,610
Low Range		
Benzol	1.5–8	18,170
Methane	4.9–16	23,750
Toluol	1.2–6	18,280
Ethyl acetate	2.2–11.5	10,990
Ethane	3–15	22,080
Butane	1.5–6.3	21,200
Acetone	2.2–13	13,270
Petroleum products (Gasoline)	1.5–8	20,097 to 20,250

Table II

Explosive Limits



All of these products are commonly used in industry and most of them are used by the public either directly or as constituents of other materials. For example fly sprays consist essentially of a light petroleum oil similar to kerosene with an insecticide. Lacquers and quick drying paints contain mixtures of solvents such as ethyl alcohol, butyl alcohol, ethyl acetate, benzol, toluol, etc.

In attempting to compare the relative fire and explosion risks of the various industrial products a number of factors have to be considered.

First, there is the inflammability and what may be termed the explodability. By this is meant the ease with which the product is ignited, the range of air-gas mixture over which fire and explosion can take place and the explosive force produced.

Secondly, there is the nature of the product, whether a solid or gas, whether it vaporizes easily and whether it is miscible with water.

Thirdly, there is the question of the use to which the product is put, the quantities usually handled, and, most important of all, whether it is in general use by people who do not realize the dangers inherent in it.

Classing these products in a general way, based on their inflammability and explodability, they may be placed in three main divisions.

First, products with a wide explosive range, such as acetylene, hydrogen, carbon monoxide, carbon bisulphide, and water gas.

Secondly, products with a fairly wide range, but with considerably narrower limits than class one, such as acetone, coal gas, ethylene, ethyl alcohol, methyl alcohol, and ethyl acetate.

Thirdly, those products with narrow explosive limits, such as benzol, ether, toluol and the petroleum products of which gasoline and kerosene are examples.

Class I

It is very obvious that products with a wide explosive range are highly dangerous.

Acetylene

Acetylene, which has the widest explosive limits, and forms explosive mixtures in almost all proportions with air, is the most explosive of all industrial gases. The violence of acetylene explosions is well known. It has approximately the same specific gravity as air.

Fortunately acetylene is used in industry under very careful supervision. Where used by the public, as in lamps or lighting, it is in comparatively small quantities. Its characteristic odour makes leaks readily detectable. It possesses the disadvantage of forming compounds with certain of the metals which are solids and are highly explosive and very sensitive.

Hydrogen

Hydrogen also has a wide explosion range and its lack of characteristic odour or colour makes it difficult of detection. It is the lightest known gas and when mixed with air burns or explodes to form water. Very high temperatures are reached in the combustion of hydrogen, thus extremely violent explosions may result from the ignition of such mixtures. It has wide industrial uses in the field of welding and in the hydrogenation of oils. Its use and risk in aeronautics are well known. It comes into the hands of the public in relatively small quantities in steel cylinders.

Where used industrially the dangers inherent in its use are recognized and guarded against. As hydrogen and oxygen are formed by the electrolysis of water care must always be exercised to avoid the accumulation of these gases where hydrogen may be generated by electrolysis, particularly where electricity is used for the direct heating of water.

Carbon Monoxide

Carbon monoxide gas is rarely used in the pure form although it is an important component of coal gas. It is always formed in the burning of fuels, more particularly coal, and is chiefly responsible for the small and sometimes large explosions occurring in domestic coal furnaces. Greater danger however lies in its toxic properties, for it is one of the most poisonous of gases, has no characteristic smell, is formed in large quantities in domestic heating furnaces, and is a constituent of the exhaust gases from all internal combustion engines.

Carbon Bisulphide

Carbon bisulphide is a liquid with a boiling point of 115 degrees F. and of specific gravity 1.268. Its vapour is more than twice as heavy as air and it vaporizes down to temperatures below zero. It also possesses the dangerous property of igniting spontaneously when heated to about 300 degrees F.

The liquid is practically insoluble in water and consequently carbon bisulphide fires, like oil fires, are difficult to deal with. Carbon bisulphide is chiefly used in industry more particularly in the manufacture of rayon.

Ether

Ether is a highly inflammable liquid. At ordinary temperatures it volatilizes easily and its vapour forms explosive mixtures with air in proportions of from 2 to 48 per cent. It is consequently a highly dangerous product.

Class II

In this intermediate class are found a number of widely used products.

Alcohols

The alcohols commonly used are highly inflammable in pure form and form dangerous explosive mixtures with air. The fact that most alcohols are readily soluble in water is an important safety factor, as water can be used to extinguish fires resulting from their use.

Alcohol vapours are also readily soluble in water and the explosive risk from vapours in drums or tanks is easily eliminated. Consequently although alcohol is used industrially on a large scale (some 2,300,000 gallons were used in Canada in 1934), the fire and explosion hazard is not very great.

Ethyl Acetate, Acetone

Ethyl acetate and acetone are both highly inflammable and volatile liquids and form explosive mixtures with air. They are largely used as industrial solvents, particularly in the paint and varnish industry. Acetone is water-soluble, and ethyl acetate partially so, which materially lessens the risks involved.

Coal Gas

Coal gas has long been recognized as causing a serious fire and explosion risk.

It is lighter than air and has a characteristic odour somewhat difficult to distinguish from that of gasoline. It has fairly wide explosive limits, although the range over which it burns with explosive violence is narrow and lies between 12 to 18 per cent of gas to air. It is one of the commonest inflammable materials in the hands of the public.

In 1934 in Montreal about 5,400,000,000 cubic feet of coal gas were used. Despite the familiarity of the public with coal gas, explosions occur all too frequently from apparent lack of knowledge that mixtures of coal gas and air can be explosive. Looking for gas leaks with a lighted match or candle frequently leads to disaster.

Coal gas, next to light petroleum products, causes the most serious explosion hazard to be contended with in cities. An important safeguarding feature is the relatively high percentage of the gas required to form an explosive mixture, the odour of gas thus making itself evident before an explosive mixture results, and enabling proper precautions to be taken.

Class III

In this group are found those products having a small explosive range. All are highly volatile and inflammable liquids and the vapours are heavier than air.

At first sight this narrow range would seem to lessen the risk involved, but the very fact that a minimum of 1.5 per cent of such vapours will form an explosive mixture renders them potentially highly dangerous.

Fig. 1—Oil Flowing from Sewer Outlet into River.

One gallon of such liquids can under perfect conditions render some 2,500 cubic feet of air explosive. Put in another way, one gallon, if allowed to evaporate and thoroughly mix with the air of a room 15 feet by 15 feet by 10 feet may cause a violent and powerful explosion capable of destroying the room.

Benzol and Toluol

Benzol and toluol are liquids closely related chemically and are by-products of coal distillation. Their properties are very similar and they are used extensively as solvents and as an addition to motor fuels. The density of their vapours is greater than that of air. They are not miscible with water. They constitute a serious fire and explosion risk, but this risk is largely limited to industrial establishments where these materials are used and where the dangers involved are recognized and dealt with. The vapours of both benzol and toluol are exceedingly poisonous.

Petroleum Products

Petroleum products are among the most widely used articles of commerce and industry, are usually classified on the basis of specific gravity, and range from gases and very volatile liquids such as ethane, propane, petrolic ether and gasoline, to heavier liquids such as kerosene, naphtha, gas oils, lubricating oils, fuel oils, and finally to solids like waxes and asphalts.

They are widely used as fuels and lubricants and also find extensive application as solvents in the manufacture of many products daily used by the public such as floor waxes, polishes, fly sprays, paints, paint removers, etc.

All petroleum products are combustible; under certain conditions all are inflammable and when vaporized can form explosive mixtures with air. Statements that certain of these products are non-inflammable are misleading and dangerous. The flash and fire points and consequently the inflammability vary with the volatility. They are not however pure materials and the flash and fire points are dependent in large measure on the processes used in manufacturing and refining.

For example a fuel oil for household furnaces will have a fairly high flash and fire point, around 150 to 170 degrees F. If however a small percentage of some of the lighter petroleum products is present the oil may ignite at a very much lower temperature, and will therefore be hazardous to use.

Light petroleum products undoubtedly cause the greatest fire and explosion hazard existing today in large centres of population. They are not miscible with water so that fires must be dealt with by cutting off the supply of air or by lowering the temperature of the product below the flash and fire points.

They are widely distributed to the public. In Canada in 1934, 534,782,000 gallons of gasoline were consumed.

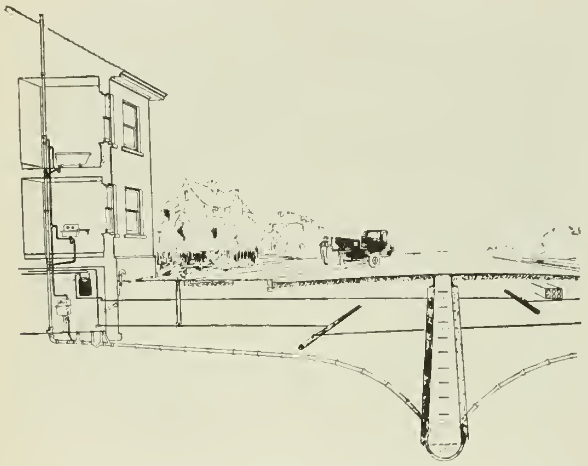


Fig. 2—Typical Street Section.

Estimated sales in the city of Montreal were about 60,-000,000 gallons or a daily average of 172,000 gallons or 1,204,000 pounds.

This compares with 15,000,000 cubic feet or 650,000 pounds of coal gas distributed in Montreal in an average day. It is obviously necessary to compare pounds of coal gas with pounds of gasoline.

Unfortunately the properties and risks of petroleum products are not generally recognized and their very wide distribution and use has led to the familiarity which breeds contempt.

It may well be asked why if gasoline constitutes such a serious hazard there are not more fires and explosions when it is being so widely used under the conditions that exist at filling stations, garages and the like? The answer lies in the comparatively narrow explosive range which as has already been pointed out acts as a compensating factor.

If in addition to forming explosive mixtures in comparatively small quantities the light petroleum products also had wide explosive limits it would be impossible to use them as we use them commercially today.

Having noted the principal materials causing explosion risk, the resulting hazards may be considered as they arise in domestic and industrial use, and in distribution.

Domestic Hazards

By domestic hazards are meant those risks which arise in ordinary homes and dwellings.

Coal gas is very generally used in the home and coal gas leaks are a serious hazard. Fortunately the dangers are fairly well known and coal gas being lighter than air is quickly dissipated by ventilation. As the poisonous effects of coal gas are felt before concentrations high enough to be explosive are attained, gas leaks are regarded with great suspicion and promptly attended to. Thus although gas is more commonly used in the home than any of the other products discussed the explosion hazard is fairly well controlled.

Gasoline is frequently used in households as a solvent for cleaning purposes. Most homes have a small quantity on hand. The practice of keeping gasoline in dwellings is highly dangerous and leads to frequent disaster. A pint of gasoline spilt and ignited will cause a very serious and sudden blaze of fire and may cause a violent explosion. Just how rapidly gasoline burns is not realized until a fire happens and then it occurs with startling rapidity. Containers with even a little gasoline should never be left uncovered.

One pint of gasoline will make about five cubic feet of vapour, approximately equivalent in heat value to 45 or 50 cubic feet of coal gas. A large burner on an ordinary gas stove consumes about 25 cubic feet per hour.

A particularly dangerous feature of gasoline vapour lies in its high specific gravity which is about three times that of air. As a result gasoline vapours are not quickly dissipated and the vapour ignited by a flame can easily flash back for considerable distances to the container.

In the author's opinion the sale of gasoline for household purposes should be prohibited, because so many other satisfactory solvents, such as carbon tetrachloride, are available which are relatively safe or even non-inflammable.

A common cause of disaster is the use of kerosene for starting fires in stoves. Kerosene should never be poured into a stove which has any spark of fire or which is hot. Once kerosene is vaporized the risks are identical with gasoline risks. A not uncommon cause of fires is the use of gasoline instead of kerosene. To distinguish between them is difficult. This difficulty could be readily overcome by giving gasoline or kerosene a standard colour. There would be much more point to this than to the multicoloured gasolines now on the market.

Fig. 3—Effect of Explosion in Basement of Dwelling of Block Construction.

Fig. 4—Effect of Explosion in Basement of Convent.

Another serious domestic hazard sometimes arises from the presence of gasoline vapour in sewers. Most houses have drains in the cellars. Such drains, if they are not trapped, or if, as frequently happens, the trap is dry, give direct entry of vapours from the sewer to the house. Sewer contamination which will later be discussed more fully has been the cause of disastrous fires and explosions. Therefore, for reasons of health as well as for safety, keep water in the sewer trap.

A number of household articles contain petroleum products, for example, floor waxes, fly sprays, cleaners, and paint removers, etc. Regulations should be enforced to prevent the use of any solvents flashing at room temperature.

Industrial Hazards

Industrial hazards can be divided into two classes, namely those incidental to manufacturing operations using inflammable materials, and the risks involved in the manufacture of the inflammable products themselves.

Practically all the inflammable materials named above are used singly or together in numerous industries. Wherever they are used a fire and explosion hazard exists, which it is very difficult to assess, because the human factor is involved. The question of quantity is of primary importance. Equally important is the knowledge or care with which these products are used. One dry cleaning establishment blows up and others have no accidents. Recently a hydrogenation plant was destroyed by an explosion. Others have operated for years without trouble. Some regulation should obviously be exercised over operations where the quantities of material are such as to make possible serious fires and explosions.

To attempt to draw up regulations of this kind would bring many difficulties. Probably the most important safeguard would be to see that all users of such products are competent financially or adequately insured to cover fully any damages which may result from the products they use.

Petroleum products are stored by the industry in steel tanks. Repairs or alterations to such tanks are usually carried out with the use of oxy-acetylene torches or electric arcs. Often accidents and loss of life take place because such operations are undertaken before the last trace of petroleum product or vapour has been removed from the tank.

Emptying a drum or tank and allowing it to vent is not an adequate precaution. Petroleum vapours are three times as heavy as air and tend to lie in pockets in corners, flanges, etc. The tank should be tested to prove that it is gas-free before any flame is allowed on it or in it. Suitable apparatus for this purpose is available. Such precautions are always taken in oil refineries but this hazard is not properly realized in many other industries. It goes without saying that work on the outside of oil tanks should never be carried out while the tanks contain any petroleum product or vapour. Oil tankers, barges, etc., under repair are a similar hazard on a much larger scale. A year or two ago in Montreal in the course of repair of a tanker great loss of life occurred among workers and firemen. The basic cause of the disaster was a failure to realize that crude oil may possess as great a risk as gasoline. Within less than a year, and despite the lesson of the Montreal disaster, similar disastrous explosions and fire occurred on a tanker in Toronto harbour with considerable loss of life. These disasters demonstrated the lack of appreciation (even by those engaged in the industry) of the risk involved in the storage of petroleum products.

Every plant manufacturing or refining an inflammable material must of necessity be an explosion and fire risk. Many of the products discussed are manufactured in a city like Montreal.

Oil refineries are recognized as having serious fire hazards but very special precautions are taken to diminish the risks involved. Every responsible oil refinery has its own fire fighting staff and equipment and they bring to bear on oil fires a skill and experience which is not found outside of the oil industry. The industry has given a great deal of attention to the question of standard safety practice and there are to be found in the rules and regulations of the American Petroleum Institute and the National Fire Protection Association very comprehensive safety rules and regulations. Every municipality should see that these rules and regulations are enforced.

Under this heading can also suitably be discussed the risks involved in above-ground storages for gasoline, crude oil or other inflammable products. Many of these storages are of very large size and consequently demand special safeguards.

Fig. 5—Telephone Cable Torn from Pole by Manhole Cover.

The general rules suggested by the National Fire Protection Association covering above-ground storages of larger size, 50,000 gallons (1,200 barrels) and over, require the construction of dykes around the tanks with a capacity at least equal to the volume of the tank or tanks surrounded, and that the tanks shall be separated from one another by approximately the diameter of the largest tank.

Where crude oil or gasoline are concerned it is also considered standard practice that there should be adequate spare tankage to at least take care of the capacity of the largest single tank in the event of any failure. That this latter precaution is necessary is very evident when the risks involved by a tank failure are considered even if surrounded by a dyke.

Despite these obviously necessary safeguards such regulations are not in force in Montreal and gasoline storage tanks of very large capacity have been installed without adequate spare tankage.

The advisability of allowing exceptionally large storages within city limits is a matter of serious doubt and where such storages are not adequately protected the fire hazard is entirely unreasonable.

That failures in such storages or in their mode of operation can take place was well exemplified about a year ago on the island of Montreal when through the failure of a pipe line about 8 inches in diameter a very large quantity of gasoline (probably of the order of 50,000 gallons) escaped into a field within the limits of one of the outlying municipalities. It was a matter of great good fortune that a serious conflagration did not result. Sewers were flooded with gasoline and explosive vapours were found in the basements of many houses for some time afterwards. Very special and expensive precautions had to be taken to try and safeguard the municipality in question as well as an adjoining municipality.

Distribution Hazards

Modern cities are highly complex organizations. On the surface they consist of thousands of buildings served by miles of streets, lanes, railway lines, and, where water transportation exists, harbours and canals. Underlying the city are miles of sewers, water mains, electrical conduits, manholes, etc.

Serious hazards arise from the distribution of coal gas and gasoline. Less serious hazards occur in the distribution of other products because the quantities involved are very much less. The distribution of coal gas means a network of gas pipe lines throughout the city. When a leak occurs, coal gas escapes. Owing to its lightness it readily travels for considerable distances and may escape into basements of buildings, sewers, conduits and manholes. Cases are on record where coal gas explosions have caused considerable damage to buildings, sewers and manholes.

Fortunately, gas distributing systems are laid out under trained and thorough engineering supervision, with a view to maximum safety and efficiency and are properly serviced and maintained. Leaks are carefully watched for and promptly dealt with. The fixed responsibility, which in the final analysis is a financial responsibility, automatically insures proper regulation of the risks involved in distribution.

The very large quantities of gasoline distributed throughout a modern city have already been pointed out. Gasoline is stored at central points and distributed largely by tank trucks which make delivery to garages, service stations, etc., where the gasoline is stored, usually in underground tanks.

Sewer systems serve all parts of a city and are connected to street drains and buildings of all descriptions. Any waste liquid, unless specially dealt with, finds its way eventually to the sewer. Surface drainage also eventually reaches the sewer. To the average citizen the sewer is the proper place to put any liquid not wanted, whether it be gasoline or water. It is not surprising therefore that with the growth of the use of petroleum products practically all large cities have suffered from sewer fires and explosions arising from gasoline or waste oil.

Just how serious is the problem was well demonstrated in Montreal in 1932* when one of the main sewers was severely damaged by fire and explosion twice within the same year, with damages running into many thousands of dollars. Severe damage also occurred in buildings connected with the sewer and a general panic resulted from the spectacular nature of the fire and the explosions which affected some miles of streets.

This whole question of sewer explosions has received a good deal of study. Among others, Mr. F. V. Dowd,

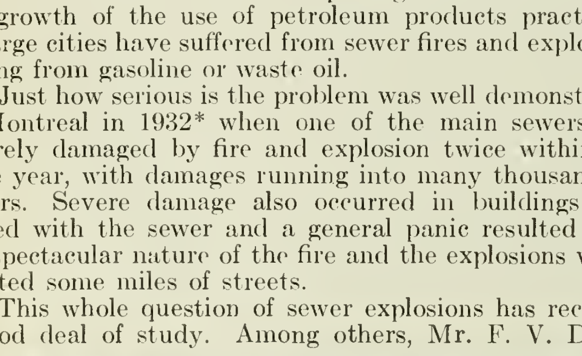


Fig. 6—Effect of Gasoline Explosion on 6-foot diameter Brick Sewer.

A.M.E.I.C., assistant superintendent engineer, Water and Sewerage Division, Department of Public Works, Corporation of the city of Montreal, has made important contributions, and the photographs appearing in this paper have been obtained through his courtesy. It has already been pointed out that $1\frac{1}{2}$ per cent of gasoline vapour makes an explosive mixture with air. Forty-five gallons of gasoline is sufficient to make 2,000 feet of an 8-foot sewer explosive.

Fortunately and for several reasons this does not mean that an explosion is going to result every time forty-

Fig. 7—St. Lawrence Blvd., Montreal, after Explosion in Sewer.

five gallons of gasoline find their way into a sewer. In the first place while gasoline vaporizes rapidly from the surface of the sewer water, the vapours are heavy and do not mix quickly with the air of the sewer.

Secondly, owing to the flow of the sewage and the ventilation which exists in every sewer the risk does not persist for any great length of time at any one point unless there is a substantial or continuous leakage.

Finally, an explosive mixture does not explode unless the gasoline vapours become ignited. (See Fig. 2.)

A sewer may be connected to street drains, to vents in houses and to openings in houses. Depending upon weather conditions air circulation is set up through this system. In winter when the weather is cold, air will enter the sewer from some of the manholes or street drain openings and rise through the vents into the houses. If the floor drain in the cellar is not trapped and sealed with water, vapours from the sewer may enter the cellar.

In summer the air movement in this ventilating system may be reversed, but it is evident that there must always be a fairly good air circulation through the sewer. If we imagine a quantity of gasoline entering the sewer, floating down on the water of the sewer, and gradually vaporizing, it is evident that these vapours, although heavy, will eventually become mixed with the air of the sewer. An explosive mixture can therefore exist not only in the sewer but wherever these vapours are carried. Thus one of the great dangers of gasoline in sewers is not in the sewer only but also in the buildings connected to the sewer and into which the explosive vapours may find their way.†

In the city of Ottawa in January 1931 a sewer explosion occurred; the second in the same sewer. It was very similar in results to the Montreal explosion but became of especial interest because of serious differences of opinion which

*In this connection reference may be made to articles by F. V. Dowd, A.M.E.I.C., as follows:

"Causes of Sewer Explosions and Methods of Tracing Them." Canadian Engineer, October 23rd and October 30th, 1934.

"Explosions in Sewers." Caandian Public Health Journal, September, 1935.

Also, "Inflammable Liquids and Gases in Underground Structures," by James Smith. Canadian Engineer, December 4th, 1934.

†In April 1936, after these words had been written, a large manufacturing plant was blown up in Montreal owing to this cause, with a damage in excess of $50,000. (Editor's Note)

arose as to whether the cause of explosion was coal gas or gasoline, eventually leading to litigation.

Unfortunately, as in the case of most such fires and explosions, the evidence was largely destroyed by the fire, but the case produced some very interesting evidence and expert testimony. The explosion occurred over some three miles of six-foot sewer and was very violent at certain points.

If it is assumed that it requires about 15 per cent of coal gas mixed with air to bring about a powerful explosion it follows that there must have been about 15 per cent of coal gas throughout the three miles of this six-foot sewer. Furthermore, as has been pointed out, coal gas is lighter than air and with the normal ventilation taking place in a sewer there would be a fairly rapid turn over in the atmosphere of the sewer. Substantial coal gas leaks are not likely to be intermittent. If there is a large break in a gas line the leakage will continue until it is reported or shut off.

Taking these factors into consideration it becomes evident that to bring about an explosive mixture of coal gas in three miles of six-foot sewer there must have been a very large leakage of gas. It was estimated that to keep this sewer in an explosive condition would involve a leakage of something like 20 per cent of the daily output of the Ottawa Gas Company over a twenty-four hour period. In the case of gasoline, four or five hundred gallons leaking into the sewer could easily bring about the conditions necessary for the disaster as it occurred. There were a number of service stations on the line of the sewer as well as dry cleaning establishments. While no definite conclusion as to the cause was arrived at, damages were not awarded against the Gas Company.

To prevent sewer explosions from petroleum products it is obviously necessary to prevent the entrance of these products into the sewers. The great danger in gasoline lies in the comparatively small quantities needed to bring about an explosive condition and the very large quantities being distributed. Garages and service stations have been erected in a haphazard way with little regulation. Comparatively light weight steel tanks have been buried underground without any adequate means of visual inspection and leaks are only discovered when they become apparent in sewers or the loss of gasoline is reflected in the records kept.

Many of the existing gasoline stations were installed a good many years ago and it will be surprising if leaks from these sources do not show a considerable increase in the future. It is quite evident that further regulation is necessary to insure that both new and existing stations are not a constant source of menace.

Fig. 8—Street Pavement over Sewer after an Explosion.

Probably the simple expedients of eliminating sewer connections between service stations and sewers and compulsory installation of gasoline underground storages in steel or concrete pits so that leaks in such storages could be detected would adequately solve the service station problem.

There should also be regulations covering the disposal of waste oil, and means other than sewers provided for this purpose. This problem should not be difficult as such oils can be retreated at the refinery.

Fig. 9—Manhole Frame and Cover torn from Pavement.

Transportation Hazards

Transportation of petroleum products takes place by pipe line, tank steamer, tank car and tank truck. Crude oil is usually shipped by pipe line or tank steamer. Gasoline and other refinery products are transported by tank steamer, tank car and tank truck.

In and out of Montreal petroleum products are transported by all methods except pipe line. Tank steamers bring crude oil to the refineries, and gasoline is distributed by tank steamer and tank barge to the city and inland points. Oil or gasoline carrying tankers are specially constructed, have specially trained crews and annually carry vast quantities of these products.

Obviously the risks involved in inland waters such as the St. Lawrence river and its tributary canals and rivers are much greater than in tidal waters. So far as the author knows, there is little or no regulation of this type of transportation in the St. Lawrence river or harbours nor is the harbour of Montreal well equipped to handle oil fires.

Tankers, like any other type of vessel are subject to collision and other navigating risks. An oil tanker on fire in the harbour of Montreal with its rapidly moving water might easily lead to serious disaster, particularly in view of the fact that a steady stream of tankers feeds the refineries in the lower harbour throughout the navigating season and there are usually a number of such tankers unloading or at anchor. A tanker aground or in collision with oil escaping would likewise be a very serious hazard.

Crude oil on the surface of a harbour or river is perhaps more dangerous than gasoline. In the first place it contains gasoline possibly up to 40 or 50 per cent, and consequently ignites as easily as gasoline. The crude or heavy fractions do not easily volatilize and the burning heavy fractions are carried along on the surface of the water until they are extinguished or burn themselves out. The value of water in fighting such fires is very limited. Gasoline on water burns rapidly, a great deal of it volatilizing, and while the fire is extremely intense is likely to be more localized.

In 1928 a report was issued by the Ministry of Transport, London, dealing with the transport of petroleum spirit (gasoline) on the Thames and in the port of London.

At that time oil tankers containing petroleum spirit were not allowed to navigate above Thames Haven and any petroleum spirit, whether in bulk or otherwise, which had to be taken up the river was loaded on petroleum barges which had to be towed by tugs. These barges had to conform to fixed specifications as to size and construction. It was proposed that this by-law should be changed so that oil tankers complying with the requirements of Lloyd's Registry of Shipping should be allowed further up the Thames, with certain restrictions depending upon the size of the tanker.

After a very thorough inquiry changes were not made, and the then existing restrictions were retained. The main reasons for not allowing oil tankers further up into the narrow reaches and into the port of London were the risks involved in case of collision or grounding, whereby inflammable oil would escape to the surface of the river with the resultant hazard, and because of the dangers from fire on the tankers themselves.

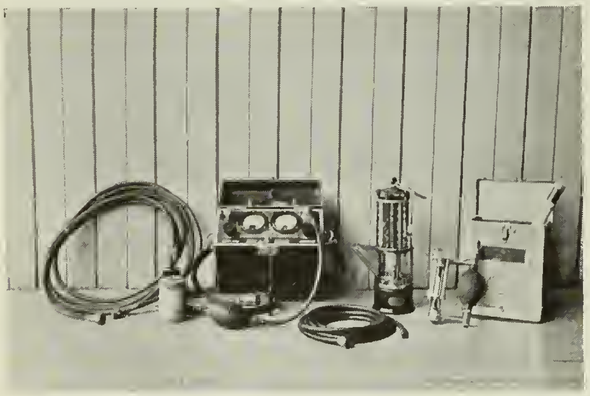


Fig. 10—Test Instruments used by City of Montreal to Locate Explosive Gases in Sewer.

From the above it will be evident that the conditions surrounding the transport by water of petroleum products in the St. Lawrence river, the harbour of Montreal and our other inland waterways should be thoroughly studied and regulated. There is reason to believe that such an investigation would receive the support of the major units of the oil industry. In making such an inquiry a committee might very well keep before it the following question which was addressed to the Port of London committee referred to above:—

"Are the risks such that they can properly be taken, having regard to the public interest and the interest of other users of the port?"

The transport of petroleum products by rail is subject to the regulations of the Canadian Railway Commission. It is obvious that the transport of light petroleum products must always be subject to some risk, but existing regulations and the limitations automatically placed on the amount carried in a single tank car tend to lessen the hazards of rail transportation.

Road transportation by tank truck is not without its dangers. Cases are known where oil trucks have been involved in accidents and the gasoline has escaped. There are records of this occurring in cities with resulting explosive mixtures in sewers. Transportation of light petroleum products by tank truck should be regulated both as to the type of tank permitted and also as to the speed of the vehicle.

From the above brief treatment of a vast subject it will be seen that modern technical developments have introduced into trade and commerce and into our daily lives fire and explosion hazards which must be carefully considered and adequately regulated.

It would appear that real responsibility devolves upon bodies like The Engineering Institute, to see that the public are adequately protected in the development of the use of hazardous materials. It is unreasonable to expect non-technical bodies adequately to appreciate and deal with technical problems, and if engineers do not guide public opinion they and the industries concerned must sooner or later expect criticism, probably resulting in the enforcement of over-drastic and technically unsound regulations.

In the author's opinion The Engineering Institute of Canada could render a public service by maintaining a strong and active committee whose duty it should be to place fairly and impartially before the public and our legislative bodies sound technical information on such developments, leading to their proper regulation and control.

The Island of Orleans Bridge

P. L. Pratley, M.E.I.C.,
Monsarrat and Pratley, Consulting Engineers, Montreal.

Abstract of a lecture given before the Quebec Branch of The Engineering Institute of Canada, April 8th, 1935, and subsequently before the Border Cities, Montreal, Vancouver, Winnipeg and Lakehead Branches.

SUMMARY:—A concise description of the construction and erection of the highway suspension bridge having a central suspended span of 1,059 feet and a total length, including approach spans, of some 6,000 feet. It crosses the north channel of the St. Lawrence which separates the Isle of Orleans from the mainland.

Spanning the north branch of the St. Lawrence river, this highway bridge provides the only means of continuous communication between the island of Orleans and the mainland. It connects the coast road of the island with the lower Quebec road near Montmorency village. The bridge was built by the Quebec government as part of a programme of public works undertaken as a measure for unemployment relief, and for this reason the construction was not hurried but was spread over a period of four years (1931-1935).

The river channel at the site is about 2,400 feet wide and is flanked on either side by wide tidal flats. When these are submerged at high water (the mean range for spring tides being about 18 feet) the full width of the river is some 6,000 feet. Climatic conditions are severe in the winter months when the river freezes over completely; the ice on the main channel moving up and down with the tide, while the shallower water at the sides is frozen solidly to the bottom. The site is also subject to high winds which blow almost incessantly either up or down the river and which considerably impeded erection progress.

The bridge works consist of two long approaches over shallow water and the main channel crossing. The north approach is comprised of a stone-pitched earth embankment, about half-a-mile in length, leading up to a concrete viaduct of nine 60-foot beam spans, which in turn connects with a series of six 150-foot steel deck-truss spans on concrete piers. The south approach is similar except that there are nine 150-foot spans. These approaches (Fig. 1) were built during the years 1931-1933.

The central part of the bridge is more particularly the subject of the present article. The Federal Department of Marine required the maintenance of an unobstructed fairway 600 feet wide with a minimum clearance of 106 feet above high-water; and an exhaustive investigation of the merits of different styles of structure led to the adoption of the suspension type as being that best adapted for economy, foundation conditions, simplicity of erection and a good appearance. This central part, which has a total length of 2,370 feet inclusive of the two 238-foot flanking spans, is shown in Fig. 2.

Fig. 1—View of Approach Viaduct.

The structure is carried on six granite-faced piers of which Nos. 21, 22, and 23 are founded on a hard limestone shale. At the Montmorency end of the bridge, however, this formation is out of reach, and piers 15, 16 and 17 are founded on a coarse, well-packed sand of a satisfactory nature. The piers were built in the summer of 1934. Floating equipment was used and at each side of the river a trestle was built to give access at low water to the two shoreward piers. The trestle at the Montmorency end of the bridge is shown in Fig. 3. On account of the depth of water (about 35 feet) in the navigable channel of the river, where piers 17 and 21 are located, excavation for these piers was, after some preliminary dredging, carried out in pneumatic caissons. Apart from the difficulty of accurate location of the caissons in swift water, no trouble was encountered in sinking these piers. The maximum air-pressure used was 31 pounds, at high tide. The intermediate piers Nos. 16 and 22 are located in much shallower water and were built inside a steel-sheet-piled cofferdam and a timber cofferdam respectively. No extraordinary problems were offered by their construction.

The anchor piers (Nos. 15 and 23), however, presented unusual problems in both design and execution. These piers, in order to provide adequate sliding resistance to the cable pulls and to avoid heavy toe-pressures, are very massive and are considerably larger in plan than the other piers. They are hexagonal in shape, with overall dimensions of 94 feet transversely and 62 feet longitudinally with the bridge. Excavation was made as for the other shallow-water piers, in timber cofferdams, sheet piling being used around the crib in the case of pier 15. The first stage of construction (Fig. 3) provided a watertight box with 8-foot walls extending above high water level and with a heavy bottom seal of concrete. In the case of pier 15, which is founded on sand, additional resistance to movement is provided by a sloping foundation profile and by seventy steel piles of 10-inch by 10-inch H-section, driven at an inclination to the vertical.

The anchorage steel, which is described later, was then assembled and accurately positioned inside the dry shell of the pier. Further pours of concrete incorporated the steel into the mass of the pier, the construction of which then proceeded as far as the stage shown in Fig. 4. At this stage, the pier-shaft was built to its finished elevation and was capable of supporting the approach spans, which it was expedient to erect as far as piers 16 and 22 in order to provide access at deck level to the suspension superstructure. At the same time there was ample space available at the base of the pier for storage of cable-strand reels and for assembly of the strands to the anchorages. The anchor piers remained in this unfinished condition throughout the winter of 1934 and were completed in the following spring, after full assembly and wrapping of the cables.

The superstructure of the central part of the bridge consists of a central suspended span of 1,059 feet and two suspended side-spans of 417 feet 6 inches each. The two

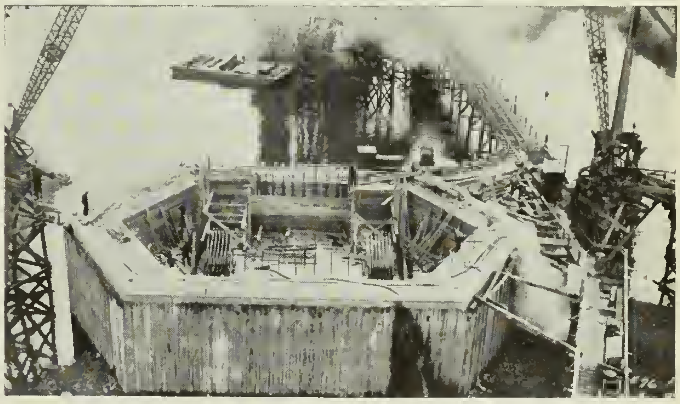


Fig. 3—Anchor Pier: First Stage of Construction.

main cables, 10 inches in diameter and spaced at 31 feet 8 inches, are carried on two towers which rise to a height of 220 feet above the pier masonry, and on two rocker-bents at the ends of the side-spans. The cables are 2,468 feet long between anchorages. The stiffening trusses, 13 feet deep, are of "through" type of somewhat light construction, suspended at 32-foot intervals and discontinuous at the towers. The superstructure was erected during the winter of 1934 and the spring and early summer of 1935.

Two alternative live loadings were considered in the design, namely a "normal" load (N) of 900 pounds per

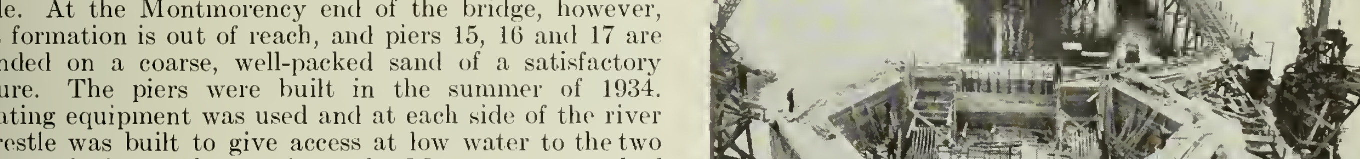


Fig. 2—General Elevation of Central Portion of Bridge.

linear foot and a "congested" load (*C*) of 1,200 pounds per linear foot. A heavier concentration representing truck-loading was used in the case of the floor and suspender members. The wind load (*W*) was taken as 400 pounds per linear foot, and stresses (*T*), due to temperature variations over a range from −20 degrees F. to +120 degrees F., were considered. The cables and trusses were designed by the "deflection" theory of stress-analysis, which takes into account variations in the cable curve consequent on loading changes.

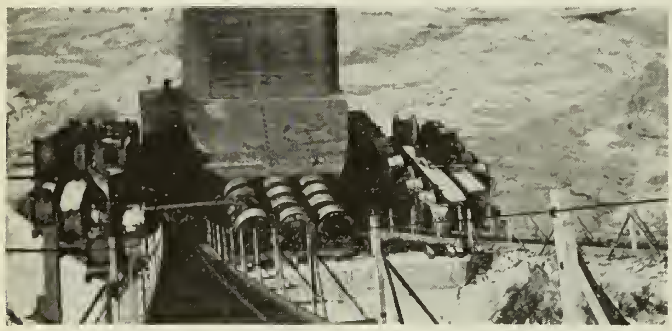


Fig. 4—Storage of Strand Reels on Anchor Pier.

The main cables are of acid open-hearth cold-drawn bridge wire, with a specified tensile strength of 220,000 pounds per square inch. Each cable, the maximum load on which is 3,087,000 pounds, consists of thirty-seven galvanized twisted-wire strands laid parallel to one another to form a hexagonal cross-section which is finally filled out to circular shape with cedar-wood fillers and bound with a continuous serving of No. 9 gauge soft annealed galvanized wire.

The individual strand is built up of thirty-seven wires of 0.193 and 0.201 inches in diameter, with six smaller filler wires, the total metallic area being 1.19 square inches.

The strands were required to develop a breaking load of 217,000 pounds each and to have a modulus of elasticity of at least 24,000,000 pounds per square inch after pre-stressing. Numerous tests gave eminently satisfactory and uniform results, the average strand breaking load being 258,500 pounds and the elastic modulus just over 26,000,000 pounds per square inch.

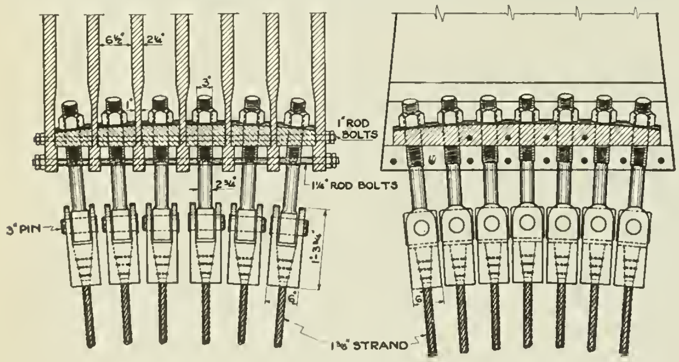


Fig. 5—Strand Anchorage System.

The pre-stressing of the cable strands and suspender ropes was carried out in a very efficient plant built for the purpose by the superstructure contractors. Each strand and rope-length was subjected, by means of a 75-ton hydraulic ram, to a load equal to one-half of its ultimate strength. The tension was maintained in each case until all stretching of the strand or rope, due to internal adjustment of the wires relative to one another, had ceased. The opportunity was then taken of applying a load equal to the future working dead-load stress, at which load marking points on the strand or rope were established for cutting to the precise length, and for other purposes incident to erection procedure.

At the anchorage, the strands of each cable are splayed out through a steel splay-casting and their sockets are attached to 3-inch eye-bolts which pass normally through sections of a spherically-surfaced steel slab and are secured by standard 3-inch nuts. The slab sections are held between fan-shaped 2¼-inch plates, notched to a thickness of one inch for this purpose (Fig. 5) and connected to a 15-inch diameter anchorage pin. Alternating on the pin with these plates are eight 30-inch by ⅞-inch plates which are attached to grillages and built into the structure of the anchor pier as already described.

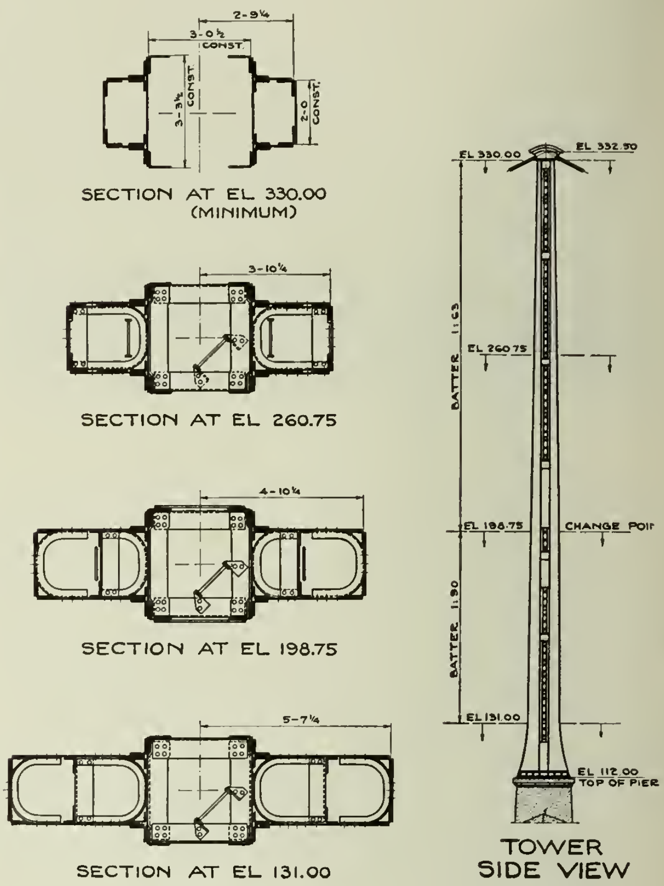


Fig. 6—Column Section and Side View of Tower.

The stiffening trusses are fabricated of ordinary medium-carbon steel, the basic working stress of 18,000 pounds per square inch being increased for loading conditions which involve combinations of "*W*," "*C*," or "*T*" stresses. The trusses are of the Warren type, and are supported from the main cables by suspenders attached to alternate verticals. Lateral X-bracing is provided in the plane of the lower chords, beneath the floor steel. The deck, which consists of a patent "Teegrid" composite steel-and-concrete slab, is carried on stringers and floor-beams, the latter being spaced at 16-foot centres. The steel grids, formed of parallel 3-inch by 3-inch tees, are entirely of welded construction. This type of slab is very light, weighing 50 pounds per square foot, and, although intrinsically more expensive than an equivalent reinforced-concrete slab, was selected on account of the consequent saving effected in the towers, cables, and anchorages. The roadway is bounded by fences of No. 6 gauge galvanized wire-mesh, attached to the truss members by welded connections.

At the main and subsidiary towers, expansion joints are provided in the roadway. These are of the conventional "finger" type employed for long bridges, but are designed to incorporate a noteworthy new modification. Each set of fingers, assembled as a unit, is supported from the stringers by short, heavy vertical links, and normally rests in contact with the deck slab, the fingers functioning in the usual manner. In the event of the fingers becoming frozen together, however, and the temperature continuing to fall, the slab on either side of the joint is free to retreat from the fingers, leaving small transverse gaps in the roadway. The gaps remain until such time as a rise in temperature, or a shock from a passing vehicle, breaks the ice bond, when the fingers will fall back into their original positions.

The two main towers (Fig. 6), which were designed with special regard to their æsthetic as well as their structural importance as the main supporting members of the bridge, each consist of two heavy columns connected by vertical X-bracing and, at truss level, by a stout horizontal strut which supports the truss live-load and temperature reactions (there being virtually no dead-load reaction from the truss) and receives the lateral loads from the truss wind-bracing. The column section is a triple box-section of silicon steel, the area of which increases from 145 square inches at the top to 340 square inches near the base, where the column is flared out in both directions in order to emphasize the stability of the design. Inspection ladders are provided inside the sections. The tower-columns were fabricated in six sections each, with five field splices. Abutting surfaces at the splices were machined after the sections had been fully riveted, and were brought to bear in the shops before the splice material was reamed for riveting.

The tower pedestals are entirely of welded construction. The pedestal is 2 feet in depth, built up of 1½-inch and 1¼-inch plates which were shop-welded together to form a unit 18 feet long and 8 feet 2 inches in width, and conforming in plan to the shape of the column cross-section. Each pedestal weighs 9 tons and is anchored to the pier by twenty-eight anchor bolts of 1½-inch diameter. The pedestals were placed in position by a floating crane which also erected the heavy lower tower-sections.

The towers were assembled by a 20-ton creeper traveller, designed for the purpose. Owing to the centre of gravity of this creeper being off-centre of the towers during erection, it was not possible to plumb the latter until they were fully assembled and the creeper dismantled. Complete reliance was placed, therefore, on the accuracy of the shop work and the dressing of the pier surfaces. This reliance was well justified, as the tower columns were found to be all within 1½ inches of being perfectly plumb. The cables are supported on the tower-tops by means of all-welded steel saddles. These (Fig. 8) are built up of a heavy curved forging (grooved to seat the cable strands) supported on 2-inch and 1½-inch web plates. The total weight of one saddle is 3 tons. The saddles are bolted to the tops of the columns and each saddle is protected from the weather by a waterproof cover fabricated of corrosion-resisting steel plate and provided with a door to give access for inspection. These covers were designed also with a view to their architectural function as finials for the towers, and one is shown in Fig. 9.

The cable-bents or intermediate towers (on piers 16 and 22) each consist of two rocker-posts 41 feet 6 inches in length, connected together with sway-bracing and a double cross-girder to which the end stringers of the approach- and side-spans are secured with sliding details. The side-span trusses and lateral systems are also supported here with sliding connections.

Cable saddles, similar to but smaller than those on the main towers, are carried on the tops of the cable bent posts (Fig. 10). These saddles, however, are provided with heavy caps, grooved to fit the profile of the top half of the cable, and secured to the saddles proper with high-tension Mayari steel bolts. The caps are necessary to produce the friction required to maintain the posts in position.

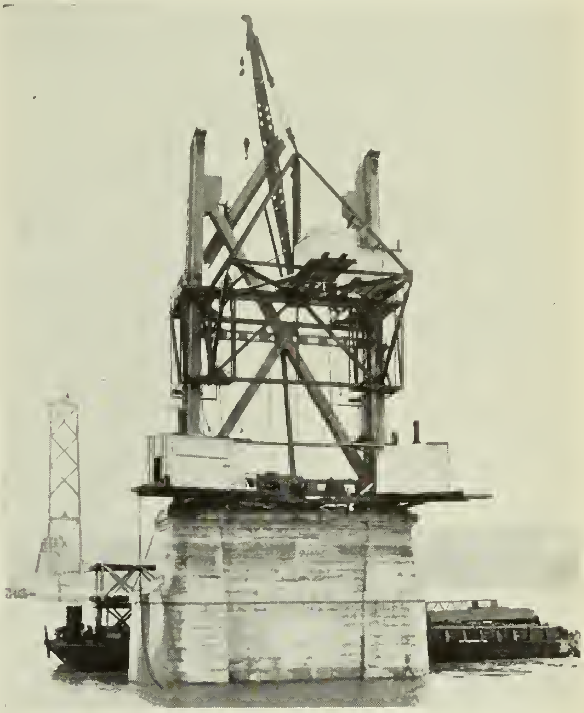


Fig. 7—Erection of Tower.

Fig. 8—Tower Saddle.

After erection of the towers, cable-bents, approach spans and anchorage steel, "catwalks" with wooden decks were assembled, one on each side of the bridge. Each catwalk was sustained by two 1⅜-inch strands slung from the towers and cable bents on temporary saddles, and secured to special anchorages by heavy turnbuckles for adjustment. The catwalks hung about four feet below the main cables and gave convenient and safe access to the latter for purposes of erection, adjustment and assembly of cable-bands, suspenders and stiffening trusses.

The cables were erected strand by strand. The first strand on each side was used as a guide-strand and was very carefully adjusted to its correct position by means of small movements at the saddles and anchorages after instrumental observations of the sags in the mid points of the five cable-spans had been made. The guide-strand adjustment was a tedious operation on account of the unfavourable weather conditions which normally obtain at the bridge site, particularly during the winter months.

Fig. 9—Column Finial.

When the two cables had been erected, the cable-bands which carry the suspender ropes were assembled. Each cable-band consists of two steel castings, shaped on their inner surfaces to fit the profile of the cable, and clamped on to the latter by four 1½-inch Mayari steel bolts, which were tightened to a specified tension of 33,000 pounds per bolt.

The galvanized suspender ropes, of "Warrington" lay, were designed for a maximum theoretical load of 96,000 pounds, and are built up of an independent-wire-rope-centre of seven strands of seven wires each, surrounded by six strands of nineteen wires each. The total metallic area is 0.926 square inches and the breaking load when tested over a specified 14-inch sheave was 325,000 pounds. The required breaking load was 296,000 pounds. These suspender ropes were also pre-stressed. An interesting feature of the bridge is the provision of ladder rungs fixed between

Fig. 10—Cable Bent Saddle.

the two parts of each suspender (Fig. 12), the purpose of these being to give access to the cable for inspection.

After the suspender ropes had been placed in position on the cable-bands, the stiffening trusses were erected. These came to the site in sections 32 feet in length and weighing from 5 to 9 tons per section. They were delivered to Montmorency village by rail and hauled across the ice of the river, and were raised into position by means of tackle hanging from the main cables. Assembly of the trusses was commenced in the middle of the central span and at the outer ends of the two sides spans simultaneously. The floor beams, stringers and lateral members were at once attached to them in order to stiffen the structure against undue wind movements; and adjacent truss sections were connected together as soon as the gradual increase

Fig. 11—Erection of First Truss Section.

of the dead-load deflection of the cable would permit. The erection of one of the truss sections is shown in Fig. 11. Final riveting of all the chord splices was not possible until after the full dead-load had been developed. The trusses were all assembled in a period of two weeks. The erection of the floor-grids and fences was a straightforward

Fig. 12—View of Trusses, Floor Grids, Kerbs and Fences.

matter, although involving a great deal of field welding. A very dry mix of concrete was used for the "Teegrid" slab and the grids were vibrated during the pouring. Figure 12 shows the trusses, kerbs, fences and grid sections in place before concreting.

After completion of all other parts of the superstructure, the cables were treated with a heavy coat of red lead paste. The wrapping wire previously described was then applied by a machine which laid three adjacent turns of wire simultaneously. At the cable-bands, saddles, etc., the wrapping was soldered into place, the last few turns in each case being applied by hand. A further coat of red lead paste was given to the cables after wrapping, and final treatment consisted of two field coats of green-grey paint as for the remainder of the exposed steelwork.

The bridge roadway is lighted throughout with electric light units spaced about 150 feet apart on either side, the fixtures being supported on the upper chords of the trusses. Navigation lights, operating on independent circuits, were installed to meet the requirements of the Federal Department of Marine.

The substructure contract was let to the Foundation Company of Canada Limited, and the contractors for the superstructure were the Dominion Bridge Company Limited. The work of making the cable-strands and the suspender ropes was sub-let to the Dominion Wire Rope Company Limited.

The bridge was built by the Department of Public Works of the Province of Quebec, under the direction of Mr. O. Desjardins, Chief Engineer. Messrs. Monsarrat and Pratley of Montreal were appointed consulting engineers for the design and execution of the works comprising the central portion.

The bridge was opened to traffic early in July 1935.

High Altitude or Stratosphere Flying

Group-Captain E. W. Stedman, M.E.I.C.,
Chief Aeronautical Engineer, R.C.A.F., Department of National Defence, Ottawa, Ontario.

Paper presented before the Aeronautical Section of the Ottawa Branch of The Engineering Institute of Canada, February 20th, 1936.

SUMMARY:—The possibilities of high-altitude flying will depend on many factors, the characteristics of the atmosphere, the design of the aircraft, the engine, its cooling, air supply and fuel, the airscrew and other considerations which are concisely discussed in this paper.

All scientific men like a challenging problem, and for this reason the problem of flying in the stratosphere has attracted world-wide attention from aeronautical scientists. This problem owes its fascination not only to the immediate economy that it promises in long distance and high speed transportation, but to the fact that when it is being considered numberless features appear under a new aspect, each one of which challenges the ingenuity of the designer.

A number of papers have been written on this subject, and references will be given to many of these. The only excuse for the presentation of another paper is that up to the present no writer has attempted to outline the chief points which confront the designer when he starts to consider the stratosphere aeroplane, and, therefore, a collection of a large number of these queries, which must of necessity be still very incomplete, should be of some value to others when they are confronted with this problem for the first time.

In many instances reference will be made to matters which are well known to aircraft designers, and this has been done purposely so that those readers who are not closely connected with the design of aircraft can appreciate the points raised and perhaps give the assistance of their own specialized knowledge towards the solution of a common problem—the conquest of the elements.

The Atmosphere

The atmosphere consists of a mixture of gases in nearly constant proportions for normal altitudes, and with varying amounts of water vapour.

Near the earth these gases are subject to continual changes in velocity both horizontally and vertically, and, therefore, the properties, such as pressure, density and temperature, vary considerably with time, with the result that, for the purpose of standardizing our methods of calculation, it is necessary to adopt average values for these properties. This has been done by the adoption of what is known as the "International Standard Atmosphere." Since the adoption of this standard it appears as though designers and operators have lost sight of the fact that the atmosphere usually departs widely from standard conditions.

Mr. Glaisher's record of temperatures during a balloon flight on April 6th, 1864, illustrates this point, and shows that wide ranges of temperature occur during even a short flight. (See Fig. 1.)

Composition of the Atmosphere

The average composition of the atmosphere at sea level is nearly ⅕ oxygen and ⅘ nitrogen, with small quantities of other gases and water vapour in varying quantities.

It was at one time thought that the composition varied greatly with altitude, but Gay-Lussac in 1804 obtained samples of air from a height of about 23,000 feet, and determined that the composition was practically the same as at the sea-level. It is known now that the oxygen proportion remains constant up to about 45,000 feet and then begins to fall off slightly. At about 270,000 feet there is probably no oxygen.

The hydrogen content becomes appreciable from 150,000 feet, and at very great height there is reason to believe that the atmosphere consists largely of pure hydrogen.* (See Fig. 2).

It should be noticed that at a certain height the hydrogen and oxygen will be present in the proportions of 2 to 1.

Air Temperature

The temperature at the surface of the earth varies widely with location and season. The extremes of temperature recorded are 133.3 degrees F. in the Sahara and −94.5 degrees F. in Siberia. Air temperatures at heights have been recorded, and it is found that on the average the temperature decreases steadily with height at a rate of approximately 3 degrees F. per 1,000 feet up to a height of about 35,000 feet, in temperate zones, above which the temperature remains almost constant, for some considerable height. The standard atmosphere assumes that the absolute temperature (T) varies with height in kilometres (h) according to the formula

$$T = 288 - 6.5\,h$$

These values are plotted in Fig. 3.†

*Wood's "Technical Aerodynamics," McGraw-Hill, New York.
†"Handbook of Aeronautics," Gale and Golden Ltd., London.

At the equator the fall in temperature with height continues to greater heights, before a nearly constant temperature is reached, with the result that the constant temperature at height over the equator is lower than that over the temperate regions.

Various writers have different opinions upon the variations in temperature at great heights, but obviously the number of observations must be so small that they are useless for obtaining average values.

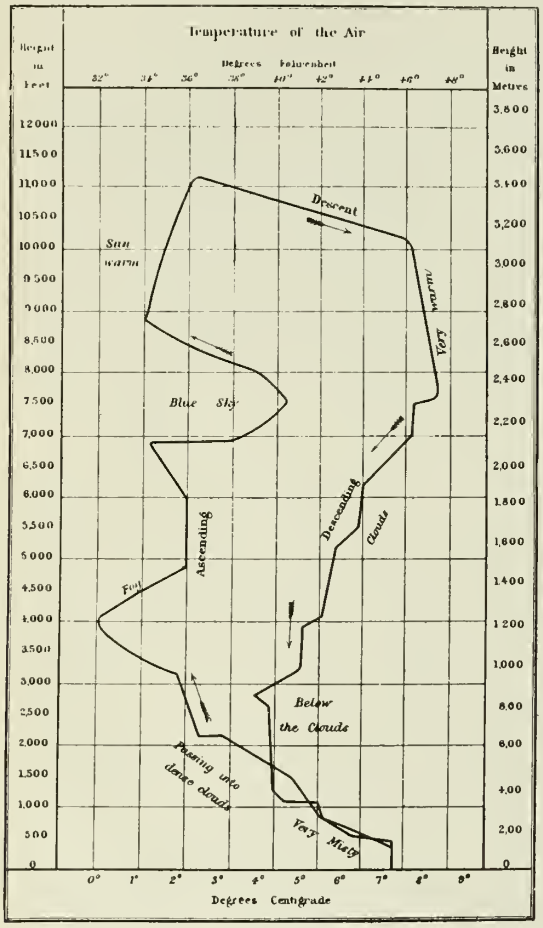


Fig. 1—Temperature of Air at Different Heights observed in Ascent and Descent, 1864.

Air Pressure

The air pressure is determined by the weight of the column of air above the point under consideration. It is seen, therefore, that the pressure must decrease with height.

The law used for the standard atmosphere is

$$\frac{p^0}{p} = \left(\frac{288}{288 - 6.5\,h}\right)^{5.256}$$

where h is in kilometres and the standard sea-level pressure is 760 m.m. of mercury (see Fig. 3). The pressure at the ground and at heights is variable as is well known from the continual variations of the barometer.

Air Density

The air density varies in a sim lar manner to the pressure, and can be calculated from the values of temperature and pressure, by using the formula $\rho = \frac{p}{RT}$.

The values for the standard atmosphere are plotted in Fig. 3.

The Stratosphere

It has been shown that at a height of about 35,000 feet in the temperate zone the temperature of the atmosphere ceases to fall with height. That portion of the atmosphere below this height is called the "troposphere," whilst the portion above this height is called the "stratosphere." The dividing line is called the "tropopause," and its height above sea-level varies from about 50,000 feet at the equator to 35,000 feet in the temperate zone, and probably much less nearer the poles.*

Clouds

Clouds may consist of either water or ice particles held in suspension by rising currents, therefore, at heights at which there is no water vapour there can be no clouds.

Clouds exist up to about 30,000 feet, and will certainly not be met with in the stratosphere.

Winds in the Stratosphere

Some writers have discussed the probability of the existence of strong winds prevailing at the height of the stratosphere with velocities as high as 120 m.p.h. from the west to east. These winds if they actually existed would have a bearing upon the height at which it was economical to fly, particularly when it was desired to travel towards the west.

The author has been unable to find any authoritative source which would confirm the existence of such prevailing winds, and in fact the evidence so far collected indicates very little wind at great heights.

It is well known that winds increase in strength as the height above the ground increases, but on the other hand the evidence collected from the flights of stratosphere balloons and from the observation of pilot balloons does not reveal the presence of any very formidable wind, but these balloon flights and observations have, of course, been made under good weather conditions.

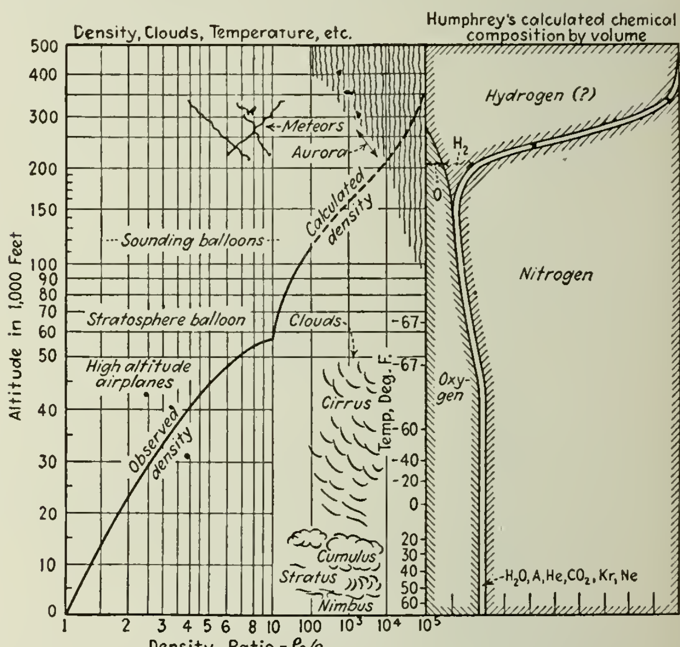


Fig. 2—Calculated Chemical Composition of Atmosphere by Volume.

In Captain Stevens' flight of July 28th, 1934,† the wind recorded at 40,000 feet was S.E. 55.7 m.p.h., and at 60,000 feet was S.W. 10 m.p.h. Also the stratosphere flight in the balloon "Explorer II" of November 11th, 1935,‡ indicates a total drift of 225 miles in eight hours thirteen minutes, of which one and a half hours was at approximately 70,000 feet; the details are not yet available. Similarly, results

*"Travel in the Stratosphere" by G. T. R. Hill, Journal of Royal Society of Arts, December 20th, 1935.

†National Geographic Magazine, October, 1934.

‡National Geographic Magazine, January, 1936.

obtained, from the Meteorological Office in Toronto, by observers of pilot balloons in Canada indicate that under the fair weather conditions when the pilot balloon can be seen at great heights, the wind speed rarely exceeds 50 m.p.h. with one or two notable exceptions, e.g., Victoria, B.C., May 5th, 1933, 12,000 metres, wind 123 m.p.h. S.S.E., Belle Isle Newfoundland February 20th, 1931, 10,000 metres, wind 79 m.p.h. W.S.W.

The Human Machine

The human machine like the internal combustion engine needs both fuel and oxygen, but in addition demands that the oxygen shall be served up in a manner suitable to its needs.

Adaptability to Conditions

Air at sea-level contains about 20 per cent of oxygen at a pressure of nearly 15 pounds per square inch, and both the engine and the human machine are normally suited to working under these conditions.

As the height above sea-level increases the pressure and density of the air decrease, and the power given out by an internal combustion engine also decreases in a similar manner, but the human machine is less accommodating.

It has been found that if the human machine is not required to perform much work it can accommodate itself to a height of 15,000 feet without any serious inconvenience. At this height the pressure has been reduced to nearly one half (0.55) of its sea-level value. If given time the human machine can adapt itself much more fully to the new conditions by actual changes in the blood. A quick rise to 20,000 feet may cause fainting due to failure of the oxygen to reach the blood. The pressure is then about 0.45 of sea-level pressure. Greater heights can be reached if the quantity of the oxygen in the air is increased artificially, and by this means a height of about 35,000 feet can be reached when the pressure is about 0.2 of sea-level pressure.

It appears, therefore, as though the human machine is satisfied with air containing 1/5 oxygen at sea-level pressure, or with pure oxygen at 1/5 sea-level pressure, which resolves itself into the statement that it requires an equivalent oxygen pressure of 1/5 sea-level pressure.

Just as it is possible for a height of 15,000 feet to be reached within the range of accommodation available when using air, so is it possible by using oxygen to reach 42,000 feet, provided that no work is to be done, and the fainting height for pure oxygen is at about 46,000 feet.

Donati, a well trained altitude pilot, reached a height of 47,360 feet using oxygen with some CO_2, and landed in a state of collapse, indicating that he had reached the limit for the apparatus available.

Above these heights it becomes necessary to supply air, or oxygen, under pressure, but as a human being cannot stand even a small internal pressure, the pressure must be applied externally at the same time.

Respiratory System

The air contained in the lungs (alveolar air) under normal conditions has the following composition:

	CO_2	N_2	O_2	H_2O
Per cent	5.3	74.1	14.4	6.2

The oxygen, therefore, contributes about 1/7 of the air pressure within the lung spaces, or alveoli.

The red pigment in the corpuscles of the blood has the power of taking up, or giving off, oxygen with increase or decrease in pressure with a maximum richness of oxygen when the oxygen pressure is about 1/7th atmospheric.

The pressure of the oxygen in the lungs causes the oxygen to diffuse through the light membranes into the blood contained in the capillaries in the walls of the alveoli. The oxygen is carried by the blood to the tissues where it is to be used, and when the oxygen is given up to those tissues the blood automatically picks up the waste product CO_2 and carries it back to the lungs. When the CO_2 laden blood reaches the lungs, the CO_2 diffuses through the membranes into the alveoli at the same time that oxygen is entering the blood.

The diffusion of oxygen in one direction and CO_2 in the opposite direction is due to the fact that the partial

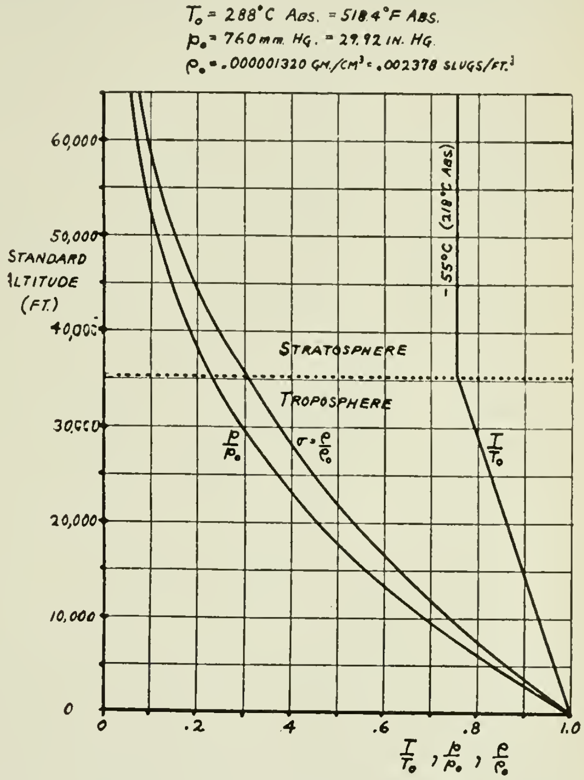


Fig. 3—Properties of the International Standard Atmosphere.

pressures due to these gases are different on the two sides of the membrane. With a high oxygen pressure in the alveoli, and a low oxygen pressure in the returning blood, oxygen passes into the blood; similarly with a high CO_2 pressure in the returning blood, and a low CO_2 pressure in the alveoli the CO_2 will pass from the blood into the alveoli.

Also the more work that is done by the tissues the more the used blood is robbed of oxygen and charged with CO_2, resulting in increased oxygen supply to the blood, and the necessity for greater breathing action to keep up the oxygen pressure in the alveoli.

The presence of CO_2 in the air that is to be inhaled is also of importance, because it appears to act as a stimulus for breathing action, and it is interesting to note that Donati actually used a small proportion of CO_2.

Anoxœmia (Oxygen starvation)

We have seen previously that although the proportion of oxygen in the air remains practically constant up to great heights, the pressure diminishes rapidly. The result of this diminution of pressure is that the oxygen pressure available in the lungs is not sufficient to saturate the blood with oxygen, and a lower percentage of oxygen is absorbed by the red pigment in the blood as can be seen by a change in the colour of the blood from red towards the blue.

If the change takes place slowly the blood can adapt itself within limits to the new conditions by increasing the number of red corpuscles, and even have an increased chemical affinity for oxygen due to change in chemical composition.

The effects of oxygen starvation are vividly described by Glaisher, who noticed particularly that the first symptom was loss of power of the hands. The effects are diminution of judgment, drowsiness, breathlessness and muscular weakness, followed by a gradual loss of power over the members, starting with the hands, and finally unconsciousness.

Amount of air required

The discomfort experienced in a crowded room is not due to the increase in the carbon dioxide as much as the fact that the body becomes surrounded by moisture laden air, and relief can be obtained by circulating the air without actually changing it. Also air containing as much as 5 per cent of carbon dioxide can be breathed without distress

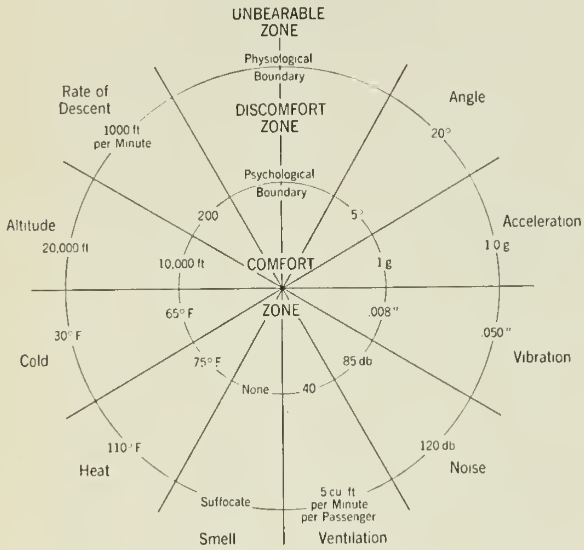


Fig. 4—Passenger Comfort Chart.

It has been found, however, that more cubic feet of air per passenger are needed in aeroplanes than in other forms of transportation. Studies of passenger comfort indicate a requirement of 30 cubic feet of air per minute per passenger, with a possible range of from 40 cubic feet per minute down to a minimum, which would be accompanied by discomfort, of perhaps 5 cubic feet per minute.*

Angle of Tilt

The angle of tilt also has to be considered, and it has been found that whereas 5 degree change is comfortable 20 degree change is unbearable, and, therefore, with rapid climbs and glides it may be necessary to provide some means of changing the position of the seats.

Rate of Climb

From experience gained with transport aircraft it has been found that the rate of climb must be limited to a figure of about 200 feet a minute, in order that the passengers can adapt themselves to changing pressures. Any higher rates of climb, or descent, cause inconvenience. It has also been found that with "sleeper planes" changes of height cannot be made while the passengers are asleep, because they do not swallow sufficiently, and consequently suffer from the change of pressure.

The Internal Combustion Engine

Power Variation with Altitude

The power given out by an internal combustion engine depends directly upon the weight of oxygen entering the cylinders, other conditions remaining constant. Therefore, as an engine is taken to greater heights the power will fall off almost in direct proportion to the fall in density of the air, but it is important to note that unlike the human machine there is no upper limit, and the internal combustion engine will continue to give power even at very low air densities.

In order that the engine can be usefully employed at heights it is necessary to provide some method by which the power given out at heights can be maintained at a value which is commensurate with its weight.

Methods of Maintaining Power at Heights

Various methods have been suggested for maintaining the power of aero engines at heights, but the method now generally adopted is the use of a supercharger. The supercharger consists of an apparatus, which will compress the air from the free atmospheric pressure to some predetermined figure usually taken as sea-level pressure, and maintain this predetermined pressure up to some predetermined height. Under these conditions the engine output will be approximately constant up to the predetermined height, but some of the output will be absorbed in driving the supercharger itself.†

The Geared Supercharger

This is the type most generally used at the present time. It consists of a centrifugal fan driven by gearing from the engine crankshaft, and discharging into a diffuser, which is part of the induction system of the engine. This type of supercharger involves a high power loss at low altitudes, because it is necessary to throttle the engine considerably, in order to keep down the induction manifold pressures to figures that can be handled without engine troubles.

For this reason geared superchargers have not usually been constructed for maintaining sea level pressure at heights greater than 15,000-20,000 feet.

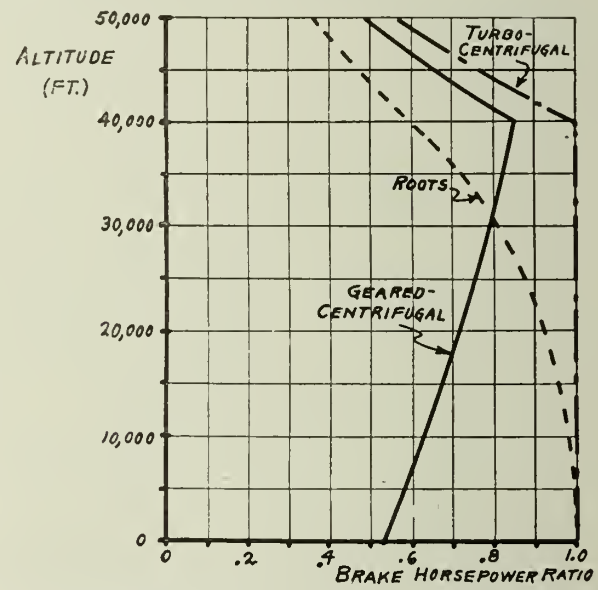


Fig. 5—Net Brake Horsepower of various Types of Supercharged Engines of 40,000 ft. Critical Altitude. (Based on data from N.A.C.A. T.R. No. 384.) Specific Fuel Consumption Ratio at 40,000 ft. critical altitude; Turbo = 1.00. Geared Centrifugal = 1.18. Roots = 1.69.

In order to fly in the stratosphere one must contemplate maintaining sea level power at 30,000-40,000 feet. It is possible to consider the use of a gear driven supercharger, in which there is incorporated a change speed gear, so that at low levels the fan wheel can be run more slowly, and the amount of throttling thus reduced.

The Root's Type Supercharger

In this supercharger a rotary blower of the Root's type draws in air at the suction pressure, and forces this

*"Passenger Comfort in Air Transportation," by G. R. Bassett, Journal of Aeronautical Sciences, March 1935.

†"High Altitude Flying," by W. B. Oswald, Journal of Aeronautical Sciences, January, 1935.

air against the pressure existing at the discharge side. If the blower is not required to give full output it is only necessary to open a valve on the discharge side, thus reducing the pressure that is built up in that region, with consequent reduction in the power required to drive the blower.

With a supercharger built on this principle the losses of power at low altitudes can be much less than with the geared type supercharger, but it is less economical in fuel than other types, and is unwieldy.

It is probable that superchargers of this type with suitable coolers, and even with tandem superchargers, could be constructed to suit the requirements of stratosphere flying, if more attractive methods of doing the same thing were not available.

The Exhaust Driven Supercharger

With this type of supercharger a centrifugal fan wheel similar to that used for the geared supercharger is driven by a turbine, which uses the exhaust gases escaping from the cylinders.

By arranging a by-pass it is possible to allow only the required amount of the exhaust gases to pass through the turbine, and thus the work done by the supercharger can be regulated to that actually required at all heights up to that at which the supercharger is giving its maximum output.

The fact that the power for the drive comes from the exhaust gases allows considerable economy, because the engine output is only called upon to the small extent resulting from the slightly greater back pressure on the exhaust valves.

Theoretically the power available for driving the supercharger increases with height, due to the fact that the exhaust pressure remains nearly constant, whereas the pressure of the air is reducing with height. Actually the problem is more complicated, because the speed of the turbine wheel coupled with the high temperature of the blades causes difficulties in construction, which become much worse as the height range is extended. Also the high temperatures resulting from the compression of the air make the air quite unsuitable for use in the engine until it has been cooled. This means that a two-stage supercharger would be necessary with a cooler between the stages, and between the second stage and the engine. This problem is difficult, but by no means impossible.

Another possible arrangement is that in which the engine is provided with a geared type supercharger suitable for moderate heights, and in addition with a Root's type, or exhaust driven type of supercharger with intercooler, for providing the additional supercharging required.

Engine Cooling

The air density being lower at altitudes, and the temperature also being lower, these two factors act in opposite directions upon the transmission of heat from a heated surface to the surrounding air. Increase in speed assists the cooling, provided that the speed does not approach the velocity of sound. At the stratosphere there is no further lowering of temperature, and in fact it may increase with greater heights, and then the loss in density becomes the deciding feature.

Crocco has estimated that for any given set of conditions, such as the temperature of the surface to be cooled, height, etc., there is a most efficient speed for cooling, above which the cooling falls rapidly.* When the speed approaches the velocity of sound it becomes impossible to consider the use of the internal combustion engine, at any rate in its present form, because it cannot be cooled by systems at present in use. The cooling of the engine must, therefore, be studied along the lines outlined by Crocco, in order to determine to what extent the cooling surface of the cylinders must be increased to suit the conditions likely to be encountered.

Magnetos and Insulation

The distance across which a spark will jump between two metal spheres, maintained at a constant difference of potential varies in rough proportion with the density of the surrounding air. If, therefore, it is contemplated operating in air at a density of 1/5 sea level density, then the distances across which sparks will jump will be increased by approximately five times.

The design of magneto parts, particularly distributors may under these conditions offer some difficulty, and screened spark plugs, as at present used, may need redesigning by bringing the insulation right over the terminal on the end of the plug, if this does not introduce plug cooling difficulties.

All the electrical installation will need to be considered from this point of view, and the use of coil-ignition may prove of some assistance.

Fuel

The vapour pressure of the fuel employed at present is usually about 7 pounds per square inch at 37.8 degrees C., and, therefore, evaporation of fuel may take place if great heights are reached before the fuel has cooled sufficiently to decrease its vapour pressure materially, and unless arrangements are made to maintain the pressure in the fuel tanks.

The most suitable method of overcoming this would probably be to seal the tanks and to connect them to the supercharger outlet, so that they are kept at sea level pressure, with the supercharger supplying the air necessary to replace the volume of fuel consumed. Under these conditions the tanks will be subjected to considerable internal pressure at heights, which must be provided for in the design. The freezing point of the fuel is around −50 degrees C., a temperature which will certainly be reached by the atmospheric air, necessitating the retention of sufficient heat in the space surrounding the fuel tanks. This should not be difficult because the problem of getting rid of heat in the supercharger coolers, and the engine cooling should make ample supply of heat available for this and similar purposes.

Ozone Effect

It has been shown that the presence of a very small percentage of ozone in the air supplied to an engine will cause an appreciable decrease in the apparent octane value of the fuel being used. This may be a serious question because the engines will be working at sea-level power at altitudes, due to supercharging, and the full octane value of the fuel will be required.

The amount of ozone in the atmosphere is not known very definitely, but the stratosphere flight by the balloon "Explorer II" of November 11th, 1935, may give some interesting information on this point, as it is known that air samples from above 60,000 feet were obtained on that flight.

It is considered possible, however, that ozone exists in appreciable quantities in the Heaviside layer, at heights of about 130,000 feet during the day, and there may, therefore, also be appreciable quantities at the heights now being considered.

Batteries

The stratosphere balloon "Explorer II" was surrounded by mist, when at the top of its flight, due it is assumed, to evaporation from the batteries, which were slung outside the gondola.

With an aeroplane flying at great heights the batteries would probably be kept quite warm, and serious evapora-

*Technical Memorandum 690, National Advisory Committee for Aeronautics, Washington, 1932.

tion might occur if they were not carried inside the pressure compartment.

The Aircraft

In considering the aircraft requirements it is desirable to investigate the most difficult type, in order to bring out as many as possible of the questions that require attention. It is proposed, therefore, to consider a passenger carrying aeroplane with capacity for about twenty passengers.

Fig. 6—Gondola of "Explorer I."

Actually the difficulties can be greatly reduced by considering a mail carrying aeroplane with a crew of two, because the problem of looking after the requirements of two men for a journey of nearly eight hours in the stratosphere has already been solved for the stratosphere balloons. It would, therefore, only be necessary to follow the experience already gained by building into the fuselage a spherical cockpit equipped with air-conditioning apparatus similar to that used for the balloons. The weight of the structure of the gondola of the balloon "Explorer I" was about 700 pounds* (see Fig. 6).

Effect of Change of Fineness and Loading

The performance characteristics of an aeroplane can be represented by a curve, such as A in Fig. 7, in which the ordinates represent the horsepower required, and the abscissæ represent the forward speed. Curve "A" represents the characteristics of an aeroplane of 1913, which had a top speed of about 72 m.p.h., and a landing speed of about 42 m.p.h.

By calculating the total resistance at top speed the relation of this to the total weight gives a measure of the efficiency or gliding angle. In the example considered, the gliding angle at top speed is 1 in 5.5. If the same aircraft is supplied with a more powerful engine, without changing other features, the speed is increased, but at the expense of the gliding angle. For instance, by increasing the horsepower available per 1,000 pounds from 36 to 48 the speed is increased from 72 m.p.h. to 80 m.p.h., but the gliding angle is reduced to 1 in 4.4. The top speed can be still further increased by increasing the wing loading, and, therefore, the landing speed.

Curve "B" shows a typical performance curve for an aircraft of military type in 1932. In this aircraft the stalling speed is now 65 m.p.h., and the top speed is 170 m.p.h., but the best gliding angle is no better than that of the 1913 aeroplane, and the gliding angle at top speed is only 1 in 4.2 showing that performance has been obtained by increase in power rather than by improvement in the aerodynamic properties of the aeroplane. Curve "C" gives the performance of a modern transport aeroplane of clean design, in which increase in wing loading is accompanied by the use of flaps to keep the landing speed down, and in which the best gliding angle approaches the figure 1 in 16. This aeroplane at a top speed of 196 m.p.h. has a gliding angle of 1 in 7.6, which is almost as great as the best gliding angle for the aeroplane of curve B, and the top speed is obtained at an effective horsepower per 1,000 pounds of 68 as compared with 109 for the previous aeroplane.

This comparison indicates the enormous advantages to be obtained from clean design.

Effect of Altitude upon Aeroplane Performance

In any aeroplane flying at a constant angle of attack

$$W = \frac{\rho}{g} \cdot K_L \cdot A V^2 \quad \ldots\ldots (1)$$

$$HP = \frac{\rho}{g} \cdot K_R \cdot \frac{A V^3}{550} \quad \ldots\ldots (2)$$

with W, K_y, K_D, A and g constant.

ρV^2 is constant from equation (1) and for a given angle of attack V will vary as $\frac{1}{\sqrt{\rho}}$

Also from equation (2)

HP will vary as ρV^3, i.e. as V for ρV^2 is constant

i.e. HP will also vary as $\frac{1}{\sqrt{\rho}}$

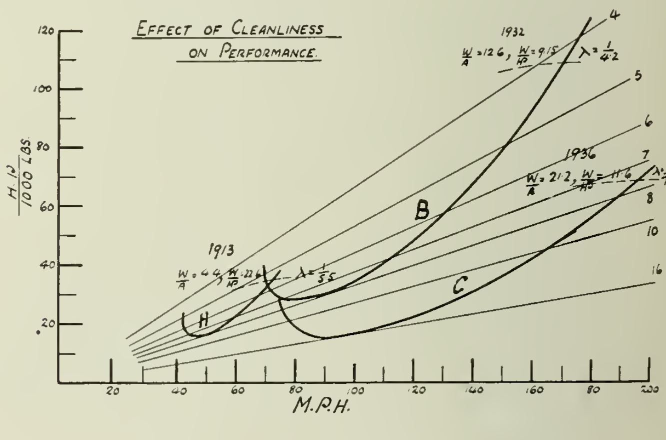


Fig. 7—Effect of Cleanliness on Performance.

In order to determine the effect of altitude it is, therefore, only necessary to increase the ordinates and abscissæ of the curves for performance in the proportion of $\frac{1}{\sqrt{\rho}}$. This has been done in Fig. 8 for a large passenger carrying aeroplane of good aerodynamic efficiency.

At sea level with an effective horsepower of 2,400 the top speed is 180 m.p.h., and the gliding angle at this speed is 1 in 6.

*The National Geographical Magazine, October, 1934.

If the horsepower available is kept constant without increase in weight up to about 22,000 feet with $\rho = .5$, then the top speed becomes 227 m.p.h., and the gliding angle at top speed is 1 in 7.6.

Similarly at 40,000 feet with $\rho = .25$ the top speed becomes 292 m.p.h. and the gliding angle 1 in 9.6.

So that for each decrease in ρ or increase in height at which the horsepower can be maintained constant there is a corresponding increase in top speed and in efficiency up to the maximum when the aeroplane is flying at its best gliding angle, which occurs at the point D on the figure.

This indicates that at heights of about 50,000 feet, if the engine power can be maintained, the speed can be increased by about 100 per cent over the sea level figure. The pay load will, however, be reduced by the increase in weight necessitated by flying high, i.e., superchargers, etc., which may be compensated for by the reduction in fuel needed for a given journey.

There is another interesting way of regarding this question, and that is by supposing that it is desired to fly at constant speed at sea level top speed figure of 180 m.p.h., then the curves A and B indicate that by flying at 22,000 feet, this same speed can be obtained by using only 1,200 h.p. instead of 2,400 h.p. as required at sea level.

The fuel required for a given journey depends upon the horsepower and the time, i.e., the fuel consumption for a given journey depends upon the horsepower required divided by the speed, and if the horsepower remains constant the fuel required is decreased proportionally to the increase in speed, with allowance made, of course, for climbing to the desired height. Considerable economy can, therefore, be made by flying at great heights for long distances when the fuel consumed in climbing to the height becomes a small proportion of the whole, and is partially offset by the fact that at the end of the journey during the glide little fuel is consumed.

Speed Limitations

From what has gone before it must not be assumed that the speed of an aircraft can be increased indefinitely. The reason for this is that at high speeds, approaching the velocity of sound, the compressibility of air becomes important, and the characteristics of an aeroplane wing section may be considerably changed.

This problem has not yet been fully investigated, but tests on models at speeds up to the speed of sound indicate that at about .7 of the speed of sound the lift of an aerofoil at a given angle of attack may be considerably decreased and the drag increased. When flying at great altitudes and low temperatures the speed of sound is reduced (see page 335) and the speed of the aircraft may approach the conditions under which the change in the characteristics of the wing takes place. It has been found, however, that these changes vary a good deal with changes in the shape of the wing section, and it may be possible to obtain a wing section which will be suitable for use at speeds well beyond the range required.

It should be remembered that the Reynolds number will be low, due to the low air density, in spite of the greater speeds and lower viscosity of the air.

Refinements in Aerodynamic Features

It is important to remember that the full benefit of high altitude flying can only be obtained by using aircraft of high aerodynamic efficiency. Therefore, every refinement such as high aspect ratio, tapered wings, flaps, retractable undercarriage, etc., must be employed.

Cabin Design

In the first instance consideration will be given to the problems that arise in the design of a cabin to carry passengers at great heights.

To provide for the requirements of the personnel the cabin must be supercharged, and it is necessary to decide upon the pressure difference that must be provided for in the design.

The human machine works quite satisfactorily up to heights of about 15,000 feet where the pressure is 0.55 of sea level pressure. Therefore, the internal pressure of the cabin need not be kept above this, or perhaps a slightly

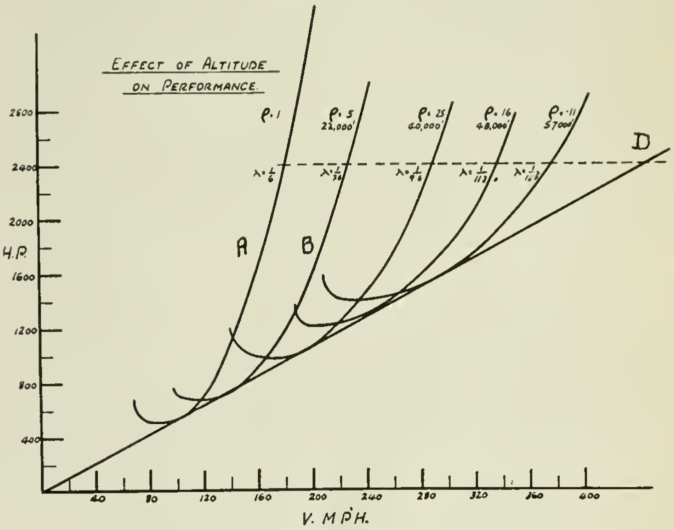


Fig. 8—Effect of Altitude on Performance.

higher pressure, say, 0.7 of sea level pressure (10,000 feet). If the maximum height to be employed is 50,000 feet, then the minimum external pressure will be about 0.12, and the difference between internal and external pressure will be (.7 − .12) p or 8.6 pounds per square inch. This figure could be still further reduced if the oxygen content was maintained higher than normal by the evaporation of stored liquid oxygen.

There are, however, many objections to maintaining the pressure at anything below the sea level pressure, the chief one being that if the cabin is to be kept open to the air until a height of say 13,000 feet is reached, then the climb to that height has to be done very slowly, in order to avoid discomfort to the personnel.

It is, therefore, advisable to seal the cabin at ground-level and design to a maximum difference of pressure of (1 − 0.12) × 14.7 or 13 pounds per square inch. This figure must be multiplied by a factor of safety of at least 2½ for design purposes, giving a design figure of 32½ pounds per square inch.

Assuming that the usual monocoque construction will be used and that the cabin will be circular in section with a diameter of about 7 feet the thickness required will be found to be only slightly greater than is at present employed for similar structures. The internal pressure puts the whole skin in initial tension, and the loads applied to the fuselage as a whole apply additional compression and tension loads, so that the effect of the internal pressure is to reduce the compression loads which usually determine the size of members to be used.

It is essential that the cabin shall not suddenly develop leaks, and the usual single row riveted joints are not likely to be suitable, because of the liability of the plate opening up between the rivets, therefore, the joints must have two or three rows of rivets.

The usual type of construction employs longitudinals of extruded section, which are supported at the transverse frames of the fuselage. If the frames are stiff, then the longitudinals will bow between the frames, giving the outside a corrugated appearance when the cabin is under pressure.*

It has been suggested that to overcome this, it might be desirable to employ flexible frames which would expand under pressure, and allow the longitudinals to take up a continuous curve.

The tail end of the fuselage will not be under pressure, and, therefore, there will be a discontinuity in the structure where the tail end joins on to the pressure cabin, which must be allowed for in the design of the longitudinals.

The frames must be true circles because any change in radius means large bending moments and increased stresses.

To provide the most economical bulkheads they should be of hemispheric shape. This is easy at the rear end of the cabin, but more difficult if it is desired to provide a pressure bulkhead between the pilot's cockpit and the passengers. This latter point will be referred to again.

Floors must be independent of the walls of the pressure cabin, because a large flat surface carrying pressure cannot be designed economically. The pressure compartment must, therefore, extend out to the circular shell, and the floor supported inside, but not made air-tight.

When under pressure the cabin will increase both in length and diameter involving some complications in the neighbourhood of port holes and doors. Also the attachment of the fuselage to the wing, which will not expand, needs special provision for this relative movement.

The high internal pressures make it necessary for the doors and windows (or perhaps port holes) to open inwards so that the pressure can be employed to hold them against rubber rings to keep them airtight.

The windows for the pilot offer the greatest difficulty for although when once well clear of the ground it would only be necessary for the pilot to have small port holes, the aircraft when operating near the ground must be provided with ample visibility for the pilot. This could perhaps be obtained by operating the aircraft up to say 15,000 feet, after which the pilot would close metal shutters over his windows and rely on small port holes in the shutters. The space between the shutter and the large windows would require to be put in communication with the atmosphere to avoid having difference in pressure on the two sides of the window.

Supercharging the Cabin—Up to the present it has been tentatively assumed that the cabin would be retained at sea-level pressure, mainly for operating reasons, which demand high rates of ascent and descent.

It has been stated already that in so far as the personnel are concerned the pressure could be much lower if the oxygen percentage was raised to compensate for the lower pressure. There are serious objections to using pure oxygen by reason of the great risk of fire, therefore, assuming once more that air at sea-level pressure is to be used, it becomes necessary to provide some form of supercharger somewhat similar to that required for the engine.

The best method of driving this supercharger would probably be by providing an auxiliary engine, which drives only the supercharger for the cabin and for its own requirements. The volume of air required by the personnel is comparatively small, i.e., 20 to 30 cubic feet per minute per person, but absolute reliability is necessary. To secure reliability it may be desirable to divide this supercharger unit into two, because the personnel can easily, if necessary, exist with a much reduced supply of air, provided the pressure is maintained, and particularly if the air is kept in circulation within the cabin, and under these emergency circumstances one supercharger would be ample.

*"Structural Features of Supercharged Cockpits and Cabins," by J. E. Lipp, Journal of Aeronautical Sciences, November, 1935.

The cabin supercharger would require intercoolers with a close adjustment of the temperature of the air entering the cabin.

Pressure Regulation—It would be necessary to adjust the air supply so that pulsations did not exceed the equivalent of ± 10 feet in height or ± .005 pounds per square inch, necessitating a very delicate automatic control. The supercharger would probably discharge through coolers into a reserve tank kept slightly above cabin pressure with a regulating valve admitting the air to the cabin. The outlet from the cabin would be by a similar regulating valve set at a pressure slightly below that used for the inlet valve, thus allowing the required quantity of air to pass through the cabin.†

The design of the outlet valve again requires special attention, because this valve must maintain a given pressure inside the cabin whatever the pressure may be on the outside. Actually this problem is not so formidable as it seems, because with a cabin attendant available it is possible to use a simple screw down valve adjusted from time to time to maintain the desired rate of flow, as indicated by a meter of the gas-meter type.

Emergency Equipment—In the event of failure of the supercharger, and especially if the duplicate supercharger units were not provided the first consideration would be to close off the outlet valve. This would be automatic if an automatic outlet valve was used. Then it would be necessary to draw upon an emergency supply of liquid air carried for the purpose. This liquid air would be evaporated to supply the minimum amount required, and the pressure kept down to normal by regulating the outlet valve. In the meantime the pilot would lose height as quickly as possible, necessitating perhaps twenty minutes before the cabin could be opened to the outside air at a height of 15,000 feet.

A loss of pressure from any cause is much more serious, but could be countered for a short period by carrying a supply of liquid oxygen, and enriching the oxygen content in the cabin as the pressure fell, always bearing in mind the risk from fire with very rich oxygen mixtures. It has been argued that in an emergency it is in the interest of the whole that the pilot should be given the last remaining air, and that for this reason the pilot's cockpit should be separated from the cabin by an airtight bulkhead. This would allow the pilot to shut off the air supply to the cabin, and use the last remaining air in his own cockpit, whilst he manœuvred the aeroplane to a height at which the cabin could be opened.

Alternatively, the pilot could be provided with a Wiley Post type suit (Fig. 9), or emergency oxygen apparatus, to achieve the same purpose. It is hardly likely to be popular for the passengers to be provided with suits of this type, or even for them to wear oxygen apparatus and thus avoid the structural difficulties in making a supercharger cabin.

Water Vapour and CO_2—The air given off from the lungs contains appreciable quantities of moisture and carbon dioxide, whereas the air drawn in at great height will be devoid of moisture, and contain very little carbon dioxide. It is probable that with a continual leak of air, the amount of CO_2 will not cause any difficulty, because the CO_2 content of the air may be allowed to rise to 5 per cent without trouble. The moisture may on the other hand become too high in spite of the dry air that is being supplied. In the stratosphere balloons, bags containing sodium hydroxide, over which the air was circulated by a fan, were used to keep the air in good condition, and some such device may be necessary.

†"Methods of Cabin Supercharging and Their Necessary Control Systems," by A. L. Klein, Journal of Aeronautical Sciences, November, 1935.

Cabin Insulation—The gondola of the last stratosphere balloon was painted white on top to reflect sunlight and black below to absorb heat from the earth. It was found that at the lowest outside temperature the temperature inside the gondola was 21 degrees F., and that at greater heights where the outside temperature was higher the inside rose to 43 degrees F. As indicated previously, there should be plenty of heat available from the intercoolers

Fig. 9—Suit for Stratosphere Flying.

for the superchargers, and consequently not much difficulty about keeping the cabin warm.

However, as the air temperature will be at least −50 degrees C. the metal skin of the fuselage will be much too cold to sit against, and some provision must be made for insulation to avoid the proximity of cold walls to the seats, and to reduce condensation of moisture on the cabin ceilings.

Insulating boards can easily be used for this purpose, but other proposals may appear more attractive.

If the cabin was provided with a double wall the space between the walls would be useful for cooling and storage space for the air from the cabin supercharger. In this event the outside wall would probably be the pressure wall, because there would be little difference of pressure between the cabin and the air storage space, and the inner wall could be very light. Leaks inwards are not a serious matter.

Controls and Instruments

Some designers who have investigated this problem foresee some difficulty in carrying the pilot's controls from inside a pressure cabin to the other parts of the aeroplane. Professor Piccard recently pointed out that by using a tube led into the side of his gondola with a rubber tube fitting over this tube and the rope passing through it, he was able to keep down the leakage to very low figures.

In any event there should be little difficulty in arranging for controls of any kind to pass through the walls of the cabin by suitable glands.*

*"High Altitude Problems," by M. E. Gluhareff, Journal of Aeronautical Sciences, March, 1926.

The altimeter is comparatively simple, depending as it does upon the expansion of a sylphon disc when subjected to reduced pressure, but it must be remembered that the altimeter case must be made airtight and connected to the outside of the cabin.

Another altimeter open to the cabin would be a suitable instrument for measuring cabin pressure.

The airspeed indicator measures the difference between the pressure and suction sides of the pitot head, and, therefore, will at great height be subjected to large corrections to take account of the lower density of the air. The important thing again is to ensure that the instrument case is airtight at the comparatively large pressure differences, which will occur between the inside and outside of the case when the cabin is under pressure. Also rubber connections will not be suitable because they will collapse under the cabin pressure, and are liable by failure to cause leaks from the cabin.

Load Factors

The aircraft will be designed to suit the operating conditions, and nothing unusual should be encountered, except that an economical flight path calls for high rates of descent. At these high rates of descent when the aeroplane reaches disturbed air, gusts become of great importance and must be provided for in the load factors.

De-icing Equipment

In order that the stratosphere aeroplane shall be able to enjoy the full advantages of its great operating height it is essential that it should be capable of reaching that height under really bad weather conditions near the ground.

The worst condition that will be encountered is probably an icing condition, and, therefore, the aeroplane must be provided with some form of de-icing equipment, which will allow it to climb for perhaps twenty minutes while reaching more suitable atmospheric conditions.

Any accumulation of ice will presumably be evaporated when once the aeroplane has reached atmospheric conditions of very low humidity. At 25,000 feet, for instance, the average moisture content of the air is reported to be less than 4 per cent of the average for sea level.

The Airscrew

The airscrew presents one of the most difficult problems to solve because it must be efficient under such widely different conditions. A continuously variable pitch airscrew is evidently necessary.

The airscrew top speed must not approach too closely to the velocity of sound in air, and this velocity decreases with decrease in temperature.

$$V_t = V_o \left(1 + \frac{\alpha t}{2}\right)$$

Where V_o is 33,060 cms./sec. at 0 degrees C.

t is in degrees C. and $\alpha = .00366$.

So that at $t = -55$ degrees C. the velocity of sound is decreased by about 10 per cent.

A rough estimation of the requirement for an airscrew for cruising at a height of about 48,000 feet indicates that the airscrew requirements dictate a larger diameter than would normally be used, and the limitation in tip speed indicates the necessity for low revolutions.

This leads to the use of a geared down airscrew of large diameter and four blades.

The requirements for an airscrew for climbing at intermediate heights can be met fairly well with the same airscrew as is required for cruising at heights, but as lower heights are considered the efficiency falls. Also the pitch changes necessary to meet the varying conditions are very great causing inefficiency, due to the unsuitability of the helix on the airscrew blade, but pitch changes of 30 degrees have already been used experimentally.

These considerations lead to the necessity for reducing the variations in $\frac{P}{D}$ and the most suitable method of doing this appears to be by using greater blade widths than are used at present.

The airscrew will be a compromise to meet greatly varying conditions, and in order to obtain efficiency at great heights it may be necessary to consider the use of a catapult for starting, or alternatively, a carrier-aeroplane of the Mayo type, in order to provide suitable take-off conditions.

The Flight Path

If the meteorological conditions that would be experienced at all heights over the proposed journey could be accurately forecast it would be possible to work out the most economical heights at which to fly, and also the most economical rates of climb and glide. These calculations would be based upon the known performance characteristics of the aircraft at all heights.

For a long flight, such as has been contemplated here it is improbable that anything beyond a general forecast of weather near the ground at the two ends of the journey will be available, and the flight path must be based upon general considerations.

If the passengers' cabin is to be open to the air up to 15,000 feet, then the rate of climb up to this height must be limited to about 200 feet per minute, occupying seventy-five minutes during which time the aircraft has travelled forward at a comparatively slow speed. This time is too long, and, therefore, the cabin should be sealed at ground level, and the aircraft can then be flown at greater rates of climb. It is probable that the best climbing speed for average conditions will be that at which the combination of propeller and aircraft gives the greatest rate of climb, thus allowing the aeroplane to reach its operating height in the shortest time. This applies particularly to bad weather conditions when it is obviously desirable to reach clear sky conditions as soon as possible.

It has been shown that the speed increases with height for constant horsepower, and, therefore, the theoretical economical height, other things being equal, would be that at which the supercharger equipment reached its maximum output. This statement must, however, be subject to the qualification that the actual economical height will also depend upon the characteristics of the supercharger-engine-propeller-specific fuel consumption combination, particularly when the engine is running at cruising speeds.

For short journeys this height may also be reduced, due to the loss of time in climbing.

A clean aeroplane fitted with a supercharger suitable for maintaining power to 40,000 feet will reach this height in such a short time that little is to be saved by reducing the height, and much can be gained from the increased speed at the greater heights.

When at its operating height the aeroplane could gradually descend with engines throttled in a long glide, but this is open to the objection that the aeroplane encounters the bad weather conditions which have been avoided by flying high. Therefore, it appears probable that the height should be maintained to a position from which the aeroplane can reach its destination with a given rate of descent. This rate of descent may be determined by the load factors employed in the design or by the question of allowable tilt.

Conclusion

At this stage one would be prepared to argue either for or against the possibility of realizing stratosphere flights within the next few years.

The various factors will be reviewed starting with those that appear to be unfavourable.

Unfavourable Factors

(*a*) Difficulties of supercharger design and chances of cabin supercharger failure.
(*b*) Difficulties of designing the cabin pressure and temperature regulators.
(*c*) Difficulties of designing the airscrews.
(*d*) Impossibility of making short flights.
(*e*) Difficulty of designing the pilot's cockpit to give adequate view.
(*f*) Decrease in pay load due to extra equipment to be carried.
(*g*) Increased cost of equipment and maintenance.
(*h*) Possibility of unfavourable winds when travelling towards the west.
(*i*) Uncertainty of attaining the speeds predicted due to breakdown in the air flow.

Favourable Factors

(*a*) Economy of fuel due to high speeds, and thus allowing for increased pay loads.
(*b*) Greater speeds obtainable for a given power.
(*c*) No ice, clouds or fog.
(*d*) Clear skies for navigation, day and night.
(*e*) No bumps.
(*f*) Possibility of favourable winds when travelling towards the east, with little evidence of any high winds.
(*g*) High speeds have already been realized near the ground, and, therefore, breakdown in air flow not probable within the speed range contemplated.
(*h*) Greater safety and comfort.

Maritime General Professional Meeting

of

The Engineering Institute of Canada

In Co-operation With

The Association of Professional Engineers of the Province of New Brunswick

SAINT JOHN, N.B.
AUGUST 27th to 29th, 1936

PROGRAMME

(Subject to Minor Change)

Headquarters: Admiral Beatty Hotel, Saint John, N.B.

THURSDAY, AUGUST 27th

2.00 p.m. **Registration.**

4.00 p.m. **Professional Session.**
Modern Highway Construction.
(Author to be announced later.)

7.30 p.m. **Dinner, Dance and Bridge**—Admiral Beatty Hotel, price $1.75 per person.
Moving pictures on Industrial Subjects.

FRIDAY, AUGUST 28th

10.00 a.m. **Professional Session.**
Reconstruction of Berths 1, 2, 3 and 4, Saint John Harbour Commission, V. S. Chesnut, A.M.E.I.C., Senior Engineer, Saint John Harbour Commission.

11.30 a.m. **Improvements in the Method of Heat Treating Steel Rails,** I. C. Mackie, Testing Engineer, Dominion Steel and Coal Corp. Ltd.

1.00 p.m. **Luncheon**—West Saint John.
Guests of the Foundation Company of Canada Limited.

2.30 p.m. **Inspection of Reconstruction of Berths 1, 2, 3 and 4, Saint John Harbour.**

4.30 p.m. **Boat Trip around Harbour.**

7.00 p.m. **Smoker.** Guests of the Saint John Branch.
Speaker, Hon. Michael Dwyer, A.M.E.I.C., Minister of Mines, Nova Scotia.

SATURDAY, AUGUST 29th

9.00 a.m. **Drive to Eastport, Maine.**

1.00 p.m. **Luncheon at Eastport,** Guests of the United States Army Corps of Engineers.

2.30 p.m. **Inspection of Passamaquoddy Project.**

5.00 p.m. **Return Drive to Saint John.**

Arrangements are being made to entertain visiting ladies while in Saint John.

Four golf courses are available for visiting members who desire to play.

Aerial View of Saint John, N.B.

Reversing Falls, Saint John, N.B.

THE
ENGINEERING JOURNAL
THE JOURNAL OF
THE ENGINEERING INSTITUTE
OF CANADA

VOLUME XIX JULY 1936 No. 7

The Scope of Chemical Engineering and the Chemical Engineering Congress

The growing complexity of modern life is characterized by the ever-increasing diversity of the material needs of the community and by the rise of many new kinds of industry engaged in satisfying those needs. This is well illustrated by the rapid growth of the chemical industries during the past twenty-five years, during which in the older chemical plants there has been extensive replacement of former methods by new processes which utilize recent scientific advances, while new plants are producing a host of entirely new materials. Huge organizations have been established to control these new activities and market their products.

The branch of engineering science which has made all this possible is outstanding because the characteristic feature of the work of the chemical engineer is its utilization of physical processes. Actually, the chemical engineer is more frequently concerned with physical operations and the physical effects of chemical reactions than with purely chemical considerations. Thus his technique employs catalytic reactions, biological processes, methods based on the diffusion of gases, and procedure which involves the use of extremely high and very low pressures and temperatures. He has to deal with baffling problems of separation, distillation and extraction, and is concerned in the synthesis and manufacture of a multitude of novel materials such as plastics, or acid- and corrosion-resisting alloys. The needs of the chemical engineers have therefore given rise to remarkable developments in other branches of engineering, particularly in the electrical and metallurgical fields. They have led, for example, to research on the embrittlement of steel, the behaviour of metals and alloys at high temperatures, the causes and prevention of corrosion, new and more efficient methods of heat-exchange, drying and separation, and great progress in electrolytic and electrothermal work.

In the words of Dr. Little "Chemical engineering . . . is not a composite of chemistry and mechanical and civil engineering, but itself a branch of engineering, the basis of which is those unit operations which in their proper sequence and co-ordination constitute a chemical process as conducted on the industrial scale."

In connection with the World Power Conference to be held this year in the United States there is taking place in London an international Chemical Engineering Congress. We may perhaps regard this event as a timely recognition, if any were needed, of the importance of that branch of engineering in the world's work. The programme of the Congress includes contributions from practically all European countries, as well as from North America and Japan. The official representative of The Engineering Institute of Canada at the Congress is Dr. L. F. Goodwin, M.E.I.C., and Canadian authors have contributed four papers, dealing respectively with new Canadian refractories, power for chemical industry, raw materials for chemical manufacture in Canada, and on recent advances in Canada in the realm of chemical engineering. In all some one hundred and twenty papers are being presented for discussion.

Those who are not familiar with the organization of important international congresses of this kind will be interested in an outline of the methods adopted for dealing with the multitude of papers submitted. Those selected for presentation are classified and are summarized in a series of general reports,* each prepared by an authority on the subject and dealing with one section, the report usually indicating the salient points in the various papers and the topics upon which discussion is suggested. In this case, for example, in the section dealing with ferrous metals in chemical plant construction, papers have been sent in from Great Britain, Holland and the United States, dealing with forgings for the handling of fluids at high temperatures and pressures; heat-, rust- and acid-resisting steels; the use of cast iron in the chemical industry, and the corrosion and protection of cast iron and steel pipe lines. In a similar way the section dealing with separation, either with or without change of phase or physical state, includes contributions from Great Britain (filtration); Holland (coal washing); Germany, Great Britain and Holland (absorption and adsorption); France (crystallization); Sweden, Great Britain, United States and Germany (distillation and rectification); Russia (the design of evaporators); and Poland (fractionation of heavy oils).

The work of the Congress is carried on under twelve main headings which comprise materials of construction, physical and chemical processes, treatment of waste materials, education and training, statistics and administration and the trend of development of the industry.

The whole series of Congress reports thus gives an impressive general survey of the achievements, present activities and future possibilities of the chemical industries in the leading countries of the world.

*To be obtained from C. H. Gray, International Secretary, Chemical Engineering Congress of the World Power Conference, 36 Kingsway, London, W.C.2.

Results of May Examinations of The Institute

The report of the Board of Examiners, presented at the meeting of Council held on June 12th, 1936, certified that the following candidates, having passed the examinations of The Institute, have satisfied the examiners as regards their educational qualifications for the class of membership named:—

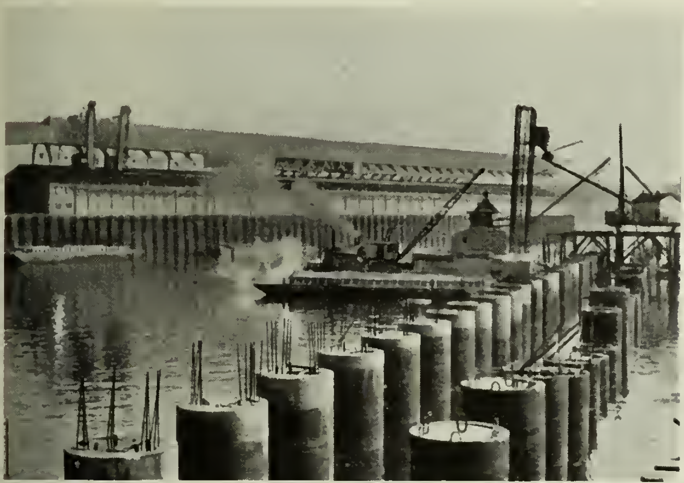
Schedule C—For Admission to Associate Membership.
Harry P. World, Toronto, Ont.

Schedule B—For Admission as Junior:
Ian A. Robertson, Toronto, Ont.

Maritime Professional Meeting 1936

Three years ago The Institute branches in the Maritime Provinces sponsored a very successful professional meeting at White Point Beach, Nova Scotia. At the end of August this year, Saint John will be the scene of a similar meeting at which the members of all of our Maritime branches will welcome the attendance of members from all other parts of Canada.

As will be seen from the announcement on another page, an interesting programme of social and technical events has been planned. Saint John is easily accessible by road, rail or water, and a visit to the shores of the Bay of Fundy at any time can be confidently prescribed as a restorative after exposure to hot summer weather elsewhere.



Floating Mixing Plant Filling Cylinders—Berth No. 4, Saint John Drydock.

The Third World Power Conference

The British National Committee of the World Power Conference will present twenty-three papers at the Third World Power Conference to be held in Washington between September 7th and 12th, 1936; in addition, six papers and one "communication" are being presented by the British Committee of the Commission at the Second Congress, International Commission on Large Dams of the World Power Conference, which is being held in Washington concurrently with the Third World Power Conference. The Conference and Congress are taking place by invitation of the Government of the United States.

There will be a large and influential British delegation at Washington, including several official representatives of His Majesty's Government. The total British participation is likely to exceed one hundred persons, the majority of whom will travel on the *Queen Mary*, sailing from Southampton on September 2nd.

Canadian participation in the Conference is being arranged through the Canadian Management Committee, of which the Secretary is Mr. Norman Marr, M.E.I.C.* from whom those interested can obtain the necessary information.

Ten official delegates have been named from Canada and a representative series of papers has been arranged for, dealing principally with the economic aspects of the power situation in this country.

Following the Conference in Washington, the United States Committee has arranged for the official delegates from the various participating countries to make a trans-continental tour by special train, visiting many important developments in the United States, including the Boulder Dam, Grand Coulee and the Tennessee Valley project.

On the invitation of the Canadian Committee, this trans-continental tour, which will take place immediately following the Conference in Washington, will be routed through Montreal, Ottawa, and Niagara Falls, Ontario, on September 15th, 16th and 17th respectively, thus giving the delegates two and a half days in Canada.

In Montreal, the delegates will have an opportunity of inspecting the power developments in the St. Maurice Valley, and will be entertained at dinner by the Government of the Province of Quebec. On the following day at Ottawa, the power plants on the Gatineau will be inspected, and there will be a formal dinner, at which it is expected that the Prime Minister will address the delegates. The special train will then proceed to Niagara Falls, Ontario, where on the 17th the party will be the guests of the Hydro-Electric Power Commission of Ontario, and in the afternoon the special train will re-enter the United States at Buffalo.

In addition to the trans-continental tour, the American Committee is arranging for a series of "study tours" on which points of interest from a power standpoint in the eastern United States and Canada will be visited, and on each of which one day at least will be set aside for technical discussions.

*Chief Hydraulic Engineer, Dominion Water Power and Hydrometric Bureau, Dept. of the Interior, Ottawa, Ont.

Unrecognized Fire and Explosion Hazards

It is a commonplace remark that a large proportion of the accidents whose reports dot the pages of our daily newspapers are due to carelessness and ignorance. Apart from the toll taken by the automobile, and the injuries to workers which occur in the course of industrial occupations, there happen every day in people's homes and in our cities a number of accidents of the "didn't know it was loaded" type, in which the victims employ wrongly or carelessly some one of the many industrial products which are now in use for all sorts of domestic and everyday purposes.

In the minds of many people, the engineers, who have complicated our daily lives by providing so many facilities for communication and transportation, and have revolutionized lighting, sanitation and power production, should take some responsibility for the resulting increased hazards to life and limb. As regards accidents resulting from the ignorance of the public in this matter, perhaps there is something in this contention. Possibly too little has been done to warn the public of the hazards to which they expose themselves when using inflammable fly-sprays or entering a room filled with poisonous gas from a leaky house furnace or an automobile engine. At all events, the publicity given to such occurrences does help to warn the average citizen, but it has very little effect on the type of man who realizes that he is doing something foolish but will persist in "taking a chance." In many cases such a person has not sufficient imagination to visualize the probable result of his action, and the only remedy that might do good would be a universal course of education in common sense, if such a thing were possible.

It is noteworthy that while industrial risks have been largely brought under control by legislative action, by well-thought out schemes of instruction in safety measures for industrial workers, and by other means of keeping the hazardous features of his employment in the worker's mind, little seems to have been done to educate the housewife or the man in the street to the necessity of avoiding the risks attached to the domestic or non-industrial use of many inflammable or poisonous materials employed in modern life. A very real service may therefore be rendered by the circulation of such articles as that on Fire and

Explosion Hazards printed elsewhere in this issue of The Journal, and to the reports of the investigations made by various public bodies as to the causes of such occurrences as sewer explosions and fires at places where petroleum products are stored or handled.

Mr. Donald does well to draw attention to the carelessness and ignorance displayed in the use of so many inflammable products, and the lack of adequate enforcement of such safety regulations as do exist. There is no doubt, for example, that the underground gasoline storage equipment in many existing filling stations has been so cheaply and unwisely installed as to be a continual source of grave risk, and that in many cases the arrangements for the storage of crude oil and gasoline in bulk within the city limits of our larger centres of population are open to severe criticism from a safety point of view, particularly as regards the possibility of a severe conflagration. Co-operation between the responsible representatives of the industry, the civic authorities, the underwriters and bodies like The Institute would appear to be the best means of awakening public opinion in this matter, and informing the general public as to the avoidance of domestic risks.

OBITUARIES

Robert Wentworth Macintyre

Regret is expressed in placing on record the death at Victoria, B.C., on May 30th, 1936, of Robert Wentworth Macintyre, for many years a member of The Institute.

Mr. Macintyre was born at London, England, on July 14th, 1867. In 1884 he entered his father's office, the firm of Edward Wilson and Company, London, and was employed on plans and specifications and on railway construction. In 1885-1886 Mr. Macintyre became a pupil under the district engineer at Slough on the Great Western Railway, and from that time until 1888 he was assistant to the surveyor to the local board at Edmonton, England. In that year he came to Canada, and was employed as a rodman on the Great Falls Railway. In 1890 Mr. Macintyre was in the assistant superintendent's office of the Galt Railway Company (Lethbridge to Dunsmore) and in 1890-91 he was assistant to A. O. Wheeler, D.L.S. From 1894 to 1896 he was chief assistant on Dominion Land Surveys in Alberta, and in 1897-1904 was on the staff of the Dominion Government irrigation surveys in the North West Territories. Mr. Macintyre was assistant chief engineer for the public works department in the North West Territories from 1904 until 1911, when they were divided into the provinces of Alberta and Saskatchewan, and he then held a similar position for the Alberta government. In 1911 he went to Victoria, and until 1913 was assistant engineer in the city sewer department. In 1913-1915 Mr. Macintyre was in private practice in Victoria, and then went as assistant to F. C. Gamble, chief engineer of railways for the British Columbia government on the construction of the Pacific Great Eastern Railway. From 1917 until 1922 he was assistant to A. F. Proctor, chief engineer of railways, who succeeded Mr. Gamble. From 1922 to 1924 Mr. Macintyre was engineer of railways for the province, and had charge of all engineering work, together with the inspection of Canadian National Railways terminal work and estimates. Later he returned to private practice, and from 1928 to 1930 was municipal engineer for the North Cowichan municipality.

Mr. Macintyre joined The Institute (then the Canadian Society of Civil Engineers) as an Associate Member on May 22nd, 1902, and became a Member on October 8th, 1908. His resignation was accepted by Council on March 22nd, 1921. During his years of membership Mr. Macintyre took a most active interest in Institute affairs, having been the first secretary of the Victoria Branch at its inception in 1912, holding that office for six consecutive years, and being elected chairman of the Branch in 1918. He was a member of Council in 1919-1920.

Farley Granger Clark, M.E.I.C.

It is with regret that we place on record the death at Toronto, Ontario, on May 31st, 1936, of Farley Granger Clark, M.E.I.C.

Mr. Clark was born at Palmer, Mass., on July 21st, 1871, and was educated at the Massachusetts Institute of Technology and Cornell University. From 1894 to 1897 he occupied various positions learning the practical end of electrical engineering, and from 1897 until 1903 he was with the Metropolitan Street Railway Company, New York. In 1903-1905 Mr. Clark was electrical engineer with Westinghouse, Church, Kerr and Company, New York, and in 1905-1910 he was superintendent of power with the Pennsylvania Railroad on the North and East River tunnel electrification. In 1911 Mr. Clark became superintendent of power with the Westinghouse Electric and Manufacturing Company, at Pittsburgh, being in charge of all power equipment of all the company's works. In 1912 he was chief engineer of the Toronto Railway Company, the Toronto Power Company, the Toronto Electric Light Company and the London Electric Company, being in charge of all engineering of these companies. Since that time Mr. Clark has practised in Toronto as a consulting engineer.

Mr. Clark joined The Institute as a Member on June 27th, 1916.

PERSONALS

R. C. Mold, Affil.E.I.C., formerly manager of H. C. Vogel Company (Canada) Limited, Montreal, is now connected with the Associated Factory Mutual Fire Insurance Companies, and is located in Boston, Mass.

Dr. L. F. Goodwin, M.E.I.C., Professor of Chemical Engineering at Queen's University, Kingston, Ontario, has been named one of the five official representatives from Canada to the Chemical Engineering Congress of the World Power Conference which is now taking place in London, England.

Dr. E. A. Cleveland, M.E.I.C., President of The Institute, has been appointed one of the ten official delegates from Canada to the Third World Power Conference which will be held in Washington, D.C., in September, 1936.

Dr. Cleveland also attended the First World Power Conference held in London on June 30th to July 12th, 1924, the Engineering Congress in Tokyo on October 29th to November 7th, 1929, and the Second World Power Conference in Berlin on June 16th to 25th, 1930.

W. S. Wilson, A.M.E.I.C., has been appointed chief engineer of the Dominion Steel and Coal Corporation Ltd., Sydney, N.S., succeeding the late Karl H. Marsh, M.E.I.C. Mr. Wilson has been connected with the Corporation in various capacities for twenty-five years, and until lately, held the position of chief engineer of the Steel Division. J. A. MacLeod, A.M.E.I.C., formerly chief draughtsman of the Company succeeds Mr. Wilson.

Herbert Cantwell, A.M.E.I.C., formerly Industrial Engineer with the Canadian Pacific Railway Company, Montreal, has announced the opening of his office in the Shaughnessy Building, Montreal, for the general practice of engineering evaluations, expropriations and engineering legal matters, specializing in the pulp, paper and textile trades. Mr. Cantwell has had considerable experience in the pulp and paper industry, having been connected with the Howard Smith Paper Mills Ltd. at Beauharnois, Que., the Cornell Wood Products Company at Cornell, Wis., and the Spanish River Pulp and Paper Mills Limited.

James Robertson, A.M.E.I.C.

James Robertson, A.M.E.I.C., is the present chairman of the Vancouver Branch of The Institute. Mr. Robertson served an articled pupilage of three years with Glenfield and Kennedy, Kilmarnock, and joined the staff of the Dominion Bridge Company in 1907. In 1914 he graduated from McGill University with the degree of B.Sc. in civil engineering, and in the same year he rejoined the staff of the Dominion Bridge Company as designing engineer in the Montreal office. In 1918 he was appointed erection engineer, and in 1929 Mr. Robertson became engineer of the company's Pacific Division being located in Vancouver.

J. Frank Roberts, A.M.E.I.C., formerly hydraulic engineer with the Power Corporation of Canada, Ltd., Montreal, is now connected with the Tennessee Valley Authority as senior mechanical engineer, and is located at Knoxville, Tenn. Mr. Roberts graduated from the University of Wisconsin in 1918 with the degree of B.S. and from 1919 until 1922 was testing engineer with the Allis Chalmers Manufacturing Company. In 1922 he became sales engineer with the hydraulic department of the same company, and in 1924-1926 he was sales engineer in charge of the company's Canadian work for the hydraulic department. In 1927 Mr. Roberts accepted the position from which he has now resigned.

J. C. Nutter, A.M.E.I.C., who has been connected with the Gair Company of Canada Limited, Montreal, has been transferred by the company to Toronto. He is production manager for the Dominion Box Board Division. Mr. Nutter graduated from McGill University in 1921 with the degree of B.Sc., and following graduation was for several years with the Groveton Paper Company Inc., Groveton, N.H. In 1927 he joined the staff of the Nashwaak Pulp and Paper Company, Saint John, N.B. In 1931 Mr. Nutter became connected with Price Brothers and Company Limited, Quebec, and in 1932 he went to Toronto where he was with the Canadian Paperboard Company.

A. I. Cunningham, A.M.E.I.C., who was formerly with the Aluminum Company of Canada at Arvida, Que., has been appointed managing engineer of the Ontario Paper Company Limited at Baie Comeau, Que. Mr. Cunningham graduated from McGill University in 1914 with the degree of B.Sc., and following graduation was employed for a time with the Bathurst Lumber Company and with the Grand Trunk Railway. From 1915 to 1919 Mr. Cunningham was in the Canadian Siege Artillery with the rank of captain, and following the war he was until 1922 field engineer for the St. Maurice Lumber Company at Three Rivers, later joining the staff of the Parklap Construction Corporation as field engineer on the Sherman Island hydro-electric development at Glen Falls, N.Y. In 1923-1924 he was attached to the Moreau Manufacturing Corporation at Glen Falls, N.Y. From 1924 to 1927 Mr. Cunningham was in charge of the construction of an extension to the St. Maurice Lumber Company's paper mill at Three Rivers, and in 1927 was resident engineer for the Canadian International Paper Company at Gatineau, Que. In 1928 he became resident engineer for the New Brunswick International Paper Company at Dalhousie, N.B., and in 1930 he was appointed vice-president and general manager of Merritt-Chapman and Scott Limited, general contractors, Montreal.

Major F. L. C. Bond, M.E.I.C., has been appointed general manager, central region of the Canadian National Railways, and will be located in Toronto, Ontario. Following graduation from McGill University in 1898, with the degree of B.Sc., Major Bond entered the service of the Grand Trunk Railway System as assistant to the resident engineer, eastern division. In 1901 he was appointed engineer in charge of double track construction and from January to March 1902 was night superintendent on the construction of the Park Avenue tunnel of the New York subway system, returning to the Grand Trunk in April of that year. He was then appointed resident engineer, eastern division, and remained in that position until 1913 when he became division engineer of eastern lines. In 1916-1918 Major Bond was overseas as company commander with the 10th Battalion, Canadian Railway Troops, and was the recipient of the D.S.O. Returning to Canada after demobilization he was appointed chief engineer of the Grand Trunk Railway System and following amalgamation of the lines comprising the Canadian National Railways he was appointed regional chief engineer, central region, with headquarters at Toronto. Major Bond held this position until 1924 when he became general superintendent, Montreal district, which position he now relinquishes.

C. E. Webb, M.E.I.C.

C. E. Webb, M.E.I.C., is the district chief engineer for British Columbia of the Dominion Water Power and Hydrometric Bureau, Department of the Interior. Mr. Webb graduated from the University of Toronto in 1910 with the degree of B.A.Sc., and since 1913 has been in the service of the Department; from 1913 to 1918 as assistant engineer to the assistant chief engineer, from 1918 to 1925 as assistant chief engineer, and since 1925 in his present capacity. In 1934 Mr. Webb was the recipient of the degree of Civil Engineer from the University of Toronto. He is a member of the Council of the Association of Professional Engineers of the Province of British Columbia.

Recent Graduates in Engineering

Congratulations are in order to the following Associate Member, Juniors and Students of The Institute who have recently completed their course at the various universities:—

Nova Scotia Technical College

Degree of Bachelor of Science

Harrington, Arthur Russell, B.Sc. (El.), Halifax, N.S.

University of New Brunswick

Degree of Bachelor of Science

Eldridge, John Bryson, B.Sc. (El.), Saint John, N.B.
Nason, Edward McKinney, B.Sc. (Ci.), Welsford, N.B.
Sadler, Robert Francis, B.Sc. (Ci.), Chatham, N.B.
Somers, Claude Judson, B.Sc. (Ci.), Moncton, N.B.
Wallis, William Herbert Cyril, B.Sc. (Ci.), Montreal, Que.

McGill University

Honours, Medals and Prizes

Armstrong, John Lloyd, Outremont, Que.—B.Eng. (El.); Honours in Electrical Engineering; Montreal Light, Heat and Power Consolidated Second Prize.
Esdaile, Hector Milton, Montreal, Que.—B.Eng. (Mech.); Honours in Mechanical Engineering.
McCrady, Donald Carmen, Montreal, Que.—B.Eng. (El.); The Jenkins Brothers Limited Scholarship (Nov. 1935); The Engineering Institute of Canada Prize (May 1935).
McGregor, Leslie Stewart, Montreal, Que.—B.Eng. (Mech.); British Association Medal; Honours in Mechanical Engineering.
Royer, Jacques Auguste, Montreal, Que.—B.Eng. (Met.); Honours in Metallurgical Engineering; Milton Hersey Prize for Summer Essay; Undergraduate Society's First Prize for Summer Essay; Canadian Institute of Mining and Metallurgy Prize for Summer Essay.
Skaperdas, George Theodore, Outremont, Que.—B.Eng. (Chem.); Honours in Chemical Engineering.
Smyth, William Christopher, Montreal, Que.—B.Eng. (Ci.); The Robert Forsyth Prize in Theory of Structures and Strength of Materials.
Sproule, William Kelvin, Westmount, Que.—B.Eng. (Met.); British Association Medal; Honours in Metallurgical Engineering; Sir William Dawson Fellowship in Metallurgical Engineering; American Society for Metals Prize for Metallography and Thesis.

Degree of Master of Engineering

Lupton, Mac Joseph, B.Sc. (Univ. of Manitoba '34); M.Eng. (Ci.), Winnipeg, Man.
Pidoux, John Leslie, B.Sc. (Univ. of Alberta '34); M.Eng. (Ci.), Birmingham, England.
Poole, Gordon Dean, B.Eng. (McGill Univ. '32); M.Eng. (Ci.), Montreal West, Que.
Schippel, Walter Herbert, B.Sc. (McGill Univ. '20); M.Eng. (El.), Montreal, Que.

Degree of Master of Science

Smith, Philip Durnford Pemberton, B.Sc. (McGill Univ. '34), M.Sc. (Physics), Westmount, Que.

Degree of Bachelor of Engineering

Archibald, Frank Rorke, B.Eng. (Mech.), Harbour Grace, Newfoundland.
Baggs, William Clyde, B.Eng. (Mech.), Curling, Newfoundland.
Barry, Donald John Oswald, B.Eng. (El.), Montreal, Que.
Bedoukian, Zareh Paul, B.Eng. (Chem.), Montreal, Que.
Béique, Henri Frechette, B.Eng. (El.), Montreal, Que.
Booth, Keith Alexander, B.Eng. (Mech.), Winnipeg, Man.
Bradley, Alan Edward, B.Eng. (Mech.), Winnipeg, Man.
Chapman, Stuart MacDonald, B.Eng. (Chem.), Montreal, Que.
Charters, Stewart Anderson, B.Eng. (Ci.), Westmount, Que.
Coppick, Sydney, B.Eng. (Chem.), Montreal, Que.
Crawford, Kenneth Stewart, B.Eng. (Chem.), Lennoxville, Que.
Dale, James Munroe, B.Eng. (Mech.), Winnipeg, Man.
Gildea, William Frederick Peter, B.Eng. (Mech.), Brownville Jct., Maine, U.S.A.
LaRivière, Marcel Gerard, B.Eng. (Ci.), Westmount, Que.
Lefort, Jean, B.Eng. (Ci.), Montreal, Que.
Loomis, James Gordon Mann, B.Eng. (Mech.), Montreal, Que.
Macfarlane, Robert Murray, B.Eng. (Mech.), Westmount, Que.
Miller, Errol Leslie, B.Eng. (Ci.), Montreal, Que.
Murphy, Daniel Francis, B.Eng. (Ci.), Montreal, Que.
Ross, Henry Urquhart, B.Eng. (Met.), Sault Ste. Marie, Ont.
Shaw, Keith Walker, B.Eng. (Chem.), Westmount, Que.
Suthren, Joseph William, B.Eng. (Mech.), Welland, Ont.

Degree of Bachelor of Commerce

Garvock, Alexander Graham, B.Comm., Ottawa, Ont.

Ecole Polytechnique

Honours, Medals and Prizes

Beaulieu, Gerard, Montreal, Que.—B.A.Sc. (Ci.); Honours in Civil Engineering.
Bricault, Fernand, Montreal, Que.—B.A.Sc. (Ci.); Honours in Civil Engineering.
Branchaud, Henri, Montreal, Que.—B.A.Sc. (Ci.); Honours in Civil Engineering.
Brossard, Leo, Brosseau Station, Que.—B.A.Sc. (Ci.); Honours in Civil Engineering; Silver Medal of the Lieutenant-Governor of the Province of Quebec; Silver Medal of the Association of the Alumni.
Cousineau, Ls. Philippe, Montreal, Que.—B.A.Sc. (Ci.); Honours in Civil Engineering; Gold Medal of the Association of the Alumni; Ecole Polytechnique 1926 Graduates' Prize.
Hebert, Camille, Montreal, Que.—B.A.Sc. (Ci.); Honours in Civil Engineering.
Lemieux, Denis, Quebec, Que.—B.A.Sc. (Ci.); Ernest Cormier Architectural Prize; Honours in Civil Engineering.
Lemieux, Gilbert, Quebec, Que.—B.A.Sc. (Ci.); Honours in Civil Engineering.
Trudel, Louis, Montreal, Que.—B.A.Sc. (Ci.); Bronze Medal of the Association of the Alumni.

Degree of Bachelor of Applied Science

Cadrin, Paul Emile, B.A.Sc. (Ci.), St. Anselme, Que.
Dumont, Georges Heliodore, B.A.Sc. (Ci.), Amos, Que.
Laflamme, Marcel, B.A.Sc. (Ci.), Montreal, Que.
L'Heureux, Paul Emile, B.A.Sc. (Ci.), Montreal, Que.
Nadeau, Leopold, B.A.Sc. (Ci.), Montreal, Que.
St. Jacques, Gustave, B.A.Sc. (Ci.), Montreal, Que.

Queen's University

Honours, Medals and Prizes

Carmichael, James Irving, Fort William, Ont.—B.Sc. (Mech.); Honours in Mechanical Engineering.
Erickson, Martin Adolph, Scandia, Alta.—B.Sc. (Mech.); The Governor-General's Medal; Departmental Medal in Mechanical Engineering; Honours in Mechanical Engineering.
Howe, Harold Bertram, West Shefford, Que.—B.Sc. (Mech.); L. M. Arkley Prize; Honours in Mechanical Engineering.
Hunter, Lawrence McLean, Ottawa, Ont.—B.Sc. (Ci.); Honours in Civil Engineering; Departmental Medal in Civil Engineering.
Kerfoot, John Grenville, Prescott, Ont.—B.Sc. (Mech.); Honours in Mechanical Engineering.
Law, Earl Fredrick, Sarnia, Ont.—B.Sc. (Mech.); Honours in Mechanical Engineering.
Lawson, Horace Hetherington, Kingston, Ont.—B.Sc. (Ci.); Honours in Civil Engineering.
Mayhew, Earle Chandler, Moose Jaw, Sask.—B.Sc. (Mech.); Honours in Mechanical Engineering.

Degree of Bachelor of Science

Biesenthal, Clarence Gordon, B.Sc. (Mech.), Pembroke, Ont.
Billings, George Michael, B.Sc. (El.), Victoria, B.C.
Bruce, Rodney, B.Sc. (Mech.), Brooklyn, P.E.I.
King, Burton Wensley, B.Sc. (Ci.), Westmount, Que.
McDonald, Alexander John, B.Sc. (El.), Kingston, Ont.
McMillan, Colin Brock, B.Sc. (Ci.), Ottawa, Ont.
Taylor, James Lawrence, B.Sc. (El.), Barriefield, Ont.
Thoman, Russell Kenneth, B.Sc. (Mech.), Hamilton, Ont.
Warnick, William Maurice, B.Sc. (Mech.); Hamilton, Ont.
Wilkins, Ronald Edward, B.Sc. (Ci.), Penticton, B.C.

University of Toronto

Degree of Bachelor of Applied Science (with Honours)

Dembitzky, Thomas Morris, B.A.Sc. (Ci.), Toronto, Ont.
Welsh, James Gordon, B.A.Sc. (Ci.), Niagara Falls, Ont.

Degree of Bachelor of Applied Science

Lawrason, William Murray, B.A.Sc. (Mech.), Toronto, Ont.
Davidson, George Ross, B.A.Sc. (Chem.), London, Ont.
Pepall, James Edward, B.A.Sc. (Chem.), Toronto, Ont.
Rothman, Saul Morris, B.A.Sc. (Chem.), Toronto, Ont.

University of Manitoba

Degree of Bachelor of Science

Davidson, Arthur Campbell, B.Sc. (El.), Calgary, Alta.
Mathieson, John Richard, B.Sc. (Ci.), Winnipeg, Man.
Osborn, John Follett, B.Sc. (El.), Swan River, Man.

University of British Columbia

Degree of Bachelor of Applied Science

Buckland, Alfred C., B.A.Sc. (Forest Engrg.), New Westminster, B.C.
Harvie, Ralph A., B.A.Sc. (El.), Vancouver, B.C.

University of Alberta

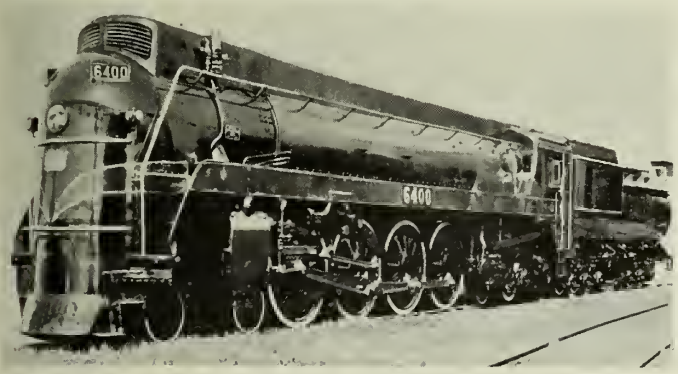
Awards

Corbett, Bruce Sherwood, Edmonton, Alta.—B.Sc. (Ci.); Professional Engineers award in Civil Engineering.

Hastie, Frank J., Edmonton, Alta.—B.Sc. (El.); Professional Engineers award in Electrical Engineering.

Degree of Bachelor of Science

Bergman, Wesley H., B.Sc. (El.), St. Albert, Alta.
Brews, Robert William, B.Sc. (El.), Calgary, Alta.
Grout, Raymond E., B.Sc. (El.), Edmonton, Alta.
Harding, Charles Malcolm, B.Sc. (El.), Calgary, Alta.
Hawkey, Bertram Jackson, B.Sc. (El.), Fernie, B.C.
Hewitt, Herbert Eugene, B.Sc. (Ci.), Blairmore, Alta.
McMath, Jack, B.Sc. (El.), Ranfurly, Alta.
Park, Fillmore R., B.Sc. (El.), Carseland, Alta.
Reikie, W. Thorpe T., B.Sc. (El.), Edmonton, Alta.



C.N.R. Locomotive 6400 Class

Locomotive 6400 is the first of five partially stream-lined engines constructed for fast passenger service for the National System, and built at the Montreal Locomotive Works.

Stream-lining extends from the nose of the locomotive above the running board to the engine cab, covering all pipes and domes which were formerly exposed. A stream of air drawn through a louvre at the top of the engine front lifts the smoke in the air as it emerges from the smokestack. This gives the engine crew clear vision and carries the smoke clear of the train.

Dimensions and Weights—4-8-4 type locomotives, Class U-4- a, Nos. 6400-6404

Cylinder	24 inches by 30 inches
Driving wheels—diameter	77 inches
Boiler—inside diameter—first course	78 inches
Boiler—outside diameter—largest course	86 inches
Working pressure	275 pounds
Firebox	126¼ inches by 84$\frac{3}{16}$ inches
Tubes—length	21 feet 10 inches
Combustion chamber—length	49 inches
Overall length	94 feet 7¾ inches
Wheel-base driving	20 feet
Wheel-base engine	44 feet 1½ inches
Weight in working order—total engine and tender	664,000 pounds
Grate area—square feet	73.7
Maximum tractive power	52,000 pounds
Capacity of tender—water	11,700 Imp. gals.
Capacity of tender—coal	20 tons

Elections and Transfers

At the meeting of Council held on June 12th, 1936, the following elections and transfers were effected:—

Members

DAVIDSON, Cecil Alexander, (Royal Tech. Coll., Glasgow), highways commissioner and director of town planning, Province of Alberta, Edmonton, Alta.

LETSON, Harry Farnham Germaine, Lt.-Col., B.Sc., (Univ. of B.C.), Ph.D. (Engrg.), (Univ. of London), chief engineer and managing director, Letson & Burpee, Vancouver, B.C.

Associate Members

DAVIS, George Clark, B.Sc., (Univ. of Man.), sales engr., Northern Public Service Corpn. Ltd., Winnipeg, Man.

DEBNEY, Philip Lawrence, Major, M.M., constrn. engr., City of Edmonton, Edmonton, Alta.

GENET, John Ernest, Major, M.C., R.C.S., supt., N.W. Territories and Yukon Radio System, West Edmonton, Alta.

HEROLD, William Henry, B.A.Sc., (Univ. of Toronto), head of dept. of mech'l. drawing, Vocational School, St. Thomas, Ont.

JAMES, William Albert, B.Sc., (McGill Univ.), gen. engrg. office, Imperial Tobacco Co. of Canada Ltd., Montreal, Que.

LONGWORTHY, Ward Odell, B.A.Sc., (Univ. of Toronto), asst. to chief engr., Imperial Oil Limited, Regina, Sask.

MacKINNON, Charles Eric, B.A.Sc., (Univ. of Toronto), mech'l. engr., Cranbrook, B.C.

MALONE, William Harcourt, B.Sc., (McGill Univ.), Kenogami, Que.

MICKELSON, Andrew Julius, B.Sc., C.E., (Tri-State Coll. of Engrg.), engrg. staff, C. D. Howe & Co. Ltd., Port Arthur, Ont.

OLSSON, Harold Matias, (Grad., Tecknikum Strelitz), designing engr., C. D. Howe & Co. Ltd., Port Arthur, Ont.

PHELPS, George Dyson, (Univ. of Toronto), field engr., Royalite Oil Co. Ltd., Turner Valley, Alta.

PHIPPS, Henry Robert, Major, M.C., divn. engr., Dept. of Northern Development, Mobert, Ont.

TELEMAQUE, Lionel Jean Baptiste Marie, B.A.Sc., C.E., (Ecole Polytechnique, Montreal), professor of engrg., School of Applied Science, Port-au-Prince, Haiti.

TROREY, Lyle Graeme, B.Sc. (Engrg.), (Univ. of London), foreman-in-charge, Dept. of National Defence, Camp 345, Yale, B.C.

*WORLD, Harry P., (Toronto Tech. School), res. engr. for Col. Mackenzie Waters, Toronto, Ont.

Juniors

DeSTEFANO, Frank Joseph, B.Sc., (Mich. Coll. of Mining and Technology), asst. field engr., International Nickel Company, Copper Cliff, Ont.

DUNCAN, Conrad Munro, B.Sc., (Univ. of Man.), 30 Lipton St., Winnipeg, Man.

KNIGHT, Clarence Archibald, B.Sc., (N.S. Tech. Coll.), engrg. staff, dept. of public utilities, Highways Dept., St. John's, Nfld.

LUNDIE, James, B.Sc., (Univ. of Sask.), transitman, C.P.R., Moose Jaw, Sask.

MATHESON, Murray Alexander, B.E., (Univ. of Sask.), engr., mtce. and constrn., Imperial Oil Limited, Regina, Sask.

RICHARDSON, Edward William, B.A.Sc., (Univ. of B.C.), engr., Wells Townsite Co., Wells, B.C.

*ROBERTSON, Ian Ansley, (Central Tech. School, Toronto), dftsman., Canadian National Telegraphs, Toronto, Ont.

RUGGLES, Edgar Lenfest, B.Sc., (Univ. of Sask.), 2032 Athol St., Regina, Sask.

Treat-Dudley Dam, Passamaquoddy Tidal Power Project, to be inspected during Maritime Meeting.

Affiliates

BALDRY, George Ephriam, (Wesley Coll., Winnipeg), engr., Baldry Engineering Company, Winnipeg, Man.

CHURCH, Charles Edward, (Dublin Tech. School), Patent Solicitor, 21 Main St. East, Hamilton, Ont.

HALLIDAY, John Currie, master mechanic, Beaver Wood Fibre Co. Ltd., Thorold, Ont.

HURST, Albert Douglas, gen. foreman, National Sanitarium Association, Gravenhurst, Ont.

SISSON, Heber Percival, inspr. of roads and bridges, Dept. of Northern Development, Port Arthur, Ont.

Transferred from the class of Associate Member to that of Member

BATES, Charles Lynn, B.Sc., (Mass. Inst. Tech.), mtce. of way engr., Pacific Great Eastern Rly., Squamish, B.C.

CHAPPELL, Frank, C.E., (Univ. College, So. Wales), public relations manager, General Motors of Canada Ltd., Oshawa, Ont.

FLEMING, David Howard, B.A.Sc., (Univ. of Toronto), consltg. engr., 125 Ranleigh Ave., Toronto 12, Ont.

FRASER, John Philip, B.E.E., (Univ. of Man.), gen. supt., Manitoba Power Commission, Winnipeg, Man.

MacQUARRIE, Edison Malcolm, B.A.Sc., (Univ. of Toronto), O.L.S., private practice, 620 Queen St. East, Sault Ste Marie, Ont.

Transferred from the class of Junior to that of Associate Member

HENDERSON, Ian Gordon, B.Sc., (McGill Univ.), Williamstown, Ont.

HUNT, Albert Brewer, B.A.Sc., (Univ. of Toronto), special products mfg. supt., Northern Electric Co. Ltd., Montreal, Que.

PATTERSON, Elmer Goodwin, B.Sc., (Queen's Univ.), engr., special products mfg. dept., Northern Electric Co. Ltd., Montreal, Que.

REEKIE, William George, B.Sc., (Univ. of Man.), mech. engr., Comeau Bay development, Ontario Paper Co. Ltd., Thorold, Ont.

SHELTON, James Frederick, (Liverpool Univ.), dftsman., Welland Ship Canal, St. Catharines, Ont.

SIMON, Robert Carleton, B.Sc., (McGill Univ.), inspr. of refinery equipment, Imperial Oil Limited, Montreal East, Que.

THICKE, James Ernest, B.Sc., (Queen's Univ.), elec. engr., Aluminum Company of Canada Ltd., Montreal, Que.

THOMSON, William John, B.Sc., (Queen's Univ.), chemist, Abrasive Co. of Canada Ltd., Hamilton, Ont.

WALLACE, Reginald Henderson, B.Sc., (McGill Univ.), plant engr., Canada Starch Co. Ltd., Cardinal, Ont.

Transferred from the class of Student to that of Associate Member

ABBOTT, Harold Felch, B.Sc., (McGill Univ.), relay and meter supervn., Beauharnois Light, Heat & Power Co., Beauharnois, Que.

AGNEW, T. Charles, B.Sc., (Queen's Univ.), engr., Minneapolis Honeywell Regulator Company, Toronto, Ont.

CONN, Hugh Gordon, B.Sc., (Queen's Univ.), plant engr., Proctor & Gamble Co., Hamilton, Ont.

GILLETT, George Herbert, B.Sc., (McGill Univ.), sales engr., Canadian General Electric Co. Ltd., Montreal, Que.

HOLMES, John Rodolph, B.Sc., (McGill Univ.), sales engr., The Robbins & Myers Co. of Canada Ltd., Montreal, Que.

RENOUF, Edward T., B.Sc., (McGill Univ.), production manager and editor of technical and scientific books, Renouf Publishing Co. Ltd., Montreal, Que.

SHEARER, John Leabourne, B.Sc., (Queen's Univ.), 475 King Edward Ave., Ottawa, Ont.

SOZANSKY, John, B.Sc., (McGill Univ.), plant engr., Coca-Cola Co. of Canada Ltd., Montreal, Que.

THOMSON, Elihu, B.Sc., (McGill Univ.), order analyst and asst. production engr., special products dept., Northern Electric Co. Ltd., Montreal, Que.

TIBBITTS, Angus Gordon, B.Sc., (N.S. Tech. Coll.), asst. chief engr., Acadia Sugar Refining Co. Ltd., Dartmouth, N.S.

VOGIN, Maurice Alfred, B.Eng., (McGill Univ.), engr., Dept. of Public Works of Canada, Montreal, Que.

WOODS, Francis Cedric, B.Sc., (Univ. of N.B.), engr.'s dept., City of Westmount, Que.

Transferred from the class of Student to that of Junior

BERGER, Bernard A., B.Sc., (McGill Univ.), designing dftsman., Ford Motor Co. of Canada Ltd., Windsor, Ont.

HAWKINS, James Edward, B.Sc., (Univ. of Alta.), instructor of electricity, Lethbridge Collegiate, Lethbridge, Alta.

McLEAN, Gordon Mitchell, B.Sc., (N.S. Tech. Coll.), mechanic, Perron Gold Mines, Pascalis, Que.

McLEOD, Wilson Churchill, B.Sc. (Elec.), B.Sc. (Mech.), (N.S. Tech. Coll.), steel heater, Lamaque Gold Mines, Bourlamaque, Que.

ODDLEIFSON, Axel Leonard, B.Sc., (Univ. of Man.), Winnipeg Electric Company, Winnipeg, Man.

POWELL, John Giles, B.A.Sc., (Univ. of Toronto), engr., Gore, Nasmith & Storrie, Toronto, Ont.

SCOTT, Lloyd George, B.Sc., (Univ. of Man.), asst. to supt. of bldgs., Hudson's Bay Company, Winnipeg, Man.

THOM, James Edwin, B.A.Sc., (Univ. of Toronto), mech. engr., Imperial Oil Limited, Regina, Sask.

THORN, Richard, asst. meter engr., Imperial Oil Limited, Dartmouth, N.S.

TIMM, Charles Ritchie, B.Sc., (McGill Univ.), estimator, Bepco (Canada) Limited, 1050 Mountain St., Montreal, Que.

WARNOCK, Robert Nicholson, B.Sc., (McGill Univ.), vice-president and treasurer, Charles Warnock & Co. Ltd., McGill Bldg., Montreal, Que.

WATIER, Arthur Hubert, B.Eng., (McGill Univ.), control operator, Shawinigan Water & Power Company, Rapide Blanc, Que.

Students Admitted

ARCHIBALD, Frank, B.Eng., (McGill Univ.), 1446 Mountain St., Montreal, Que.

ARMSTRONG, John Lloyd, B.Eng., (McGill Univ.), 74 Courcelette St., Montreal, Que.

BARRY, Donald John Oswald, B.Eng., (McGill Univ.), 1545 Mackay St., Montreal, Que.

BEDOUKIAN, Paul Zareh, B.Eng., (McGill Univ.), 977 Aqueduct St., Montreal, Que.

BOOTH, Keith Alexander, B.Eng., (McGill Univ.), 8 St. Elmo Apts., Colony St., Winnipeg, Man.

BROWN, Gordon James, (Montreal Technical Institute), 2253 Oxford Ave., Montreal, Que.

CHAPMAN, Stuart M., B.Eng., (McGill Univ.), 1271 Dorchester St. West, Montreal, Que.

COPPICK, Sydney, B.Eng., (McGill Univ.), 3546 Durocher St., Montreal, Que.

CRAWFORD, Kenneth Stewart, B.Eng., (McGill Univ.), Lennoxville, Que.

ELDRIDGE, John Bryson, B.Sc., (Univ. of N.B.), 109 St. James St., Saint John, N.B.

HUNT, William Sinclair, B.Sc., (Acadia Univ.), (McGill Univ.), Riverside Apts., Charlottetown, P.E.I.

LOOMIS, James Gordon Mann, B.Eng., (McGill Univ.), 1694 Lincoln Ave., Montreal, Que.

MACFARLANE, Robert Murray, B.Eng., (McGill Univ.), 1610 Pine Ave., Montreal, Que.

McMILLAN, Colin Brock, B.Sc., (Queen's Univ.), 415 Besserer St., Ottawa, Ont.

MOSS, Brian Victor, (Univ. of Man.), Deer Park, B.C.

MURPHY, Daniel Francis, B.Eng., (McGill Univ.), 6805 Chabot St., Montreal, Que.

OSBORN, John Follett, B.Sc., (Univ. of Man.), Swan River, Man.

ROSS, Henry Urquhart, B.Eng., (McGill Univ.), Port Colborne, Ont.

SHAW, Keith Walker, B.Eng., (McGill Univ.), 448 Lansdowne Ave., Westmount, Que.

SKAPERDAS, George T., B.Eng., (McGill Univ.), 540 St. Catherine Road, Outremont, Que.

SMITH, Philip Durnford Pemberton, B.Sc., M.Sc., (McGill Univ.), 42 Windsor Avenue, Westmount, Que.

SUTHREN, Joseph W., B.Eng., (McGill Univ.), Canadian Industries Ltd., Brownsburg, Que.

WALLIS, William Herbert Cyril, B.Sc., (Univ. of Man.), 3447 Drummond St., Montreal, Que.

---

*Has passed Institute's examinations.

Travelling Libraries

The attention of the membership of The Institute in the province of Quebec is drawn to the McGill University Travelling Libraries which are sent not only to graduates of McGill University, but to any group of people in the province without library service. There are over fifteen thousand volumes in the Department covering a wide range of subjects, and a catalogue will be sent on request from which subscribers may select their own books. Each library consists of forty books, the fee for which is $4.00, and the books may be kept for four months. Enquiries should be addressed to Miss E. G. Hall, librarian, Travelling Library Department, McGill University, Montreal.

The Dominion Bureau of Statistics have recently issued a Report on the Construction Industry for 1934. This is the first of its kind published by the Bureau since 1920.

Copies are available, and may be obtained from the Bureau upon application. No charge will be made to firms, individuals, etc., whose name appears in the Bureau's files, and from whom a construction report was obtained. To others, a nominal charge of ten cents will be made.

RECENT ADDITIONS TO THE LIBRARY

Reports, etc.

Canadian Electrical Association: Advance reports for the 46th annual convention.
United States Dept. of Commerce, Aeronautics Branch: Aeronautics Bulletin No. 2, Airport Design and Construction.
Lethbridge Northern Irrigation District: 15th Annual Report, 1935.
Canada, Dept. of Mines, Mines Branch: Natural Bonded Moulding Sands of Canada.
Ontario, Dept. of Mines: Mineral Production of Ontario, first 3 months 1936
Canada, Dept. of Mines, Explosives Division: Annual Report, 1935.
Quebec, Bureau of Mines: Annual Report 1934, Part B.
Alberta, Dept. of Lands and Mines: Annual Report for the year ended March 31st, 1935.
Dominion Bureau of Statistics: Report on the Construction Industry in Canada, 1934.
Harbour Commissioners of the City of Montreal: Annual Report 1935.
Society of Naval Architects and Marine Engineers: Year Book 1936.
Port of Vancouver, B.C.: Annual Report for 1935.
Kenya and Uganda Railways and Harbours: Report of the General Manager on the Administration of Railways and Harbours, 1935.

Technical Books, etc.

Aviation and the Aerodrome, by H. A. Lewis-Dale. (*J. B. Lippincott Company, Philadelphia.*)
The Engineering Index, 1935.
Design of Reinforced Concrete Structures, Dean Peabody Jr. (*John Wiley and Sons, New York.*) (*Renouf Publishing Co., Montreal.*)
Code of Preferred Practice for Graphic Presentation and Time Series Charts. (*American Society of Mechanical Engineers, New York.*)
Guide, 1935. (*American Society of Heating and Ventilating Engineers.*)
Presented by G. Lorne Wiggs, A.M.E.I.C., on behalf of the Society.

BOOK REVIEW

Oil Heating Handbook

By Han A. Kunitz. J. B. Lippincott Company, Philadelphia. 1936. 5 by 7¾ inches. 456 pages. Leather. $3.50.

Reviewed by Viggo Jepson, Jr.E.I.C.*

Although oil has been used as fuel since the beginning of the century, very little, if any, was consumed in the domestic field until about twenty years ago. Since that time the manufacture of oil-heating furnaces has developed into a large industry. At first the manufacturers devoted most of their efforts to making the machines safe and fool-proof, and only during recent years has any real consideration been given to the development of better methods of installation and greater economy of operation.

For engineers in charge of oil-burner installation and service, this book should be very valuable. Up to the present time very little literature has been available other than that published by oil-burner manufacturers. The author has spared no effort in producing a book that deals with both theoretical and practical questions of oil heating and has presented the matter in such form that most of it can be digested even by the man with limited technical training.

The book is divided into six parts of which Part I is an introduction and a classification of the various types of burners and methods used.

Part II gives an excellent treatment of the subject of combustion. The author has gone to some length in explaining both the technical and chemical aspects of this reaction. It contains several original tables and graphic charts which will simplify efficiency calculations and will serve as a check on other formulae used in order to get the proper information out of the various tests that such installations are or should be subject to.

Of the chapters under Part II, the reviewer finds the sixth and tenth, relating to heat, radiation and heating, and dealing mostly with heat absorbing qualities of boilers, most interesting and instructive.

Part III deals with the various systems of heating such as steam, vapour, hot water and warm air, also special systems such as have been introduced by certain manufacturers. A chapter has been devoted to electrical controls for oil burners.

Part IV contains notes on how to install and service burners, how to control and prevent noise and a noteworthy chapter on combustion space and flue passages.

Part V deals with retail selling.

Part VI contains some general tables and a terminology.

The usefulness of the book would have been increased if the author had devoted more space to the conservation of the various types of oil-burners now on the market and had dealt in some detail with the problems arising when the heavier oils are burnt.

The author is to be congratulated on this work, and it is hoped that engineers and others engaged in this field will make use of some of the many excellent ideas presented here.

*Town of Mount Royal, Que.

BULLETINS

Diesel Engines—A 4-page pamphlet received from the Dominion Engineering Company, Montreal, contains particulars of Dominion-Crossley vertical four-stroke Diesel engines. These are made with horse powers ranging in the vertical type from 6 to 600 b.h.p. and in the horizontal type from 600 to 3,000 b.h.p.

Asphalt—The Asphalt Institute, New York, N.Y., has issued a 24-page booklet which contains the historical background of asphalt and its applications in modern industry.

Fire Extinguishing Equipment—A 36-page booklet issued by the Garrison Engineering Corporation, Great Barrington, Mass., outlines the more important causes of fires, and describes the corporation's dry method for extinguishing, its portable extinguishers and motor apparatus.

Tractors—The Caterpillar Tractor Company, Peoria, Ill., has issued a 12-page leaflet giving details of the company's RD 4 and thirty tractors.

Compressors—Two pamphlets received from the Worthington Pump and Machinery Corporation, Harrison, N.J., describe their single tandem horizontal two-stage, steam and motor driven, types HB-2 and HS-2, and single horizontal three-stage, steam and motor driven types HB-3 and HS-3 compressors. Particulars of dimensions, etc., are given.

Separators—Specific gravity separators for the dry concentration of ores and minerals are dealt with in a 4-page leaflet received from Kipp-Kelly Limited, of Winnipeg, Man.

Road Scrapers—A 38-page bulletin received from the Caterpillar Tractor Company of Peoria, Ill., contains particulars and specifications of road scrapers manufactured by the company, and covers both Diesel and gas powered vehicles.

Asphalt Roads—Imperial Oil Limited have issued a 28-page booklet containing descriptions of low cost asphalt surfaces and includes particular of cold patching, surface treatments, blotter treatments, carpet coating, mixed cold-laid surfaces and macadam aggregate type.

CORRESPONDENCE

The Institute and Consolidation

The Editor,
The Engineering Journal.

Dear Sir,

It appears difficult to appreciate exactly just what are the objects of the Committee on Consolidation from reading its published reports. This refers particularly to the report for May, 1936, published in the June issue of The Journal.

In the penultimate paragraph of this report, as published, it is stated that "At 2.30 the Committee met in joint conference with the Council of The Institute, and the memorandum above referred to was discussed and its approval was recommended......." From this statement it would appear that the Council officially recommended for approval the memorandum as published. I am not aware whether this is actually correct or not; but if not, the inference should not appear unchallenged nor unqualified in The Journal.

One can hardly believe that the Council of The Institute at any time much less at the present early stages of committee study, would recommend for unqualified approval preliminary conclusions No. 2, No. 5 (a), and No. 5 (b), as published.

In preliminary conclusion No. 2, it is stated that the "Provincial Professional Associations must continue to function in their present capacities and for the purposes set out in their respective acts," but that the E.I.C. should merely continue to function. Without knowing the antecedent discussion relative to this conclusion, it appears that the wording offers the opportunity of altering the functions of the E.I.C. so as to subscribe to any subordinate position relative to the Provincial Professional Associations, and possibly so that the established objectives of the E.I.C. would be jeopardized.

It would seem that, were The Institute to admit members of a Provincial Professional Association only (No. 5-b), the objectives of The Institute would have to be much curtailed. The broad ideals presently obtaining would have to be so limited as to reduce these ideals to such an extent that the result would appeal to only a fraction of the number of those who are interested in "the acquirement and interchange of professional knowledge" and in the enhancement of "the usefulness of the profession to the public."

Again, some knowledge of the discussion leading to the wording of No. 5 (c) should be available before detailed comments or criticism can be substantiated. However, the paragraph in question offers a concession to members of a Provincial Association. There must be present in the minds of many members of The Institute the question "why?".

In addition, should not any question of Consolidation embrace not only a means of consolidation of The Institute and the Provincial Associations, but also other associations of particular activities in engineering or allied fields, such as the Canadian Institute of Mining and Metallurgy for example?

At the same time, it appears that recommendation No. 5 (a) is stated in too definite a manner at the present time. It is felt that any suggestion for the amalgamation of the two classes of corporate members should be in the nature of a discussion, and not published in the form of a definite conclusion without some reference to such discussion that may have led to this conclusion in the opinion of the Committee. It is true, no doubt, that this recommendation has been handed down by other committees on consolidation, but nevertheless members are probably not now familiar with the reasons for these previous conclusions, and these reasons may not have the same validity today as in the past. Therefore, it is felt that consideration might wisely be given to the suggestion that such conclusions as may be published by the Committee be substantiated with some summary of the reasons governing the conclusion.

If the contents of this letter are well founded and express a point of view of some number of The Institute members, it is possible that the opinion may be entertained that the Committee on Consolidation is not attempting to establish the best means of effecting this consolidation so much as establishing a particular method of consolidation. If this be the case, the members of The Institute should be aware of the trend, so that eventually The Institute as a whole may not subscribe to resolutions embodying changes in by-laws which might be regretted, and might seriously impair the standing and ideals of the Institute.

Yours truly,
T. C. Thompson, A.M.E.I.C.

4870 Cote Des Neiges,
Montreal.
June 19, 1936.

Junior Engineers in Australia

The following letter has just been received by E. R. Smallhorn, A.M.E.I.C., immediate past-chairman of the Junior Section of the Montreal Branch of The Institute, and it is believed that it will be of interest to branches of The Institute interested in the formation of Junior Sections.

Mr. C. W. N. Sexton, senior lecturer in civil engineering at the University of Melbourne, Australia, visited Canada and the United States during the past winter, and attended a meeting of the Junior Section of the Montreal Branch on November 21st, 1935.

A suitable acknowledgment has been sent to Mr. R. M. Osborne, Honorary Secretary of the Juniors' and Students' Section of the Melbourne Division of The Institution of Engineers, Australia.

The Institution of Engineers, Australia,
Melbourne Division,
Juniors' and Students' Section,
Melbourne, Australia.
May 19th, 1936.

E. R. Smallhorn Esq., A.M.E.I.C.,
2033 Vendome Avenue,
Montreal, Canada.

Dear Mr. Smallhorn:—

Mr. Sexton, who is a Member of The Institution of Engineers, Australia, and an enthusiastic supporter of the Juniors' and Students' Section in this city, has recently returned from a trip abroad. Since his return he has described his experiences in Canada and elsewhere and has been able to tell us much about the organization of kindred bodies in the countries which he visited.

Particularly was he impressed and gratified by the hospitality and courtesy shown to him by yourself, Mr. Duchastel and other members of the Junior Section of the Montreal Branch of The Engineering Institute of Canada, and at a meeting of the Juniors' and Students' Section of the Melbourne Division of The Institution of Engineers, Australia, the members desired me to express their sincere appreciation of your hospitality and to assure you of their desire to reciprocate it if any of your members will give them the opportunity.

Possibly you may be interested in the growth and activities of The Institution as it is constituted in this country, and I am, therefore forwarding, under separate cover, copies of our Articles of Association and the Rules and By-laws which, I think, will indicate the extent and nature of our organization more clearly than any brief description which I could give you.

I remain sir,
Yours faithfully,
(Sgd.) R. M. OSBORNE,
Hon. Secretary, Juniors' and Students' Section.

The International Nickel Company have forwarded a copy of the revised edition of their data book entitled "The Properties and Applications of Quenched and Tempered Nickel Alloy Steels." This book deals with two main classes of alloy steels, namely, carburizing steels containing up to about 0.25 per cent carbon, and oil and water hardening steels of somewhat higher carbon content.

Information is given as to the treatment and properties of some forty of these materials, the chart for each of them showing the relation between the tempering temperature and the tensile strength, impact strength, Brinell hardness, elongation, and reduction of area.

Grand River Water Supply and Flood Prevention

Substance of an address by Mr. E. T. Sterne, of G. F. Sterne and Sons, Limited, Brantford, Ontario, before the Hamilton Branch of The Engineering Institute of Canada, on May 15th, 1936, is contained in the following abstract prepared by F. P. Adams, A.M.E.I.C., city engineer of Brantford, Ont.

The Grand River valley in south western Ontario is the most thickly populated area in the province. Its industries cover a wide range of manufactures including textiles, leather goods, light and heavy steel industries, milling and food and animal products of all descriptions.

The pollution of the river from industrial wastes and domestic sewerage, combined with a serious reduction of the summer flow has brought about a condition that will require remedial measures if the continued p osperity of the district is to be assured.

The river and its tributaries drain an area of highly productive agricultural lands which have been improved by drainage. Permanent highways connect the towns and cities in its watershed with drainage ditches which carry the water from rains and melting snows quickly to the streams. Forests have been cut down and the land cleared to provide productive farm lands and the swamps which formerly provided summer storage at the headwater of the river have been cut through by large government drains which carry their waters off quickly in the spring.

These conditions have resulted in devastating floods during the spring run-off with corresponding low flows during the summer and early fall months.

The Grand river and its tributaries, the Nith, the Speed and the Conestoga, drain an area of 2,600 square miles. It flows in a southerly direction through the counties of Dufferin, Wellington, Waterloo, Brant and Haldimand and empties into Lake Erie at Port Maitland.

The drainage basin is about 120 miles in length with a width of from 10 to 40 miles and situated in the watershed and depending upon it for their water supplies and sewage disposal, are the municipalities of Fergus, Elora, Kitchener, Waterloo, Hespeler, Preston, Galt, Paris, Guelph, Brantford and Caledonia in addition to large numbers of smaller towns and villages.

Flood Prevention Works

Several of the larger municipalities have spent considerable sums on dyking the river banks to prevent annual damage to property and loss of life from the spring floods which rush down the valley, Brantford alone having spent about $450,000 to date for this purpose.

Preliminary Investigations

In the year 1931 conditions had become so alarming that the Grand River Valley Board of Trade, an organization composed of representatives from practically all the municipalities along the river, made representations to the provincial government for assistance in preparing plans to combat the flood menace and to maintain a summer flow in the river which would be adequate for the needs of the district.

The work was undertaken under the direction of the Hon. William Finlayson, Minister of Lands and Forests, who with the consent of the Ontario Hydro Electric Power Commission, appointed Dr. T. H. Hogg, M.E.I.C., chief hydraulic engineer for the Commission; Mr. L. V. Rorke, Surveyor General for Ontario, was associated with Dr. Hogg to make the necessary investigation and report. James Mackintosh, A.M.E.I.C., of the staff of the Hydro Commission, was deputed to carry out the field work and prepare the necessary data.

Their report on the Grand river drainage was completed in 1932. The physical aspects of the area were surveyed, temperatures, rainfall, snowfall and stream run-off were determined and the natural storage of the watershed was ascertained. Much valuable information was obtained from gauging stations which had been established at various points along the river in 1912, after a similar effort had been made by the municipalities interested at that time.

It was found that there is a drop of 1,128 feet in the river from its source in the highlands of Ontario to its outlet into Lake Erie with average grades as follows:

From Port Maitland to Brantford	.87 feet per mile
From Brantford to Elora	6.7 " " "
From Elora to Dundalk	11.2 " " "

The grades of its principal tributaries are:

The Nith river,	Length, 72 miles, grade	7.1 feet per mile
The Speed river,	Length, 24 " grade	10 " " "
The Conestoga river,	Length, 40 " grade	13 " " "

The average rainfall over the district is 33 inches, being 35 inches along its westerly edge and 32 inches along its easterly edge.

The average snowfall at Brantford is 45 inches increasing to 90 inches at the headwaters of the river.

Run-off is the amount of water which the drainage basin carries to the open stream. It is the total rainfall over the area of the drainage basin minus the water evaporated by the sun's rays; The transpiration of herbage and deep seepage which does not find its way to the stream

Fig. 1—Grand River Drainage Basin.

but sinks to lower levels. The run-off of the river above Galt is about 35 per cent of the total rainfall.

If the run-off of the drainage basin were distributed uniformly throughout the year there would be no problem, but unfortunately this is not the case. Due to inadequate natural storage the spring run-off brings down the melting snows and spring rains in tremendous volume causing disastrous floods.

The average annual run-off of the river above Galt is 1,500 cubic feet per second. At times the spring run-off is ten times this amount. During the summer the flow of the river is at times as low as 50 cubic feet per second.

Proposed Remedial Works

To remedy this condition, it is proposed to construct four impounding reservoirs on the river and its tributaries each with a storage capacity of 10,000 acre feet, and in addition, to dam back the headwaters of the river at its outlet from the Luther marsh by means of a low dam, which would add an additional 10,000 acre feet to the storage waters.

The reservoirs would be formed by the construction of dams across the river valley approximately 50 feet in height. They would control floods by holding back excessive run-off at critical times and releasing the waters during the dry summer months. The locations of these reservoirs are:

On the Grand river below the village of Waldemar.
On the Grand river below the town of Elora.
On the Grand river at the outlet of the Luther marsh area.
On the Conestoga river below the village of Hollen.
On the Conestoga river near its junction with the Grand river.

It is recommended that these works be proceeded with by stages over a period of years.

The different stages of development, the reduction in flood levels, the minimum stream flow and the estimated capital costs are set out in the attached schedule.

The spring flood of the year 1929 is taken as a typical example of a severe flood which can be expected to occur at frequent intervals. Heavier floods may be anticipated as conditions of temperature, rainfall, and the accumulation of snow occur in sequences favourable for flood conditions.

Water Supplies

The water supply for the towns and cities in the drainage area of the river depends primarily upon the flow of the river. Galt and Fergus obtain their water from wells drilled in the rock in the vicinity of the river and they depend upon infiltration from the river for their supply.

Kitchener and Waterloo obtain their water from wells in the underlying gravel and the upper rock strata. The supply to these wells comes from deep seepage of rainfall and infiltration from the river. Brantford obtains its supply directly from the river while Paris depends upon wells in the gravel near the Nith at its junction with the Grand.

As these municipalities grow in population they will eventually graduate from a well supply, as has Brantford, and place their dependence on a river supply in order to obtain quantities sufficient for their needs.

The summer flow of the river also has a distinct bearing on the water supply to farmers' wells in the valley.

Sewage Disposal

The relation of the stream flow of the Grand river to sewage disposal is of immediate importance to the health and well being of the municipalities along its course.

The river is the final means of disposal of all effluent from sewage and trade wastes of the municipalities and an increased summer flow is essential to the proper dilution of the effluents from sewage disposal plants in order that they do not become a nuisance to the inhabitants

Stage of Development	Location	Acre Feet	Reduction in 1929 Flood				Regulated Low Flow		Capital Cost
			Galt		Brantford				
			c.f.s.	Feet	c.f.s.	Feet	Galt	Brantford	
1.	Luther Waldemar	10,000 10,000	5,000	2.5	7,500	1.3	200	320	$ 673,000
2.	Luther Waldemar Hollen	10,000 10,000 10,000	10,000	4.0	10,500	2.0	220	350	1,359,000
3.	Luther Waldemar Hollen Conestoga No. 2	10,000 10,000 10,000 10,000	12,500	5.0	14,500	2.9	290	430	2,150,000
4.	Luther Waldemar Hollen Conestoga No. 2 Elora	10,000 10,000 10,000 10,000 10,000	15,000	5.6	18,500	3.6	350	500	2,955,000

A complete survey has been made of the Waldemar Dam project by the Department of Lands and Forests, and plans of the proposed dam prepared by the Hydro Electric Power Commission. The rock levels at the site of the dam were ascertained by test pits.

Estimates based on this accurate data show that the original estimates given in the report are quite accurate.

situated below such disposal plants, and to preserve the waters of the river in such a condition that they may be capable of treatment for domestic supplies.

Reforestation

The question of reforestation is dealt with in the report and it is recommended that lands unsuitable for agricultural purposes in the watershed be planted out to suitable varieties of trees as a means of assisting in the conservation of natural springs and to impede the quick run off of surface waters, but due to the highly fertile nature of the greater portion of the lands and their high degree of development for agricultural purposes, it would not be economically possible to turn back these lands to their original forest growths.

Governmental Assistance

The individual municipalities can only deal with those matters in connection with the river improvements which affect them locally. They can erect dykes to protect themselves from floods, and construct sewage disposal plants to treat their wastes. This they have done to the limit of their ability. It requires now the intervention of some central authority to carry out the larger programme of works necessary to obtain for this densely populated area the protection to its health and safety necessary for its combined development.

An appeal is made to the Federal and provincial governments for consideration of these matters in their programme of relief works designed to put more of our unemployed citizens to work. No type of construction will confer greater or more lasting benefits to large densely populated areas than the conservation and control of their water supplies.

History of Oxygen Production

In a paper read by Mr. C. R. Houseman at the recent International Congress of Acetylene, Oxy-Acetylene and Allied Industries held in London, Mr. Houseman stated that the oxygen industry was founded in 1886, when the Brins Oxygen Company was established to work the Brin process. The latter was based on Boussingault's discovery, in 1851, that at a temperature of about 540 degrees C. barium monoxide would absorb oxygen readily from the air, the oxygen being given off again at about 870 degrees C. The process only became an established success when oxidation and deoxidation were both carried out at 650 degrees C. by varying the gas pressure.

A considerable number of plants were established in this country, varying from 5,000 cubic feet to 30,000 cubic feet per day capacity. Meanwhile, the Linde process was in course of development, and ultimately superseded the Brin process. In 1845, Thompson and Joule carried out their well-known experiments on the cooling of gases by expansion, and Linde followed up the work by employing the principle to liquefy air. The author gave a description of a typical Linde plant, and then referred to the Hampson liquefier, produced in 1896. This was a laboratory apparatus depending on nozzle expansion from pressures up to 200 atmospheres without pre-cooling or high-pressure cycle. In 1892, Parkinson made the suggestion that oxygen and nitrogen in their liquid mixtures might be separated by utilizing their different boiling points. Linde effected a partial separation by fractional evaporation, and put the so-called "Linde Air" on the market, containing about 50 per cent oxygen. The apparatus employed was described in the paper. It soon became clear that the demands of industry could only be met by oxygen of higher purity. In 1902, Linde put forward the rectification process, and in the same year, Claude succeeded in producing liquid air by expanding compressed air in an engine with the production of external work. Several workers had failed previously to overcome the difficulty of lubricating the piston at low temperature, but Claude achieved success by using petrol-ether in admixture with cylinder oil until the temperature had dropped sufficiently for the liquid air itself to serve as a lubricant. Claude coupled the expansion engine to a rectification column, and obtained oxygen by a process similar to Linde's, but instead of liquefying the compressed air as such, it was divided into two liquids on liquefaction, one containing practically the whole of the oxygen, and the other very little oxygen. The poor liquid could more effectively wash out oxygen from the ascending gases in the rectification column than the liquid air of Linde's process. About 1910, Linde went a step further, and substituted a pressure rectification column, constructing the first "double-column" plant. The rich and poor liquids were formed from the treated air in the lower pressure column, and the final rectification was carried out in the upper column. By this method the separated oxygen and nitrogen were obtained in greater purity and yield. The Claude system was improved by Heylandt in 1913. About 1923, efforts were made to raise the purity of the oxygen by improving the efficiency of the rectification columns, and to-day, plants of the double-column type could yield about 95 per cent of the oxygen in the treated air at a purity of 99.5 per cent. After describing the latest improvements in the plant, the author passed on to improvements in the transport and storage of oxygen, and finally dealt with the various types of cell employed for the electrolytic decomposition of water.—*Engineering.*

The Society of Naval Architects and Marine Engineers announces that an international meeting of naval architects and marine engineers will be held in New York from September 14th to 19th, 1936. Headquarters will be the Waldorf-Astoria hotel.

Royal Commission on Transportation in Nova Scotia

Summary of a report of a Commission appointed by the Lieutenant-Governor of Nova Scotia and submitted January 1936

Ira P. MacNab, M.E.I.C., Commissioner.

On July 13th, 1933, Robert T. MacIlreith, K.C., of Halifax, and Ira Percy MacNab, M.E.I.C., of Wallace, were appointed by the Lieutenant-Governor of Nova Scotia to be commissioners to enquire into and concerning what provisions, if any, ought to be made for licensing and regulating or further regulating common carriers of passengers or freight by motor vehicles in order as far as possible to ensure that just and reasonable service should be furnished by such carriers and to prevent such carriers from unfairly competing with one another or with other common carriers, and to report thereon.

Mr. MacIlreith was later prevented by illness from assisting in the preparation and completion of the report, and on June 27th, 1935, Mr. MacNab was authorized to prepare and complete the report and submit it to the Lieutenant-Governor on behalf of the Commission. The text of the report follows:—

Introduction

Public hearings were held at Halifax, Sydney, Kentville and Truro and while no particular interests were invited to appear notice was given by advertising in the public press. A considerable volume of evidence was submitted on behalf of fifteen firms and organizations, and written briefs were submitted by six associations and transportation companies. In addition various public bodies throughout Canada, England and the United States were communicated with from which sources valuable information was obtained. Representatives of the Department of Highways of Nova Scotia gave evidence with particular reference to the financing, construction and operation of the highways.

In all eighteen sittings were held extending over the period from August 10th, 1933 to May 3rd, 1934.

At the present time the transportation of goods by motor vehicle in this province is being carried on with practically no regulation or control, and generally speaking without the carriers assuming any financial responsibility for life and property or the payment of their reasonable share towards the cost of the highways.

The transportation of passengers is, with a few exceptions where the carriers are operating under the Motor Carrier Act, in about the same position.

The railways on the other hand, are operating under definite control.

Admitting the benefit of present day motorized highway transport and considering the present situation of rail transport, there is no doubt that steps should be taken to bring about a reasonably fair basis of competition between the systems.

Discussion

After a study of the data available, it appears that there are three general courses which may be followed:—

1. The province may be considered as one zone or area and all motor vehicles carrying passengers and goods either as public carriers or as contract carriers, should be granted exclusive franchises and be under definite and complete regulation.

2. The province may be divided into several zones and all motor vehicles carrying passengers and goods in those zones be granted franchises and be under definite and complete regulation.

3. The carrying of goods or passengers, whether by contract carriers or by public carriers, may be left open to competition under such statutory control as will guarantee that the operators of such vehicles are not bonused at the expense of the general public in regard to the cost of highways, and that such carriers must pay sufficient insurance or show evidence of financial ability to guarantee safety of life and property; that the vehicle must be of such mechanical fitness as to guarantee its safe operation, and that the drivers of such vehicles must work such hours of labour as not to cause undue strain and thereby become a menace. In other words, that the service to be rendered should be such that, after paying their fair proportion for the use of the highways under such conditions as will guarantee the safety of life and property, competition is open.

After due consideration it is recommended that method number three is the one that should be carried out.

It is not felt to be desirable at this time to fix rates for the carrying of passengers or goods, but rather it is considered desirable that rates should be controlled by supply and demand, believing that the competition of the railway will prohibit the possibility of rates that are too high being charged, and that if commercial motorized transport is operated under conditions as outlined in method number three, it will enforce rates equitable to all concerned.

In the carrying out of such a plan it becomes necessary to determine:

1. What highway costs are to be charged against such vehicles?

2. After such cost is determined, how much annual cost should be allocated amongst the various classes of vehicles?

With regard to the highway cost which should be charged against motor vehicles. The year 1935 has witnessed a definite programme of highway paving being carried out which will probably result in materially different annual cost. It has therefore been decided that all calculations should be made on the basis of figures obtainable as of December 31st, 1934.

Although the motor vehicle was in quite general use during the earlier years of the present century, it was not until after the creation of the Provincial Highway Board in 1917 that a definite programme of road improvement for the comfort and safety of the motoring public of the province was begun.

Inasmuch as the roads previous to that time adequately met the needs of those that used them, it would appear only reasonable that capital expenditures since that time be considered as chargeable to motor vehicle operation.

The total of capital expenditures made by this province for the improvement of roads and bridges up to December 31st, 1934, amounts to $40,220,903.58.* The same statement shows expenditures up to September 30th, 1918, the date on which highways operation was taken over by the province, amounting to $5,152,802.52. Therefore the total capital expenditures since provincial control of roads to December 31st, 1934, and which may be considered as resulting from improvement of motor vehicle operation, amounts to $35,068,101.33.

A comparative statement of annual highway revenues and expenditures during the years 1928 to 1934 inclusive shows that the revenue resulting from motor vehicles falls short of meeting the total annual expenditure, even after deducting therefrom the amount contributed as highway tax.

An analysis of the figures for 1934 shows:

Revenue from motor vehicles ....Total	$2,317,121.86
Expenditures on highway, year 1934 ....Total	$3,475,423.16
Less paid by highway tax	367,913.29
Amount that should be paid by motor vehicles	3,107,509.87
Actual revenue from motor vehicles	2,317,121.86
Amount contributed in 1934 from general revenues	$ 709,388.01

From the evidence it appears that the annual amount being provided for sinking funds is approximately one-half of one per cent of the invested capital. No depreciation reserve is being set up. On gravel roads where full maintenance is being carried out, no depreciation results from ordinary wear and tear. There are, however, elements of obsolescence and inadequacy, which are very marked, due to the rapidly changing conditions in highway transport. Many sections of road in the province have been entirely rebuilt in fifteen years or less, to provide reasonable safety and capacity for traffic. It also appears that in many sections full maintenance has not been carried out.

With the paving programme now under way, conditions will be materially changed, but it is felt that the annual amount set aside to provide reserves for sinking fund should be increased and it is recommended that careful investigation into this matter should be made.

It cannot be questioned that the general improvement in highways and the increased use of the motor vehicle is of considerable economic and social value to the province as a whole. The measurement of this value is difficult to determine, but it is being paid to-day in the form of a highway tax which in 1934 amounted to $367,913.29.

During the course of the hearings, representations were made from both rural and urban interests, each claiming that they were being unfairly burdened with highway taxation.

A study of this point has disclosed the following:

Passenger vehicles registered 1934	34,370	
Commercial vehicles registered 1934	6,907	
Total registration	41,277	
Passenger vehicles 1934, rural	15,931	
Commercial vehicles 1934, rural	3,228	
Total rural registration	19,159	
Percentage of rural to total		46.5%
Total revenue collected by Highway Department exclusive of highway tax for the year 1934		$2,317,121.86
On basis of registration the rural population contributed 46.5 per cent of this amount		1,077,461.26
The highway tax is levied at the rate of 10 cents per $100 of assessment in towns and cities and 60 cents per $100 of assessment plus a poll tax in rural communities. In 1934 the total highway tax paid was $367,913.29 of which the rural sections contributed		267,283.74
Total contribution by rural areas		$1,345,745.00
The total revenue of the Department for the year was		$2,685,035.15
Percentage of rural to total		50.12%*

*Note: This is an average figure which may vary somewhat if full details as to size of vehicles and amount of gasoline tax contributed were known. Such statistics are not readily available but it is felt that this percentage is sufficiently accurate for all practical purposes.

Having proceeded thus far, it is necessary to find some measure to determine the benefits derived by each class. This appears to be a difficult task. At the present time the only data available are from the standpoint of the tourist traffic. The Information and Tourist Bureau of the Highway Department supply the following:—

Year		Tourists by car
1929	June 1 to September 30	101,116
1930	do.	126,192
1931	May 15 to October 16	150,664
1932	do.	135,756
1933	June 1 to September 30	105,916
1934	do.	132,284

If provincial business as a whole is considered there are no data on which to base any conclusions. General observation, however, indicates that the conditions are largely in favour of the urban communities.

With regard to business arising from the operation of motor vehicles, a complete lack of data makes it impossible to draw any definite conclusion at present. Considering sales and demonstration offices, garages, service stations and other commercial enterprises allied with the automotive industry, it would appear reasonable to assume that much the greater part is confined to the urban parts of the province, resulting in a very material increase in assessment during the last two decades.

On the other side of the ledger it must be admitted that the automobile has improved social conditions in rural communities and has given those residing in districts remote from railways, an outlet to market that was much needed. With prices for farm products as they have been, however, it does not need much argument to prove that the net profits to rural communities have not increased.

From the foregoing it would appear that the urban population receiving benefits from the operation of the automobile, can very properly pay considerably more than they are paying at present in the way of taxation toward providing the highways. If the actual users of the highways should pay on the basis of use, it would seem that the total population should pay on the basis of benefit received.

It must be clearly understood that this report does not express approval of the revenue presently being collected by highway taxation, either as to the amount or the allocation thereof. It is strongly recommended that steps be taken to study and determine the amount that should be paid by highway taxation, the allocation of such amount as between rural and urban districts and the assessment on which the tax is paid.

Assuming, however, that the present highway tax is a proper amount it would appear from the tabulation given above that the amount to be contributed by the motor vehicle on the basis of 1934 figures is $3,107,509.87. Having arrived at the amount that is to be charged against motor vehicles, it must be determined how it should be allocated among the various classes.

After a study of the methods presently in use, of arriving at the fees to be paid by motor vehicles, it is recommended that the general principle as outlined by the report of a Committee acting under authority of the Minister of Transport in Great Britain, under the chairmanship of Sir Arthur Salter, K.C.B., be adopted. On this basis a classification has been made of the vehicles registered in the province with the amount of registration fee which each class would have to pay and the average annual amount which each vehicle would pay in gasoline tax.

These calculations† are made on the basis of 1934 registration and apply to the cash requirement to cover capital carrying charges and maintenance costs for 1934, after deducting therefrom highway property tax for the year 1934, amounting to $3,107,509.87 as shown by the tabulation. Calculation is made on the basis of the average gross ton miles operated by each class of vehicle.

Assuming the estimates to be reasonably correct, it shows that the average private passenger vehicle is at present paying a license fee that covers the cost of its use of the highways. The average farm truck is not quite paying its way, while the average commercial vehicle is heavily subsidized. It is recommended that this is entirely unfair and should be corrected.

From the evidence submitted to the Commission it is probable that there are certain motor vehicles classified as farm trucks which are at certain seasons of the year used for hauling apples in the fruit growing sections, and it is felt that such farm owned trucks, desiring to engage in contract carrying during special periods, could, and probably should, be issued a special license for carrying on these particular activities during the season.

The trucking of these apples appears to be done almost entirely

*In the report of the Department of Highways for the year 1934, Exhibit P, pages 89 and 90.

†See tables appearing in original report.

by farmers owning trucks and being paid at the rate of so much per barrel. This has resulted in a material lessening of the volume of traffic to the railway, and it is claimed that continuance of the growth of the trucking business along the lines of the road can only result in a general freight rate increase.

RECOMMENDATIONS

In view of the foregoing the following recommendations are made:

(1) That the carrying of goods or passengers be open to competition.

(2) That commercial motor vehicles shall not be bonused at the expense of the general public by paying less than their fair share "on the basis of use" for the highways provided.

(3) That all capital for the improvement of highways invested since 1918 be chargeable to motor vehicle operation.

(4) That the annual interest and sinking fund necessary to carry such capital plus the annual maintenance costs of the highways less highway tax, be the amount which must be paid by motorized transport.

(5) That a study be made to determine what amount should be set aside annually, to accumulate sufficient reserves to repay capital when the property for which it was invested has completed its useful life.

(6) That further investigation be carried out to determine what amount should be paid as a highway tax and as to how it should be allocated as between rural and urban communities.

(7) That the license fees to be paid by the various classes of vehicles should be arrived at by the method outlined in the "Salter Reports."

(8) That farm-owned motor vehicles used only for the movement of owners' products be issued a particular class of license.

(9) That such vehicles may, by the payment of special fee, engage in the transportation of apples, lumber or other seasonal occupations.

(10) That motor vehicles used only within the municipal confines of cities and towns for the movement of owners' goods be granted special licenses.

(11) That the granting of all licenses for motor vehicles be conditional on the applicant giving evidence of financial responsibility for the safety of life and property.

(12) That all manufacturers of commercial motor vehicles or their agents selling within the province be compelled to register the safe maximum carrying capacity of their vehicles. The operators of such vehicles to be prohibited from loading in excess of this amount.

(13) That all commercial vehicles operating at night be required to have signal lights on the front of the body outlining their dimensions and indicating the class of vehicle.

(14) That no driver of a commercial motor vehicle be permitted to work more than a ten-hour day.

(15) That the speed limit of commercial motor vehicles shall not be greater than 25 miles per hour.

(16) That no motor vehicle be allowed to carry passengers for hire unless fitted with properly constructed body and seats suitable for the comfort and convenience of passengers.

(17) That properly authorized inspectors shall have the right to inspect any motor vehicle and if vehicle be not found to be of such mechanical fitness as to guarantee reasonably safe operation on the highway shall keep it from operating until defects are corrected.

(18) That the control of all motor vehicle operation be under the Department of Highways rather than adding to present costs by setting up a separate commission therefor.

In view of the fact that motor transportation is comparatively new and is developing very rapidly, and due to the improvement in design and operating efficiency of motor vehicles, and design and construction of modern highways, the conditions controlling such transportation are continually changing, it is strongly recommended that this study should be continued under the direction of a full time, properly qualified official to work in collaboration with the Department of Highways. It is only in this way that a sound transportation policy, which will adequately meet the needs of the people, can be developed.

Vacuum Concrete

Recent tests at McGill University before a group of Montreal engineers demonstrated the pouring of concrete and treatment by the vacuum process of C. P. Billner, a Swedish engineer now resident in the United States.

Four specimens were poured, including two walls, a section of pipe and a horizontal slab. Vacuum, varying from 12 to 23 inches of mercury was applied to the vertical faces in the first three tests and to the top surface in the latter test. In the latter, this was accomplished by means of rubber mats containing channels on the under side leading to small nipples to which are attached the hose leading to a suction pump.

In the first three tests forms were partially removed about two hours after completion of the pour and completely in about four hours, and the concrete was hard to the touch. In the case of the horizontal slab the vacuum pads were removed at the end of thirty minutes, and it was then possible to walk on the surface of the slab without making an appreciable impression.

It would appear that this process makes available the benefits known to be inherent in the use of a dry mix while permitting the use of as wet a mix as desired for pouring.

Previous tests at Yale and Columbia Universities indicated that treated concrete cylinders broken at ten days showed an increase of 81 per cent in srength, and those broken at the end of twelve days an increase of 53 per cent as compared with similar untreated specimens.

BRANCH NEWS

Hamilton Branch

A. Love, M.E.I.C., Secretary-Treasurer.
A. B. Dove, Jr.E.I.C., Branch News Editor.

The Hamilton Branch of The Institute met at McMaster University on May 15th, 1936, having as guests the Babcock-Wilcox Engineering Society of Galt. W. Hollingworth, M.E.I.C., chairman of the Branch, introduced Captain E. T. Sterne of Brantford, who spoke on "The Grand River Conservation Scheme."

THE GRAND RIVER CONSERVATION SCHEME

Captain Sterne gave a brief résumé of the history of the Grand River valley, an area of approximately 2,600 square miles, with a present population of about 350,000. Originally this section of country was the property of the Six Nations Indians, but these people have, by white settlement and sale of lands, been wedged into a small section which is the present reserve. Naturally, settlement has caused the removal of the once abundant forests in the valley also swamp drainage in the upper reaches of the Grand and its branches has been carried out in order to reclaim land. These improvements have had a disastrous effect upon the seasonal flow of the river which in peak periods carries 35,000 c.f.s.; the minimum is as low as 30 c.f.s. and the mean is 100 c.f.s. at Brantford.

Various studies have been carried out and the most recent one shows the situation to be serious. The river has a fall of 1,128 feet from source to mouth, while the fall is about 13 feet per mile in the steepest upper branches, it drops only 0.87 feet per mile at Brantford. Above Galt, all the four branches have steep drops with little holdback. Naturally, any conservation scheme put into effect must be concentrated above Galt. It is estimated that a storage area of 40,000 acre-feet will give a reduction in flood level of 2 feet at Brantford, and will result in a mean flow of 500 c.f.s. Since there is no other means of water supply or sewage disposal for the 2,600 square miles area, the Grand and its branches are most important, and this scheme will provide for a population of 700,000.

Four methods of providing the 40,000 acre-foot reservoirs and reforestation are being considered at present. These include:

(*a*) Building of Waldemar dam with 8-foot dyke which would impound 12,000 acre-feet at Luther swamp. This alone would lower the flood crest at Brantford by 1.3 feet, and increase the mean flow by 300-350 c.f.s. The cost of this work would be $673,000 with an annual cost (overhead and carrying charges included) of $65,000.

(*b*) The addition of a dam on the upper Conestoga river at a cost of $359,000. This river has the steepest gradient of all the upper branches (13 feet per mile).

(*c*) To obtain the 40,000 acre-foot reservoir area it would be necessary to build another dam farther down the river at Conestoga. The total cost for all three dams would be $2,150,000.

(*d*) To impound a further 10,000 acre-feet would cost an additional $750,000. This would be done by another dam below Elora.

The work of the Grand river conservation is in the hands of a commission of six, all residents of the area. Four members, including the speaker, were engineers. The studies of water conditions have been carried on under government supervision and it is hoped that an appropriation for at least a portion of the scheme will receive approval in the near future.

The interest of the meeting was displayed in the many questions asked at the close of the meeting, which was adjourned by Mr. Hollingworth, after which refreshments were served.

During the evening W. J. W. Reid, A.M.E.I.C., chairman of the Meetings and Papers committee, gave an outline of the subjects proposed for the latter part of the year. It is hoped that a Students' Night will be held next December. This of course will depend on the response made by Students and Juniors to a request for papers which will shortly go out.

On May 21st a number of the Hamilton Branch members journeyed to Thorold and took part in the joint meeting of the Niagara Peninsula Branch of The Institute and the American Society of Mechanical Engineers. The activities of the day included visits to three Thorold industries, and a dinner meeting in the evening, at which two members of the Ontario Paper Company staff spoke. As usual, this meeting was most enjoyable and reflects much credit on those arranging the programme.

London Branch

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

The regular monthly meeting of the Branch was held on May 28th, 1936, at the City Hall Auditorium, the speaker of the evening being Mr. E. C. Neville, bridge and building master, Canadian National Railways, Toronto, and his subject "Underwater Inspection of Bridge Structures"—with special reference to the methods employed on the Canadian National Railways.

The chairman of the Branch, Jas. Ferguson, A.M.E.I.C., presided and in introducing the speaker said the Canadian National Railway had found that many of their bridges while showing no signs of decay above water were settling to some extent and it was decided to carry out an underwater inspection and the results justified the means.

UNDERWATER INSPECTION OF BRIDGE STRUCTURES

During the summer of 1935 floods damaged the railways of central and southern New York State to the amount of over one and a half million dollars, much of which was required for the replacement of bridges that had collapsed due to the piers and abutments being undermined. This incident gives ample proof of the importance of careful underwater inspection so that definite knowledge may be had at all times of existing conditions.

There are numerous causes for these failures such as floods, a change in the current sometimes caused by sunken tree roots or drift wood, or by the erection of other structures up stream, ice jams, etc. In the case of piled structures the attacks of termites or wood borers is of vital importance.

A few years ago the Canadian National Railways under the direction of the chief engineer and the bridge engineer of the Central Region initiated a programme of underwater inspection of the bridges on the territory under their jurisdiction which took nearly four years to complete and which consisted of a thorough examination of the underwater portions of over two hundred bridges on the 8,000 miles of railroad in the region.

A complete organization was developed, the gang consisting of a foreman, diver and four men. This number was sufficient to handle the majority of inspections, but where additional help was required it was secured from the regular bridge maintenance gangs in the vicinity.

The work was carried on throughout the entire year, operations being suspended only during flood periods. The crew worked under many conditions and handled almost every type of inspection. One of the men in the gang was a draughtsman whose duties included that of keeping the notes and making sketches of each structure that was inspected.

Where plans were available, showing the construction of the structure, they were checked with the conditions as found by the diver, and any variations in the construction were shown on the plans and sent into the bridge office to be put on record. A field book was also kept with the sketches and notes, should it be necessary for reference purposes at a later date, and as many of the structures inspected had been in existence from fifty to eighty years, a number of the plans had been lost or destroyed. In such cases, new plans were made from the information obtained by the diver.

A regulation diving outfit was used, with 150 feet of life line, 150 feet of air hose, and a three-cylinder diving air pump. The telegraph engineers designed a two-way telephone system so that the diver and his attendant above water could keep in constant communication with each other, and the diver could report conditions immediately to the man keeping the notes, thus being relieved of detailed memory work and the necessity of coming to the surface at short intervals to report his findings.

This equipment consisted of a telephone transmitter and receiver mounted in the diver's helmet, with another transmitter and receiver for the use of the men above the water taking the notes. A portable case contained the transformers and dry batteries required to supply current to the instruments and a suitable length of waterproof telephone cable.

The transmitter and receiver used by the diver was attached to the inner surface of the helmet, while the equipment used by the man above water consisted of a breast plate transmitter and a head band receiver which left his hands free to make his notes. The rubber covered communication cable was coiled around the air line. In addition to speed and accuracy gained by use of the telephone system it also provided a greater element of safety for the diver, for in the majority of cases his task was a hazardous one, particularly while working around piling or old crib work and rip rap and where strong currents are encountered.

The most of this work was done from rafts but in some cases, where the water was deep or the current swift, a steam tug and large scow were employed, and in others the diver was let down in a specially constructed rectangular steel frame open sided cage which was provided with a sheet metal wedge shape nose which acted as a deflector for the swift currents. The cage was about 12 feet long and 4 feet wide and was handled by a locomotive hoist operating on the tracks on the bridge or by a derrick located on the scow.

The cage would be lowered along the face of the abutment and moved back and forth the full length of the structure so that the diver standing in the cage could examine all courses and joints.

The speaker then gave a description of the shield used to deflect the current away from the diver during his investigations. These were of wood or iron as required by the strength of the current. Ordinarily they were put in position by the use of a derrick from the railway overhead, but in some cases this was not practicable and scows with steam derricks had to be employed. Special mention was made of the International Bridge over the Niagara river where the water is 40 feet deep and the current 10 miles per hour.

He concluded with a description of the damage found and the method of repairing it.

After an interesting discussion a vote of thanks to the speaker was moved by H. F. Bennett, M.E.I.C., seconded by Jno. R. Rostron, A.M.E.I.C., and unanimously carried.

Moncton Branch

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

The annual meeting of the Moncton Branch of The Institute was held on May 29th, 1936. The annual report and financial statement were presented and adopted on motion of R. H. Emmerson, A.M.E.I.C., seconded by G. E. Smith, A.M.E.I.C. A vote of thanks moved by C. S. G. Rogers, A.M.E.I.C., was extended to the retiring officers. The election of officers for the year commencing June 1st, 1936 then took place, the incoming chairman being G. L. Dickson, A.M.E.I.C., and the vice-chairman, E. B. Martin, A.M.E.I.C.

Ottawa Branch

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

THE STEEL INDUSTRY IN CANADA

At the last regular noon luncheon of the spring season, held at the Chateau Laurier on May 28th, 1936, R. C. Manning, B.A.Sc., A.M.E.I.C., of Toronto, gave a talk upon "The Steel Industry in Canada." The luncheon, which was very largely attended, was presided over by E. Viens, the chairman of the Ottawa Branch, and additional head table guests included: W. A. Mattice, J. B. Hunter, D. J. Hartigan, M.P., B. M. Hill, M.P., M.E.I.C., Col. H. J. Lamb, M.E.I.C., A. J. Hazelgrove, Dr. R. W. Boyle, M.E.I.C., Alan K. Hay, A.M.E.I.C., K. M. Cameron, M.E.I.C., John McLeish, M.E.I.C., G. A. Dillon, and J. E. St. Laurent, M.E.I.C.

Mr. Manning's address, which was illustrated, dealt in turn with steel manufacture in Canada, the fabrication of steels, examples of the use of steel in construction during the past few years, and examples of steel sections. Mr. Manning characterized steel as the strongest building material known to man, also that it is the safest, has the highest speed of erection carrying its load with it, at the same time occupies the least space, is incombustible, has its properties fixed scientifically, is capable of quick and inexpensive alterations, has a uniform structure, stands more abuse than other materials, weighs less per unit, has the highest salvage value, and is altogether a dependable material produced by responsible concerns. In Ontario alone there is a capital investment of 85 million dollars in the steel industry with an annual pay roll of over 10 million dollars.

In his address the speaker made reference to the fact that arc welding in place of steel riveting is rapidly becoming more and more important. This new method, he stated, will revolutionize not only the fabrication of steel but also the design of steel structures.

Quebec Branch

Jules Joyal, M.E.I.C., Secretary-Treasurer.

Nous offrons aujourd'hui à nos lecteurs un bref aperçu d'une conférence faite par M. J. H. Thériault, Ingénieur au Ministère de la Voirie, à une réunion générale de notre section, tenue au Château-Frontenac, le 30 mars dernier.

CHEMIN EN BETON DE CIMENT

Le béton de ciment est un matériel de construction qui offre de grands avantages dans bien des domaines. Les compagnies qui fabriquent le ciment et ceux qui l'emploient ont dirigé leurs efforts à poursuivre des études techniques pour en tirer le plus économiquement possible, le maximum de résistance.

Les avantages du pavage en béton sont les suivants: il donne un revêtement durable sous une circulation intense, il offre une surface unie sans être glissante, il est sans poussière et facile à nettoyer, il est économique d'entretien et sa rigidité obvie au manque de résistance de l'infrastructure par la répartition des charges sur une grande surface. Par contre son coût de construction est élevé et lorsque défectueux, il est difficile à réparer.

La préparation d'un devis de pavage en béton nécessite la connaissance et l'étude des forces suivantes: la résistance du sol, la charge, l'impact, les efforts dans le béton, sa fatigue et ses déformations. Le conférencier traite de ces particularités puis expose le procédé suivi pour déterminer une dalle en béton; il parle des joints d'expansion et de la détermination des mélanges, des agrégats employés et des essais faits sur les matériaux destinés à entrer dans la construction.

M. Thériault nous transporte ensuite sur les travaux où l'effort technique développé dans la préparation du devis se continue.

La confection du béton nécessite une centrale où sont apportés tous les matériaux pour y être proportionnés; le malaxage peut se faire à la centrale, en route ou à l'endroit même de la construction.

A la centrale le département de la Voirie construit un chantier d'essais muni de tous les instruments nécessaires pour faire sur place les analyses des matériaux et les essais sur le béton. Un homme compétent continue d'appliquer la théorie et d'en vérifier les résultats.

Le conférencier passe alors en revue les diverses opérations: Malaxage, étendage, curage, etc.

Tous les jours la quantité de béton produit est mesurée sur le terrain; on calcule aussi la quantité qui doit être produite d'après le matériel employé et toute erreur de plus de 3% doit être localisée et expliquée.

L'orateur termine en disant qu'après avoir déterminé l'effort que subit le pavage et la résistance du béton, le contrôle le plus attentif et le plus suivi est exercé tant dans le mélange que dans l'éxécution des travaux; aussi les résultats obtenus sont-ils très satisfaisants et c'est avec plaisir que l'on voit chaque année notre réseau routier s'ornementer d'un peu plus de pavage de béton moderne.

St. Maurice Valley Branch

J. Albert Hamel, A.M.E.I.C., Secretary-Treasurer.

Financial Statement for the Year 1935

Money in bank, January, 1935	$ 90.91	
Sundry expenditures (stamps, funeral tributes, etc.)	....	$ 17.75
Annual dinner:		
Sale of tickets	358.16	
Expenses	....	418.36
Rebates from Headquarters for 1935	59.10	....
Balance in bank, January 1st, 1936	....	72.06
Total	$508.17	$508.17

The Australian Loan Council

More than ten years ago Australians had begun to realize that some of the states were too deeply in debt and that interest charges had become too heavy a burden upon their budgets. A further consideration was the desire to avoid competition between the Australian States and the Commonwealth in the world's money markets (local, London, New York) so as to secure stronger bargaining power by the creation of one borrowing authority. The need was also felt for an organization to meet times of crisis. Although the Commonwealth recognized the necessity for dealing with this situation, it also realized that any generally acceptable plan of relief must provide a check upon excessive future borrowings if the credit of the Commonwealth was not to be affected.

To meet this dilemma a law was enacted which established an Australian Loan Council to administer the entire debt of the Commonwealth together with that of the individual states. In return for relatively minor contributions on the part of the Commonwealth toward the payment of the interest on the existing debt of each state, the states agreed to enter upon no new indebtedness without the consent of the Loan Council. Between the time when this law first went into effect in the fiscal year 1923-1924 and the time when it was made a part of the Constitution in 1928, it became clear in practice that the states were not handing over undue prerogatives to the Commonwealth, and that the Commonwealth had not been bound hand and foot by the states.

The Loan Council is made up of Ministers, one appointed by the Premier of the Commonwealth and one appointed by the Premier of each State. To this Council each of these Ministers brings the budget of his respective government for the coming year. After the Loan Council has seen that provision has been made for all carrying charges and for the refinancing of such proportion of the maturing debt as seems advisable, it considers the total amount of new money required under the combined budgets. If the immediate needs of the states or the Commonwealth make new borrowing essential, the Council considers the condition of the money markets at home and abroad, the amount of Australian balances in London and other relevant factors, and decides *(a)* what proportion of the total suggested new undertakings the country can afford; *(b)* when, where and how the amounts required shall be raised; *(c)* how the proceeds shall be apportioned. The loans thus authorized by the Council may be loans of the individual state which needs the funds, or they may be a debt of the Commonwealth itself. In either case, they are issued upon the credit of the Commonwealth. Where there is a unanimous decision on the part of the Loan Council, the widest latitude is permitted as to the apportionment of funds.

The plan tends to emphasize the effect of new borrowings upon the total debt of the Commonwealth and to lead to consideration of just how much Australia can afford in the way of new undertakings. It would seem to minimize log-rolling and bickering between states as to the size of state allotments, since the amount allotted is charged to the individual state and the interest on that amount continues as an item in future budgets of the state... The Loan Council is forced into a position where there must be a responsible decision which gives due weight to the financial position of the country as well as to the immediate requirements within the particular state... An understanding observer of Australia has made the comment that the plan has resulted in sound decisions by the Australian Loan Council and that the existence of this plan for central control of the budgets was a large element in making possible the Premiers' plan under which Australia came through the depression with outstanding success.

—*Royal Bank of Canada Monthly Letter.*

The Ampère Centenary

André-Marie Ampère was born in the village of Polémieux, near Lyons, on January 22nd, 1775, and died at the age of sixty-one at Marseilles, on June 10th, 1836. The centenary of his death has already been commemorated in France, by the issue of a 75-centime stamp, bearing his portrait, and by the holding of an exhibition and conference at Lyons. Ampère's extraordinary ability was shown at an early age. When he was eighteen, he had the misfortune to lose his father on the scaffold. The elder Ampère had been a magistrate of Lyons and had taken a part in the defence of the city against the army of the Convention. The death of his father preyed much upon the mind of young Ampère, and for a time mathematical studies were completely abandoned. Regaining his spirits, in 1796, he fell in love with the charming Julie Carron, to whom he was happily married in 1799. He had in the meantime worked at physics and chemistry, and between 1801 and 1805 taught those subjects at Bourg and Lyons. Having attracted the attention of Lalande and Delambre, in 1805 he was given an assistant professorship in the École Polytechnique, at Paris, and he rapidly rose to a high position among his contemporaries. In 1808, he was made inspector-general of the University, and in 1809 was made professor of analysis. In 1814, he became a member of the Paris Academy of Sciences, and ten years later was made professor of experimental physics in the Collège de France. He wrote memoirs on many subjects, but the turning point in his career came when, on September 11th, 1820, he heard of Oersted's famous experiments. From his study of the action of electric currents came his famous works, *Observations Electro-dynamiques* (1822), and his *Théorie des Phénomènes Electro-dynamiques* (1830). His laws of electro-magnetism have been compared with the laws of Kepler and the theories of Newton.

Ampère was a tender-hearted, religious, simple-minded man, who experienced more than his share of troubles. His beloved Julie died before he removed to Paris, and a second marriage he contracted proved unhappy, and led to a separation. He was, wrote Dumas, "grand, mélancolique, gauche dans ses mouvements, lent dans ses allures, myope, presque aveugle: écrire une ligne était pour lui une fatigue, tracer correctement un cercle ou un carré une impossibilité." His greatest happiness was to further the interests of his son Jean-Jacques-Antoine Ampère (1800–1864), who also held a chair at the College de France, and a seat in the French Academy. Though he died in Marseilles, Ampère's remains were, in 1869, transferred to the cemetery at Montmartre, Paris. A statue of him was erected at Lyons, in 1888, the house he was born in at Polémieux has been converted into a scientific museum, and fifteen years ago the centenary of the publication of his laws of electro-magnetism was celebrated at the Sorbonne under the presidency of the President of the French Republic.—*Engineering.*

Engineering Degrees in the United States

The Committee on Professional Recognition of the Engineers' Council for Professional Development, in the United States, has undertaken the difficult task of considering how the names of, and the requirements for, degrees in engineering can be unified. That unification is necessary may be shown by the fact that in the different educational establishments in the States a course in civil engineering leads to first degrees with the following varieties of designation: Bachelor of Arts, Bachelor of Science, Bachelor of Science in Engineering, Bachelor of Science in Civil Engineering, Bachelor of Engineering, Bachelor of Civil Engineering, and finally, Civil Engineer. In contrast to this diversity, the Committee recommend the title of Bachelor of Civil Engineering for the first degree, followed by Master and Doctor of Civil Engineering for the masters' and doctors' degrees, respectively. In addition, there would be the honorary degrees of Master and Doctor of Engineering. It was also recommended that the designation of Civil Engineer as an earned or honorary degree should be abandoned. When these recommendations were put to the vote, about 80 per cent gave their suffrages in favour of the new designations for earned degrees and between 85 per cent and 90 per cent in favour of those for the honorary degrees. The discontinuation of the label civil engineer was agreed to by the smaller percentage of 61. The total number of ballot papers was 813, out of a membership of 2,325, 160 institutions being represented. Nevertheless, the results are regarded as more than ordinarily conclusive. With the exception of the vote favourable to the abandonment of the degree of civil engineer, they are also in accordance with the preference expressed by the Committee on Professional Recognition of the Engineers' Council on Professional Development.

Subgrade Drainage for Highways

Bulletin No. H-36 published by the Canada Ingot Iron Company Limited, contains an article on Subgrade Drainage for Modern Highways. This includes material on such subjects as surface or pipe-enclosed ditches, French drains, pipe subdrains; underdrains, designing the subdrain—location and depth, size of subdrain pipe, slope of pipe, outlet of pipe; upper end, openings in pipe, trench and backfill and stabilization of fills.

Copies of this article can be obtained from the Canada Ingot Iron Company at Guelph, Ontario.

Preliminary Notice

of Applications for Admission and for Transfer

June 24th, 1936

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

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

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

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

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

The Council will consider the applications herein described in August, 1936.

R. J. Durley, Secretary.

*The professional requirements are as follows:—

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

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

Every candidate who has not graduated from a school of engineering recognized by the Council shall be required to pass an examination before a board of examiners appointed by the Council. The candidate shall be examined on the theory and practice of engineering, with special reference to the branch ofengineering 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 year.

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 graduated selection 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 equiva ent standard.

A Student beshall 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 matriculat on of an arts or science course in a school of engineering recognized by the Council.

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

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

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

FOR ADMISSION

BIEDERMANN—OTHMAR, of Montreal, Que., Born at Bienne, Switzerland, April 7th, 1904; Educ., 1920-25, Bienne Technikum. Elec. Engr., 1925; 1925-26, engrg. asst. to proprietor, Arber & Co., electr'l. mfrs. and contractors, Bienne. Electric boilers and furnaces; 1926-32, dftsman., calculator, investigator and engr., in elect'l. engrg. divn., Power Corporation of Canada. Released through lack of work; 1932-34, owner of Zenith Engineering Company, selling organization, representing German, Swiss and English mfrs.; 1934 to date, mgr. of Canadian company, Oerlikon-Canada-Limited, Montreal, controlled by Ateliers de Construction Oerlikon. of Zurich, Switzerland. mfrs. of elect'l. and mech'l. equipment.

References: J. S. H. Wurtele, J. H. Trimingham, G. L. Wiggs, W. W. Timmins, N. H. A. Eager, E. Nenniger.

DOLMAGE—VICTOR, of Vancouver, B.C., Born at Souris, Man., Feb. 6th, 1887; Educ., B.A., Univ. of Man., 1912. Ph.D. (Geol.), Mass. Inst. Tech., 1917; R.P.E. of B.C.; 1909, survey, land dept., C.P.R.; 1912-17, field asst., Geol. Survey of Canada; 1917-18, asst. geologist, oil geology in Kentucky; 1918-29, with the Geological Survey of Canada, as follows: 1918-20, asst. geologist; 1920-23, associate geologist; 1923-29, geologist, officer in charge of B.C. Division; 1929 to date, consltg. geologist, 1318 Marine Building, Vancouver, B.C.

References: E. A. Cleveland, W. H. Powell, H. B. Muckleston, C. Camsell, E. E. Carpenter.

FORBES—DONALD ALEXANDER, of Port Alfred, Que., Born at Fort William, Scotland, May 14th, 1908; Educ., B.E. (Civil), Univ. of Sask., 1934; 1928-29, rodman, 1930-31, instr'man., Dept. of Highways, Sask.; 1934, chainman, C.N.R., Saskatoon; 1935, party chief, water survey, Geol. Survey of Canada; At present, asst. engr., Consolidated Paper Corporation, Port Alfred, Que.

References: C. H. Jette, C. J. Mackenzie, H. R. MacKenzie, W. E. Denley, A. M. Macgillivray.

MacLEOD—GEORGE GRANT WEBBER, of Sault Ste. Marie, Ont., Born at Richmond, Que., June 23rd, 1891; Educ., B.Sc., Queen's Univ., 1913; R.P.E. of Ont.; 1909-13, general mining and milling work during summer months; 1913-14, mining engr., Hughes Porcupine Mines; 1914-15, asst. gen mgr., Argonant Mines, Kirkland Lake; 1915-18, overseas, Lieut., C.E.F.; 1918-21, mining engr., Algoma Steel Corpn.; 1921, Belcher Island Expedition, Hudson's Bay, Geol. Survey of Canada; 1922-25, mining engr., Algoma Central Rly.; 1925-31, mining engr. for Algoma Central Rly. and C.P.R., also general consltg. practice; 1931 to date, manager, lands and mines dept., Algoma Central and Hudson's Bay Rly., Sault Ste. Marie, Ont.

References: J. L. Lang, K. G. Ross, R. S. McCormick, A. E. Pickering, C. Stenbol.

MORTON—ARCHIBALD MARSHALL, of Nkana, Northern Rhodesia, Africa, Born at Balerno, nr. Edinburgh, Scotland, April 19th, 1886; Educ., 1901-07, Heriot Watt College (evening classes), Cert. 1907; R.P.E. of B.C.; 1901-07, ap'ticeship, Carrick & Ritchie Ltd., Edinburgh; 1907-09, journeyman, various Edinburgh firms; 1909-10, 2nd Class Board of Trade Marine Ticket, New Zealand Shipping Co. Boats; 1911-13, journeyman, Mainland Iron Works, Vancouver, B.C.; 1910-11, charge hand, Swanson Bay Pulp Mills; 1913-15, charge hand, Granby Cons. Mining, Smelting and Power Co., Anyox, B.C.; 1915-19, asst. master mechanic, and 1919-30, master mechanic for same company; 1930-33, chief mech'l. engr., and 1933 to date, resident engr., Rhokana Corporation, Nkana, Northern Rhodesia.

References: J. Robertson, A. S. Wootton, P. H. Buchan, H. N. Macpherson, E. A. Wheatley.

SWAN—NICHOLAS STANLEY SCOBIE, of 1823 Lincoln Ave., Montreal, Que., Born at Westmount, Que., May 5th, 1893; Educ., 1905-10, Lower Canada College; Strength of Materials, Univ. of Wisconsin, Struct'l. Steel Engrg., I.C.S.; 1911-18, and 1919-20, detailing struct'l. steel, Dominion Bridge Co.; 1918-19, gen. dfting., and 1920-22, design of struct'l. steel and supervn. of steel drawings, Spanish River Pulp and Paper Mills; 1922-24, detail, checking and design of struct'l. steel, Canadian Vickers; 1924-25, checking struct'l. steel drawings, Dominion Bridge Co.; 1925-30, design and supervn. of struct'l. steel drawings, H. S. Taylor, M.E.I.C., Consltg. Engr., Montreal; 1930-32, layouts, struct'l. steel design and supervn. of steel drawings, asst. engr. under direction P. L. Pratley, M.E.I.C.; 1934-35, struct'l. steel design, Canadian Industries Ltd.; 1935-36, struct'l. steel design, Dept. National Defence, Engr. Service Branch; At present, struct'l. steel design, Ontario Paper Company, Thorold, Ont.

References: P. L. Pratley, F. W. Taylor-Bailey, R. M. Calvin, D. C. Tennant, M. Jacobs.

TAYLOR—EDWARD GEORGE TOWLE, of Toronto, Ont., Born at Ottawa, Ont., Oct. 10th, 1889; R.P.E. of Ont. and B.C.; 1910-12, Taylor & Young Ltd., Vancouver, B.C., in full charge of boat bldg.; 1912-13, engrg. dept., Foos Gas Engine Co., Springfield, Mass.; 1913-14, engrg. dept., Loew Victor Engine Co., Chicago, Ill.; 1914-15, engrg. dept., Kynochs Ltd., Birmingham, England; 1915-17, asst. to chief engr., Canadian Explosives Ltd., James Island, B.C.; 1917-18, Taylor Engrg. Co. Ltd., Vancouver, B.C., installn. of engines and mech'l. equipment in motor ship "Chiralite," subsequently taking charge as chief engr. in taking vessel from Vancouver to Talara, Peru, and operating same in Peru for International Petroleum Co.; 1918-19, Taylor Engrg. Co., Cassidy's Siding, B.C., mech'l. engr., i/c of all mech'l. constrn. for Granby Mining, Smelting and Power Co.; 1919-21, Taylor Mining Co., Alice Arm., B.C., chief mech'l. engr., i/c of all mech'l. constrn. and equipment, Dolly Vardon Mines; 1921, Robertson & Rendal, contractors, Ocean Falls, B.C., chief engr. i/c of all mech'l. equipment in connection with raising of present dam; 1922, engrg. dept., Kidwell Boiler Co., Milwaukee, Wis.; 1922-23, engrg. dept., Combustion Engrg. Corpn., Chicago, Ill.; 1923-28, chief field engr., Combustion Engrg. Corpn., Toronto and Montreal. Complete charge of installn. of large steam power plants in Canada; 1928-33, manager of Toronto office, Atwood Ltd., engrs. and contractors, specializing in steam power plants; 1933, organized Taylor Engrg. and Construction Co. Ltd., Engineers and General Contractors, specializing in steam power plants and industrial bldgs.; At present, President and General Manager of company.

References: J. G. Hall, H. G. Thompson, F. S. B. Heward, H. G. Acres, T. Montgomery.

WEBBER—DOUGLAS ALEXANDER, of Dartmouth, N.S., Born at Halifax, N.S., Feb. 4th, 1901; Educ., 1934-35, arch'l. course, Chicago Technical Inst.; I.C.S. Arch'tural Course; 1917-21, bldg. constrn.; 1921-22, constrn., Welland Ship Canal; 1923-24, architect's office, Boston, Mass.; 1926-30, with E. C. Fisher, Wellesley, Mass., Newton Constrn. Co., Newton, Mass., and M. J. Kindregan, Watertown, Mass., on design and erection of residences, apts., garages and stores; 1930-31, dfting., Halifax Harbour Commn.; 1931 to 1933, and 1935 to date, dftsman., Dept. of Highways, Halifax, N.S.

References: J. E. Belliveau, H. F. Laurence, C. Bennett, W. P. Morrison, J. L. Allan, R. R. Murray.

YOUNG—JAMES WILLIAM, of Calgary, Alta., Born at Mattawa, Ont., May 22nd, 1904; Educ., Courses in Higher Maths. and Chemistry, Provincial Institute of Technology, Calgary; 1922-23, chemist, Municipal Laboratory, Calgary; 1923 to date (with exceptions as noted below), asst. city chemist, Calgary, Alta. 1933, chemist, Turner Valley Gas Conservation Board (loan from city). 1933 to date, chemist, Glenmore Water Supply, 1932 to date, chemist, Calgary Sewage Plant. (Has published various papers and records of original research.)

References: J. R. Wood, S. G. Coultis, F. M. Steel, W. H. Broughton, F. J. Heuperman, P. A. Fetterley.

YUILL—JAMES L., of 63 Chester Ave., Toronto, Ont., Born at Glasgow, Scotland, Nov. 9th, 1885; Educ., Studied mining engrg., evening classes and home study; 1909-13, rodman, G.T.P.Rly. and Can. Nor. Pacific Rly.; 1913-14, leveller on location, P.G.E. Rly.; 1915-19, overseas, P.P.C.L.I. and Can. Engrs.; 1928, instr'man., Dept. Public Highways; 1929-31, instr'man., H.E.P.C. of Ontario; With the Dept. of Northern Development as follows: 1931-32, locating and res. engr., Sioux Lookout-Dinorwic highway; 1934, locating engr., Kenora-Fort Francis highway; 1934-35, locating engr., Gunflint highway, Fort William; 1935-36, res. engr., Trans-Canada highway; At present, at Heron Bay, Ont.

References: W. J. Bishop, E. A. Kelly, J. A. McCoubrey, F. Petursson, T. S. Armstrong.

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

COWLEY—FRANCIS PENROSE VAUGHAN, of Vancouver, B.C., Born at Winnipeg, Man., Sept. 6th, 1886; Educ., Grad., R.M.C., 1907; R.P.E. of B.C.; 1905 (summer), Manitoba land surveying; 1906 (summer), instr'man., Topog'l. Survey of Canada; 1907-08, rodman, National Trans. Rly.; 1908-10, asst. surveyor, Hydrographic Survey, Dept. of Marine and Fisheries; 1910-13, articled pupil to B.C. Land Surveyor and asst. in power development work; 1913-15, land surveying, private practice, and city surveyor, City of Victoria, B.C.; 1915-18, overseas, C.E.F., Major; 1918-19, city surveyor, City of Victoria; 1919-20, transitman on location, C.N.R.; 1923-24, asst. engr., municipal development engrg., Los Angeles; 1924 to date, asst. engr., City of Vancouver, Municipal engrg., in charge of paving projects. (*St. 1907, Jr. 1913, A.M. 1918.*)

References: W. B. Greig, R. Rome, E. A. Wheatley, D. O. Lewis, W. H. Powell.

FOR TRANSFER FROM THE CLASS OF JUNIOR

ADDIE—DONALD KYLE, of Westmount, Que., Born at Sherbrooke, Que., Aug. 17th, 1902; Educ., B.Sc. (Mech.), McGill Univ., 1925; Served full time as ap'tice machinist in various machine shops; 1926 to date, mech'l. engr., Dominion Glass Co. Ltd., and at present asst. mgr., Point St. Charles Plant of same company. Also Prop., Addie & Company Regd., Patents. (*Jr. 1926.*)

References: G. K. Addie, G. P. Cole, C. K. McLeod, B. R. Perry, A. E. Fry.

DOVE—ALLAN BURGESS, of Hamilton, Ont., Born at Ayr, Scotland, Apr. 9th, 1909; Educ., B.Sc., Queen's Univ., 1932; With the Steel Company of Canada, Hamilton, Ont., as follows: 1928-31, operated in various depts., cleaning, wire drawing, galvanizing, heat treatment. Set up standards and control systems; 1932-35, design of equipment, research in wire drawing and galvanizing; 1933 to date, asst. supt. and chemical engr., West Mill, Canada Works. In charge of depts. for pickling, wire drawing, etc. Control of all practice, and customer relationship with mill. Design and physical property control of spring materials, etc. Executive control over all depts. re costs, etc. (West Mill). Plating processes and control. Complaint investigation. (*St. 1932, Jr. 1934.*)

References: V. S. Thompson, A. Love, W. Hollingworth, L. F. Goodwin, F. W. Paulin.

GRANT—ERIC, of 3645 Jeanne Mance St., Montreal, Que., Born at London, England, Feb. 14th, 1902; Educ., Passed Prelim. Oxford and Cambridge Local Exams. Montreal Technical Schools—Certs. in struct'l. design and reinforced concrete design. Private study. Passed E.I.C. Exams. under Schedule "B" for admission as Junior in 1935; 1917-18, apr'ticeship., Sproston's Ltd., British Guiana; 1918-19, enlisted in 9th o/s Siege Bty.; 1919-20, machinist helper, Imperial Oil Refinery, Imperoyal, N.S.; 1920, boiler maker's helper, Halifax Shipyards; 1921-22, field asst. to Gov't. Land Surveyors of Br. Guiana; 1922-23, ap'tice to civil engr., Colonial Transport Dept. of Br. Guiana; 1924-27, pupil and civil engr's. asst. to M. A. Ravenor, M.E.I.C., res. engr. for contractors, Georgetown City Improvement Schemes, Br. Guiana; 1927-28, chief of prospecting party, United Diamond Fields of Br. Guiana Ltd.; 1928-35, field engr., Montreal Light, Heat and Power Cons., Montreal. Surveying and levelling, dfting., estimates, designing and layout work and investigations; 1935-36, with the Canada Paper Co. as instr'man. on topog'l. surveys, also supervising constrn. of gravel surfaced road; 1936, 1 month dfting. at Hawkesbury, Ont., also as instr'man. on topog'l. survey for Montreal Island Power Co. (*Jr. 1935.*)

References: J. J. Humphreys, W. J. Yorgan, D. O. Wing, L. L. O'Sullivan, V. R. Davies, G. P. Hawley.

LUCAS—JOHN WILLIAM, of Ottawa, Ont., Born at Toronto, Ont., June 6th, 1906; Educ., B.Sc. (Civil), Univ. of Alta., 1930; Summers: 1924, rodman, Topog'l. Survey of Canada; 1925, 27, 29, rodman and instr'man., Dept. of Highways, Alta.; 1926, levelman, Alta. Govt. Rlys.; 1928, silver refinery, Cons. Mining and Smelting Co.; 1930-31, rodman, inspecting concrete, etc., Beauharnois Construction Co.; 1931 to date, in Testing Laboratories, Dept. of Public Works, Canada, and from Feb. 1933 to date, in charge of the division of physical tests. (*St. 1928, Jr. 1932.*)

References: K. M. Cameron, R. deB. Corriveau, E. Viens, J. E. St. Laurent, S. J. Chapleau, R. W. Boyle.

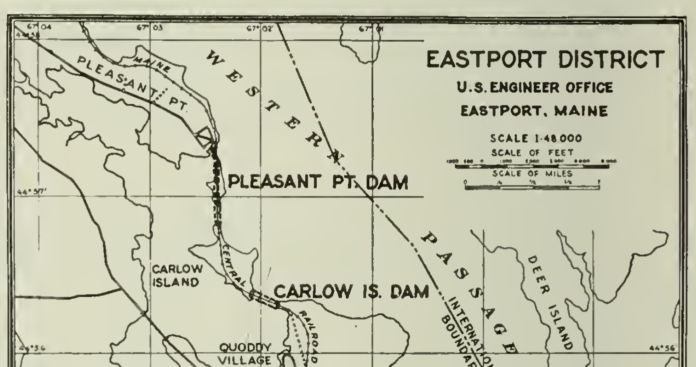
FOR TRANSFER FROM THE CLASS OF STUDENT

HULL—ROLAND STREET, of 508 Romaine St., Peterborough, Ont., Born at Woodstock, N.B., Mar. 29th, 1909; Educ., B.Sc. (E.E.), N.S. Tech. Coll., 1932; Summers 1932-33, Canadian Officers Training Corps of the Royal Canadian Signals, Camp Borden, Ont.; With the Can. Gen. Elec. Co. Ltd., as follows: 1935 (June-Sept.), engrg. staff, Davenport Works; Sept. 1935 to date, wire and cable engrg. dept., Peterborough Works. (*St. 1931.*)

References: A. B. Gates, W. T. Fanjoy, B. I. Burgess, A. L. Dickieson, T. E. Gilchrist.

The Approach to the Absolute Zero

The first of a new series of lectures on "The Approach to the Absolute Zero," which are being given at the Science Museum, South Kensington, in connection with the Very-Low Temperatures Exhibition being held there, was delivered on Wednesday, May 13th, by Dr. J. D. Cockcroft. He first explained that the absolute zero was reached when molecular motion attains its minimum value, and pointed out that defined in this way temperature could be measured by the pressure exerted by a fixed volume of gas. On the absolute Centigrade scale the temperature of melting ice was 273.14 degrees, and the temperatures of liquid oxygen, liquid hydrogen and liquid helium were 90 degrees, 20.4 degrees and 4.2 degrees, respectively. The successive approach to the absolute zero had been the result of work extending over many years. After the work of Faraday at the Royal Institution it seemed that only nitrogen, oxygen and hydrogen remained to be liquefied. Oxygen was liquefied in small quantities by Pictet and Cailletet in 1877, and the Polish chemists Wroblewski and Olszewski obtained indications that hydrogen could be liquefied in 1885. It was not until 1896, however, that Dewar, working at the Royal Institution, succeeded in obtaining appreciable quantities of liquid hydrogen and demonstrated its properties. By his work the lower limit of temperature available was reduced to 14 degrees absolute, this being the temperature at which hydrogen solidifies. The next step was taken by Kamerlingh Onnes, who first liquefied helium at Leyden, the temperature of the liquid helium being, as previously mentioned, 4.2 degrees absolute. By reducing the pressure above the liquid helium, its temperature was reduced to 0.7 degrees absolute and that, until recently, appeared to be the lowest temperature attainable. Since the work of Kamerlingh Onnes, however, several important advances in the technique of liquefaction had been made. Kapitza, for instance, had constructed a small piston machine in which helium could be expanded and so cooled continuously. The design of Kapitza's expansion engine was explained and its actual operation demonstrated. The use of the expansion engine, Dr. Cockcroft said, avoided the necessity for using liquid hydrogen as a pre-cooling agent and enabled liquid helium to be produced one hour after starting and at the rate of two litres per hour. At the temperature of liquid helium, the electrical resistance of metals such as gold or cadmium fell to below one thousandth of its value at room temperature, the resistance then depending largely upon the amount of impurity present. The resistance, however, could be greatly increased by applying to the metal a magnetic field of a few thousand gauss, this effect being due to the deflection of the electrons in their path through the metal which produced a large increase in the energy lost. These phenomena, and others of considerable interest, were demonstrated by experiments.—*Engineering.*



Projected Passamaquoddy Tidal Power Project.

EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada

2050 Mansfield Street, Montreal

Situation Vacant

TOWN MANAGER, for industrial town in the province of Quebec, preferably with personnel experience. Must speak French fluently. Apply to Box No. 1347-V.

Situations Wanted

SALES ENGINEER, E.E.I.C.; B.Sc. C.E., 1930 (Univ. N.B.), P.E.N.B. Age 28. Experience includes building inspection, structural detailing, road construction, and chemical operation. Interested in sales work on the sales staff of some manufacturing or wholesale concern. Apply to Box No. 225-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

ENGINEER AND ACCOUNTANT, Jr.E.I.C., (Capt. Can. Engrs., reserve). Age 35, Canadian. Experienced in mechanical and civil engineering, Diploma; general office, draughting and instrument work; assistant engineer erection Royal York hotel; assistant resident engineer T. & N.O. Ry. const. Desires position in Toronto where combination of technical and business experience will be of value, as have been director and accountant last three years. Apply to Box No. 377-W.

ENGINEER, A.M.E.I.C. Age 30. Single. Employed. Civil and mining experience, capable of designing and superintending construction of timber, concrete and steel structures, rock crushing and ore plants. Would consider position with mining or engineering company designing and building mills. Apply to Box No. 431-W.

CIVIL ENGINEER, B.Sc. '25, A.M.E.I.C., P.E.Q., single, experienced in pulp and paper mill construction and hydro-electric developments; also experienced in highway construction and topographical surveying. Available at once, location immaterial. Apply to Box No. 473-W.

MECHANICAL ENGINEER, B.Sc. Age 31. Married. Last ten years includes:—Mechanical structural and reinforced concrete design in pulp and paper mills, industrial plants, hydro-electric, mine, sewers and sewage disposal plant construction. My experience also includes shop production, steam plant combustion, fuel analysing, inspecting, supervising and instrument work on industrial construction. Permanent position preferred. Apply to Box No. 521-W.

CONSTRUCTION ENGINEER, age 26, unmarried, graduate C.E. Experience includes hydro-electric, railroad, highway, and industrial plant construction, both field and office, including cost accounting, estimating, stores, layout, general engineering and supervision, as well as practical work in mechanical trades. Apply to Box No. 567-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aerophotographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

ELECTRICAL ENGINEER, B.Sc., 1926. One year maintenance, one year operating, large hydro-electric plant. Five years hydro-electric construction, as wireman and foreman, on relay, metal, and remote control installations. Also conduit and switches. Three years maintenance electrician, in pulp and paper mill. Also small power system. Desires position of responsibility. Sober, reliable and not afraid of work. Available at once. Excellent references. Apply to Box No. 636-W.

ELECTRICAL ENGINEER, B.Sc. '28; M. Eng. '35. Two years student apprenticeship at Can. Westinghouse Co., including test and electrical machine design. Also about two years experience in operating dept. of large electrical power organization. Available on short notice. Apply to Box No. 660-W.

Situations Wanted

ELECTRICAL AND RADIO ENGINEER, B.Sc. '30. Variously engaged on receiver development work, testing, and transformer development, under direction. More recent experience includes transmitter test room procedure and short wave beam transmission engineering. For further information apply to Box No. 680-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.Sc. Elec. '29, B.Sc. Civil '33. Jr.E.I.C. Age 29. Experience includes four months with Can. Gen. Elec. Co., approximately three years in engineering office of large electrical manufacturing company in Montreal, the last six months of which was spent as commercial engineer. For the last year and a half employed in electrical repair shop. Best of references. Apply to Box No. 693-W.

Employment Service Bureau

This bureau is maintained by The Engineering Institute of Canada for the benefit of members and organizations employing technically trained men.

An enquiry addressed to 2050 Mansfield Street, Montreal, will bring full information concerning the services offered. Details can also be obtained from Branch secretaries who are located in the larger centres throughout Canada.

Brief announcements of men available and positions vacant will be published without charge in The Engineering Journal and the Bulletin. Replies addressed in care of the required box number will be forwarded to the advertiser without delay.

An additional service also offered those who are unemployed or wish to change their positions, is the opportunity of placing their names and records on file at 2050 Mansfield Street for consideration by employers wishing to employ engineers. This is of great assistance as many employers will not advertise or wish to locate a suitable man on short notice. If desired the information contained in these records can be kept confidential.

Forms for registration purposes may be obtained from The Institute Headquarters or Branch secretaries.

MECHANICAL ENGINEER, B.Sc., '27, Jr.E.I.C. Four years maintenance of high speed Diesel engine units, 200 to 1,300 h.p. Also maintenance of d.c. and a.c. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial. Apply to Box No. 724-W.

Situations Wanted

YOUNG CIVIL ENGINEER, B.Sc. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER, M.Sc., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering. Read, write and talk French. Married. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

RADIO AND ELECTRICAL ENGINEER, B.Sc., '31, Jr.E.I.C. Single. Age 29. One year and a half actual field experience in power and lighting equipment. Extensive work in telephone and radio layouts in switchboard and installation depts. Particularly interested and experienced in sales and traffic work in telephone and radio company. At present supervisor over sales and service of radio and electrical company. Available on short notice. Location immaterial. Apply to Box No 740-W.

CIVIL ENGINEER, B.Sc. '29, A.M.E.I.C. Married. One year building construction. One year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

MANUFACTURERS' REPRESENTATIVE, at present doing business with leading industrial organizations in Canada, wishes to represent manufacturers of mechanical equipment. Such work as would involve technical data, and the preparation of plans where necessary, would be handled by an engineer whose experience with outstanding firms and projects, would be valuable to those seeking representation. Apply to Box No. 764-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

PLANT ENGINEER or SUPERINTENDENT, capable of supervising all phases of industrial plant operation, graduate electrical, eleven years diversified industrial experience including test course, four years on large Quebec industrial development, on construction and operation, also six years with prominent consulting firm supervising electrical and mechanical engineering projects. Age 31, single. Apply to Box No. 795-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), E.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

SALES ENGINEER, A.M.E.I.C., graduate engineer, age 34, practical experience in the manufacture of power plant equipment, thoroughly conversant with Canadian power plant practice and equipment for the metal working industries. Available on short notice. Apply to Box No. 860-W.

Situations Wanted

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 32, married. Two years in pulp mills draughting and designing additions, maintenance and plant layout. Three and a half years in the Toronto Building Department, checking and designing for steel, reinforced concrete and ordinary structures. One and a half years as transitman and draughtsman on road location and maintenance work. Available at once. Location immaterial. Apply to Box No. 899-W.

CIVIL ENGINEER, B.Sc., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

ELECTRICAL ENGINEER, S.E.I.C., B.Sc., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No. 1010-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.Sc. (Queen's, '14), A.M.E.I.C., Dominion Land Surveyor, 5 months special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply to Box No. 1035-W.

ENGINEER, Jr.E.I.C., E.E. '29, is very interested in applying electrical methods to cement testing and research work. Apply to Box No. 1062-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.Sc. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

Situations Wanted

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

ELECTRICAL ENGINEER, B.Sc.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

MECHANICAL ENGINEER, B.A.Sc. (Univ. of B.C. '29); M.S. Age 27. Single. Four years experience in research work in applied mechanics and materials testing. Desires position involving analytical work in design, development or testing. Available on short notice. Apply to Box No. 1123-W.

PETROLEUM CHEMIST, B.Sc. in Chem. Eng. Age 25. Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

CIVIL ENGINEER, B.A.Sc., S.E.I.C., age 26, single. Experience includes one year in bridge construction, plain and reinforced concrete, pneumatic caissons and surveying. Available at once. Any location. Apply to Box No. 1204-W.

MECHANICAL ENGINEER, B.Sc. (Queen's Univ. '28), age 36, married, desires position of trust and responsibility. Experience includes fitting and assembly of machine tools, production, draughting, and maintenance. Five years teaching draughting and mathematics. Available on reasonable notice. Location immaterial. Apply to Box No. 1210-W.

ENGINEER, with twenty years experience in industrial, pulp and paper mill, and general engineering and design. Age 41. Last five years chief engineer of paper mill making newsprint specialties and toilet tissues. Apply to Box No. 1246-W.

ELECTRICAL ENGINEER, B.Sc. '34 (Univ. of N.B.), S.E.I.C. Age 21, single. Desires any kind of electrical work. Will con-ider any location. Apply to Box No. 1262-W.

CIVIL ENGINEER, B.A.Sc. (Toronto '33), S.E.I.C., age 25. Married. One year as instrumentman with provincial highways dept. Experience in concrete and retread construction, draughting, estimating and accounting. One year with department of National Defence on grading and reinforced concrete construction. Apply to Box No. 1265-W.

Situations Wanted

ELECTRICAL GRADUATE, S.E.I.C., B.Sc. '32, M.Sc. '34. Experience includes four years as part time operator and announcer for a radio broadcast station. At present employed in radio repair dept. of a large wholesale firm. Apply to Box No. 1283-W.

ENGINEER AND DRAUGHTSMAN, Jr.E.I.C., age 33, married. Diplomas from Mtl Tech. Inst. in R.C. and Structural Design. 11½ years experience in civil engineering, draughting and instrument work. This includes 7 years with M.L.H. & P. Cons. as field engineer on construction and maintenance of gas mains. Present location Montreal. Available at once. Apply to Box No. 1326-W.

GRADUATE ENGINEER, (McGill), in responsible charge of design, construction and operation of hydro-electric plants. Also power design and mechanical maintenance of industrial plants. Apply to Box No. 1328-W.

MECHANICAL ENGINEER, recent grad. University of Toronto, B.A.Sc. in mech. engrg, 24 years old, S.E.I.C., now managing a chain store, desires engineering work. Present location So. Ontario. Location immaterial. Best of references. Apply to Box No. 1348-W.

CIVIL ENGINEER, M.E.I.C. Married. Age 38. Twenty years experience in organization, design and estimating, and cost accounting. Active service in France. Apply to Box No. 1367-W.

FIRE PROTECTION AND SAFETY ENGINEER, A.M.E.I.C., B.Sc. '24 (Mech. Engrg.). Age 33. Bilingual. Ten years experience with insurance underwriters inspection bureau covering phases of field work. Thoroughly familiar with insurance requirements. Position desired industrial or other concern maintaining self insurance or relative departments. Location Montreal or vicinity preferred. Apply to Box No. 1395-W

ENGINEER SUPERINTENDENT, A.M.E.I.C., R.P.E., Que. and Alta. Age 47. Married. Twenty years experience as engineer and superintendent in charge of hydro-electric, industrial, railroad, and irrigation construction. Specialized in rock excavation and suction dredging. Intimate knowledge of costs, estimating and organizing. Available immediately. Apply to Box No. 1411-W.

1935 GRADUATE IN CIVIL ENGINEERING, B.Sc. (Queen's Univ.), S.E.I.C. Experience includes eleven months summer work as county engineer's assistant in charge of the surveying party, and two months as surveyor's assistant during construction of concrete formwork and installation of machinery. Keenly interested in graphical analysis, draughting, design, organization and report writing. Now available for any location. Apply to Box No. 1415-W.

CIVIL AND ELECTRICAL ENGINEER, Univ. of Man. '35 and '36, S.E.I.C. Experience in irrigation and mapping. Available at once. Location immaterial. Box No. 1418-W.

Wanted to Purchase

A second-hand transit in good condition. Please state name of maker, date and price to Box No. 30-P.

Party in Regina, Sask., would like to purchase a small architect's or surveyor's level in good condition. Send particulars to Box No. 31-P.

Laminated Safety Glass

The principle of laminated glass, as such, is old, dating back to the latter part of the nineteenth century; but, like many other industries during its early stages little money or well-directed scientific and engineering effort was expended by those closely associated with it, with the result that four or five years ago the industry was still in its infancy and required corresponding treatment.

For the idea of laminated safety glass as we know it today, as far as public records are concerned, the honours go to an Englishman, Wood, who in 1905 obtained a British patent which describes a method for safety glass manufacture by the use of Canada balsam for cementing a sheet of transparent celluloid between two sheets or plates of glass. The Safety Motor Screen Company Limited, made samples of safety glass in this manner and exhibited them at the Spring Motor Show in England in 1906. Because of the high cost of materials, the general unsatisfactoriness of this product, and the small demand, Wood's venture was without success and the patent was allowed to lapse.

The first man to capitalize on the idea of laminated safety glass was a Frenchman, Benedictus, who obtained French and British patents in 1910. Benedictus named his product "Triplex" and employed the same general principle as Wood, except that he proposed gelatin instead of Canada balsam as the bonding adhesive for glass plates and celluloid. Benedictus introduced the manufacture of Triplex safety glass in 1912 in England where production started in 1913. The new industry received an enormous impetus during the World War when laminated glass was used for the manufacture of gas mask lenses and goggles, and for automobiles and airplanes.

In 1927 the Ford Motor Company secured the manufacturing rights to the Triplex process and laminated safety glass was introduced as standard equipment in the windshields of its cars.

Early troubles included discoloration, "rainbows" and opaqueness; "fogginess" frequently was caused by opening up of the cement bond.

Improvement in bonding substances and the practice of sealing the edges of the safety glass "sandwich" followed shortly after the development of laminated safety glass became a co-operative effort, with other companies contributing.

In describing manufacturing processes, a paper by R. H. McCarroll of the Ford Motor Company follows the glass through rolling, annealing, grinding, smoothing and polishing operations until it has reached its finished thickness of ⅛ inch; it tells how the washed glass is cemented and the centre layer of cellulose acetate plastic, 0.025 inch thick, interposed between two glass layers to form the completed "sandwich."

Finishing operations include subjecting the laminated glass to heat and pressure to complete the bond, and sealing and grinding the edges.

—*S.A.E. Journal*

THE ENGINEERING JOURNAL

THE JOURNAL OF THE ENGINEERING INSTITUTE OF CANADA

Published monthly at 2050 Mansfield Street, Montreal, by The Engineering Institute of Canada, Incorporated in 1887 as The Canadian Society of Civil Engineers.

Entered at the Post Office, Montreal, as Second Class Matter.

"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."

August, 1936 **Volume XIX, No. 8**

CONTENTS

Price 50 cents a copy, $3.00 a year, in Canada, British Possessions, United States and Mexico. $4.50 a year in Foreign Countries.
To Members and Affiliates, 25 cents a copy, $2.00 a year.

Published Monthly at 2050 Mansfield St., Montreal

THE ENGINEERING INSTITUTE OF CANADA

Incorporated in 1887 as The Canadian Society of Civil Engineers

BRANCHES:

Halifax Branch, Halifax, N.S.
Cape Breton Branch, Sydney, Cape Breton.
Moncton, Branch, Moncton, N.B.
Saint John Branch, Saint John, N.B.
Saguenay Branch, Kenogami, Que.
Quebec Branch, Quebec, Que.
St. Maurice Valley Branch, Three Rivers, Que.
Montreal Branch, Montreal, Que.
Ottawa Branch, Ottawa, Ont.
Kingston Branch, Kingston, Ont.
Peterborough Branch, Peterborough, Ont.
Toronto Branch, Toronto, Ont.
Hamilton Branch, Hamilton, Ont.
Niagara Peninsula Branch, Niagara Falls, Ont.
London Branch, London, Ont.
Border Cities Branch, Windsor, Ont.
Sault Ste. Marie Branch, Sault Ste. Marie, Ont.
Lakehead Branch, Port Arthur, Ont.
Winnipeg Branch, Winnipeg, Man.
Saskatchewan Branch, Regina, Sask.
Lethbridge Branch, Lethbridge, Alta.
Edmonton Branch, Edmonton, Alta.
Calgary Branch, Calgary, Alta.
Vancouver Branch, Vancouver, B.C.
Victoria Branch, Victoria, B.C.

Members of Council 1936

PRESIDENT
E. A. CLEVELAND, Vancouver, B.C.

VICE-PRESIDENTS

*E. V. CATON, Winnipeg, Man.
†R. L. DOBBIN, Peterborough, Ont.
†H. W. McKIEL, Sackville, N.B.
†A. B. NORMANDIN, Quebec, Que.
*P. L. PRATLEY, Montreal, Que.

PAST-PRESIDENTS

F. A. GABY, Toronto, Ont.
O. O. LEFEBVRE, Montreal, Que.
F. P. SHEARWOOD, Montreal, Que.

COUNCILLORS

*C. G. R. ARMSTRONG, Windsor, Ont.
†Y. C. BARRINGTON, Sydney Mines, N.S.
*C. B. BROWN, Montreal, Que.
†G. S. BROWN, Lethbridge, Alta.
*G. H. BURBIDGE, Port Arthur, Ont.
†H. CIMON, Quebec, Que.
*A. COUSINEAU, Montreal, Que.
†A. B. CREALOCK, Toronto, Ont.
†T. H. DICKSON, Moncton, N.B.
†A. FRIGON, Montreal, Que.
†A. B. GATES, Peterborough, Ont.
*For 1936

*L. F. GOODWIN, Kingston, Ont.
*B. GRANDMONT, Three Rivers, Que.
†A. K. HAY, Ottawa, Ont.
‡F. S. B. HEWARD, Montreal, Que.
*G. H. KIRBY, Riverbend, Que.
*H. S. JOHNSTON, Halifax, N.S.
†T. C. MAIN, Winnipeg, Man.
‡E. P. MUNTZ, Hamilton, Ont.
‡E. P. MURPHY, Port Colborne, Ont.
‡H. J. McLEAN, Calgary, Alta.
‡F. NEWELL, Montreal, Que.
†For 1936-37

†E. A. RYAN, Montreal, Que.
‡F. SMALLWOOD, Sault Ste Marie, Ont.
*R. E. SMYTHE, Toronto, Ont.
*E. W. STEDMAN, Ottawa, Ont.
†H. L. SWAN, Victoria, B.C.
*J. A. VANCE, Woodstock, Ont.
*G. A. VANDERVOORT, Saint John, N.B.
*H. R. WEBB, Edmonton, Alta.
*A. S. WOOTTON, Vancouver, B.C.
*S. YOUNG, Regina, Sask.
‡For 1936-37-38

TREASURER
J. B. CHALLIES, Montreal, Que.

SECRETARY
R. J. DURLEY, Montreal, Que.

OFFICERS OF BRANCHES

HALIFAX
Chairman, C. S. BENNETT
Vice-Chair., C. SCRYMGEOUR
Sec.-Treas., R. R. MURRAY, 87 Cambridge St., Halifax, N.S.
Executive, J. R. KAYE, I. P. MACNAB, J. D. FRASER, J. F. F. MACKENZIE, W. H. NOONAN, J. W. McLEOD, J. B. HAYES
(Ex-Officio) H. FELLOWS, H. S. JOHNSTON

CAPE BRETON
Chairman, W. E. BOWN
Sec.-Treas., SYDNEY C. MIFFLEN, 60 Whitney Ave., Sydney, N.S.
Executive, M. R. CHAPPELL, W. S. WILSON, C. M. ANSON, W. E. CLARKE
Ex-Officio) Y. C. BARRINGTON

SAINT JOHN
Chairman, J. R. FREEMAN
Vice-Chair., G. H. THURBER
Sec.-Treas., F. A. PATRIQUEN, P.O. Box 24, Saint John, N.B.
Executive, T. C. MACNABB, T. MOFFAT, S. HOGG
(Ex-Officio) V. S. CHESNUT, G. A. VANDERVOORT

MONCTON
Chairman, G. L. DICKSON
Vice-Chair., E. B. MARTIN
Sec.-Treas., V. C. BLACKETT, Engrg. Dept., C.N.R., Moncton, N.B.
Executive, F. O. CONDON, C. S. G. ROGERS, R. H. EMMERSON, F. L. WEST, A. S. GUNN, G. C. TORRENS
(Ex-Officio) T. H. DICKSON, H. B. TITUS, H. W. McKIEL

SAGUENAY
Chairman, J. SHANLY
Vice-Chair., S. J. FISHER
Sec.-Treas., L. R. BEATH, P.O. Box 211, Kenogami, Que.
Executive, W. L. YACK, E. LAVOIE, H. B. PELLETIER, M. G. SAUNDERS
(Ex-Officio) G. E. LAMOTHE, J. W. WARD, G. H. KIRBY

QUEBEC
Hon. Chair., A. R. DECARY
Chairman, ALEX. LARIVIERE
Vice-Chair., J. T. F. KING
Sec.-Treas., J. JOYAL, Quebec Public Service Comm., Court House, Quebec, Que.
Executive, R. WOOD, L. P. METHE, M. BOURGET, A. O. DUFRESNE, J. G. O'DONNELL, A. ROBERGE
(Ex-Officio) A. B. NORMANDIN, HECTOR CIMON

ST. MAURICE VALLEY
Chairman, B. GRANDMONT
Vice-Chair., J. E. FLEURY
Sec.-Treas., J. A. HAMEL, 642 Notre Dame St., Three Rivers, Que.
Executive, F. W. BRADSHAW, C. L. ARCAND, H. J. WARD

MONTREAL
Chairman, J. B. D'AETH
Vice-Chair., H. MASSUE
Sec.-Treas., C. K. McLEOD, 1440 St. Catherine St. W., Montreal, Que.
Executive, R. H. FINDLAY, C. C. LINDSAY, B. R. PERRY, T. C. THOMPSON, J. A. LALONDE, J. A. E. GOHIER
(Ex-Officio) F. S. B. HEWARD, A. COUSINEAU, C. B. BROWN, P. L. PRATLEY, O. O. LEFEBVRE, E. A. RYAN, F. NEWELL, A. FRIGON, F. P. SHEARWOOD

OTTAWA
Chairman, E. VIENS
Sec.-Treas., F. C. C. LYNCH, Dept. of Mines, Victoria Memorial Museum, Ottawa, Ont.
Executive, E. M. DENNIS, T. A. McELHANNEY, N. B. MACROSTIE, G. R. TURNER, B. F. HAANEL
(Ex-Officio) E. W. STEDMAN, R. W. BOYLE, A. K. HAY

PETERBOROUGH
Chairman, H. R. SILLS
Sec.-Treas., W. T. FANJOY, 223 Crescent St., Peterborough, Ont.
Executive, V. R. CURRIE, A. L. KILLALY, E. J. DAVIES, W. M. CRUTHERS
(Ex-Officio) A. L. DICKIESON, A. B. GATES, R. L. DOBBIN

KINGSTON
Chairman, R. A. LOW
Vice-Chair., Lt.-Col. N. C. SHERMAN
Sec.-Treas., Major L. F. GRANT, Royal Military College, Kingston, Ont.
Executive, G. G. CARR-HARRIS, S. STEPHENSON, J. E. GOODMAN
(Ex-Officio) W. CASEY, L. F. GOODWIN

TORONTO
Chairman, O. HOLDEN
Vice-Chair., A. U. SANDERSON
Sec.-Treas., W. S. WILSON, Mining Bldg., University of Toronto, Toronto, Ont.
Executive, W. P. DOBSON, N. MACNICOL, W. E. P. DUNCAN, A. M. REID, D. D. WHITSON, C. E. SISSON
(Ex-Officio) W. E. BONN, A. B. CREALOCK, R. E. SMYTHE, F. A. GABY

HAMILTON
Chairman, W. HOLLINGWORTH
Vice-Chair., E. G. MACKAY
Sec.-Treas., A. LOVE, 40 Paisley Ave. S., Hamilton, Ont.
Executive, W. J. W. REID, A. R. HANNAFORD, V. S. THOMPSON, D. W. CALLANDER
(Ex-Officio) E. P. MUNTZ

LONDON
Chairman, JAS. FERGUSON
Vice-Chair., A. O. WOLFF
Sec.-Treas., D. S. SCRYMGEOUR, London Structural Steel Co. Ltd., London, Ont.
Executive, E. V. BUCHANAN, W. C. MILLER, J. R. ROSTRON, H. A. McKAY, W. M. VEITCH
(Ex-Officio) S. W. ARCHIBALD, S. G. JOHRE, J. A. VANCE

NIAGARA PENINSULA
Chairman, G. H. WOOD
Vice-Chair., L. C. McMURTRY
Sec.-Treas., P. A. DEWEY, 1224 Ontario Ave., Niagara Falls, Ont.
Executive, S. HAIRSINE, W. D. BRACKEN, M. H. JONES, C. S. BOYD, R. A. BRADLEY, C. G. MOON, A. W. F. McQUEEN
(Ex-Officio) P. E. BUSS, E. P. MURPHY

BORDER CITIES
Chairman, T. H. JENKINS
Vice-Chair., C. F. DAVISON,
Sec.-Treas., BOYD CANDLISH, 170 Rankin Blvd., Sandwich, Ont.
Executive, E. M. KREBSER, D. T. ALEXANDER, C. G. WALTON
(Ex-Officio) C. G. R. ARMSTRONG, H. J. COULTER

SAULT STE. MARIE
Chairman, J. L. LANG
Vice-Chair., W. SEYMOUR
Sec.-Treas., N. C. COWIE, 15 Hearst St., Sault Ste. Marie, Ont.
Executive, E. M. MACQUARRIE, T. FOULKES, C. W. HOLMAN, H. W. SUTCLIFFE
(Ex-Officio) F. SMALLWOOD

LAKEHEAD
Chairman, F. C. GRAHAM
Vice-Chair., G. R. DUNCAN
Sec.-Treas., G. R. McLENNAN, 80 North High St., Port Arthur, Ont.
Executive: H. G. O'LEARY, J. M. FLEMING, K. A. DUNPHY, E. A. KELLY, E. L. GOODALL, W. J. BISHOP
(Ex-Officio) G. H. BURBIDGE, R. J. ASKIN

WINNIPEG
Chairman, G. E. COLE
Vice-Chair., A. E. MACDONALD
Sec.-Treas., J. F. CUNNINGHAM, 918 Somerset Ave., Fort Garry, Man.
Executive, F. W. ALEXANDER, H. L. BRIGGS, W. D. HURST, R. W. McKINNON, W. F. RIDDELL
(Ex-Officio) E. V. CATON, F. V. SEIBERT, T. C. MAIN

SASKATCHEWAN
Chairman, W. E. LOVELL
Vice-Chair., STEWART YOUNG
Sec.-Treas., J. J. WHITE, City Hall, Regina, Sask.
Executive, A. R. GREIG, J. W. D. FARRELL, J. McD. PATTON, H. S. CARPENTER, H. J. BYRD, S. R. MUIRHEAD
(Ex-Officio) A. P. LINTON

LETHBRIDGE
Chairman, P. M. SAUDER
Vice-Chair., R. F. P. BOWMAN
Sec.-Treas., E. A. LAWRENCE, 207-7th St. S., Lethbridge, Alta.
Executive, J. M. CAMPBELL, J. B. DEHART, W. MELDRUM
(Ex-Officio) W. L. McKENZIE, G. S. BROWN, C. S. CLENDENING

EDMONTON
Chairman, E. STANSFIELD
Vice-Chair., A. RITCHIE
Sec.-Treas., M. L. GALE, 9914-111 St., Edmonton Alta.
Executive, J. D. BAKER, W. E. CORNISH, C. E. GARNETT, A. J. GAYFER, E. NELSON
(Ex-Officio) F. K. BEACH, H. R. WEBB

CALGARY
Chairman, JOHN DOW
Vice-Chair., H. W. TOOKER
Sec.-Treas., JAS. McMILLAN, 506 Insurance Exchange Bldg., Calgary, Alta.
Executive, J. J. HANNA, W. T. McFARLANE, H. J. McEWEN
(Ex-Officio) J. HADDIN, F. M. STEEL, H. J. McLEAN

VANCOUVER
Chairman, JAS. ROBERTSON
Vice-Chair., H. N. MACPHERSON
Sec.-Treas., T. V. BERRY, 3007-36th Ave. W., Vancouver, B.C.
Executive, E. C. THRUPP, P. SANDWELL, G. L. BOOKER, J. P. MACKENZIE, P. H. BUCHAN, C. P. HAMILTON, F. O. MILLS
(Ex-Officio) G. M. GILBERT, E. A. CLEVELAND, A. S. WOOTTON

VICTORIA
Chairman, I. C. BARLTROP
Vice-Chair., J. C. MACDONALD
Sec.-Treas., KENNETH REID, 1336 Carnsew St., Victoria, B.C.
Executive, G. M. DUNCAN, G. M. IRWIN, G. M. TRIPP, C. D. SCHULTZ
(Ex-Officio) D. MACBRIDE, H. L. SWAN

THE ENGINEERING JOURNAL

The Institute as a body is not responsible either for the statements made or for the opinions expressed in the following pages.

Volume XIX | Montreal, August, 1936 | Number 8

Modern Concrete Pavement Construction Methods

D. O. Robinson, A.M.E.I.C.,
Sales Engineer, Canada Cement Company.

Paper presented before the Saint John Branch of The Engineering Institute of Canada, March 26th, 1936.

SUMMARY:—The construction of concrete highway pavement involves many problems of technique as well as organization. The paper discusses these and their influence upon the cost and satisfactory character of the finished job.

The cement plants operating at the present time on this continent represent an investment of three-quarters of a billion dollars. Roughly thirty per cent of the output of these plants is sold for use in concrete pavements. At the close of the year 1935 there were in service in the United States and Canada nearly one hundred and forty-six thousand miles of concrete highways, streets and alleys. The oldest concrete pavement in service on this continent is the four sides of the public square at Bellefontaine, Ohio, built in 1892. The oldest concrete pavement of record in service anywhere is in Edinburgh, Scotland, built in 1872. Canada's contribution to the pioneering days of concrete road-building dates from 1914 when the Toronto-Hamilton highway, forty miles long, was constructed. For over twenty years this pavement has successfully carried a peak traffic amounting to twenty-three thousand vehicles per day, including 57 per cent of the truck traffic of Ontario.

The change from the early days of concrete road-building with horse-drawn carts and hand labour to the present day organization with fully automatic machinery, carefully graded and inspected materials and supervision by specially trained concrete technologists, is a remarkable development.

In the year 1921 the legislature of the State of Illinois authorized a bond issue of fifty million dollars for highway construction. To properly determine the most satisfactory type of road surface to be established as the standard of road construction one million dollars was set aside for test purposes and what is now known as the Bates experimental road was built near Springfield, Illinois. In the first series of tests a fleet of army trucks with loads of from one to ten tons made twenty-three thousand two hundred round trips over a series of sixty-three sections of all types and designs of pavements. Only ten sections survived; seven were all-concrete pavements; of the other three one had brick and two had asphalt surfaces all on concrete bases six or more inches thick. Subsequently five new concrete sections were built and emerged completely successful from a series of even more severe tests. Two important design principles were established from this outstanding investigation; first, that a road is no stronger than its base, and second, that for the most efficient design of concrete pavements the centre thickness should be two-thirds the edge thickness. As a result of the Bates road tests, the State of Illinois adopted concrete for state highway paving and have laid approximately 9,000 miles since that time.

Shortly before this the fundamental principle of concrete mixes was developed and stated by Professor Duff Abrams, then director of the Lewis Institute, and later of the Portland Cement Association research organization. It has now gained complete acceptance under the familiar title of the "water-cement ratio." It may be restated briefly now as follows:—"For given materials and conditions of handling, the strength of concrete is determined solely by the ratio of the volume of mixing water to the volume of cement, so long as the mixture is workable and plastic." This is the present basis of concrete mix design.

Further developments in concrete road-building have been the introduction and use of machinery to obtain larger and more uniformly good production and numerous refinements and improvements in construction technique. Among the organizations who have contributed to this result, the United States Bureau of Public Roads, the American Society for Testing Materials, the Canadian Engineering Standards Association and the Portland Cement Association may be mentioned.

The methods discussed in this paper are based on actual practice in the field and laboratory and on highway department records. The greater part of the methods described have been used by the author, in gaining his experience in the construction of concrete roads.

In the field of highway construction, the ultimate result must be satisfactory performance of the finished structure. The engineer is concerned primarily with the production of a pavement of definite performance qualities. As the contractor views the same production scheme, his objective is profit, and it is his function to finance, organize and operate an integrated unit of men and machinery on this basis.

Since it has become generally accepted that an engineer be placed in charge of the work, and since the construction of a concrete road involves attention to a great many details, and since concrete road contracting involves a high degree of mass production efficiency, it follows that the engineer in charge should be a man of experience both in matters pertaining to engineering and contracting. Experience has shown that with reference to concrete paving the construction methods of any job are largely determined by the engineer either in his plans and specifications or in the field. Thus, in order for a concrete road to be built successfully the engineer in charge must be specially trained and of experience and sound judgment.

As far as concrete pavement construction on any great scale is concerned, the day of shoe-string outfits is past. A good many contractors now employ trained engineers to design equipment and plant and organization layouts, supervise layouts and compute costs. More important, however, the straight line production methods characteristic of concrete paving have so influenced contracting practice that it has become an accepted maxim of concrete road practice that the profit must be made in the efficiency of the organization.

Whatever construction methods are adopted, the cost of the raw materials will not vary greatly, but job organization and construction methods do affect the cost of performing the work. Therefore the contractor has a vital interest in the amount of finished work he can secure from his organization per dollar of work expended.

The important consideration, to the contractor, is to select and use the combination of men and machinery that will produce the finished road at the lowest unit cost. Combinations of labour and machinery not suitable to mass production should be avoided for extensive work—although they may be satisfactory for small jobs. It should also be remembered that the job organization as a whole cannot produce in excess of the capacity of the most inefficiently handled operation in the series. A simple illustration will show the importance of this rule. Consider two units in a hand-grading gang—the first unit a single labourer shovelling dirt from the ground into a wheelbarrow, and the second unit a single labourer wheeling the full wheelbarrow away, dumping it and returning it to the original position for another loading to be performed by the first unit. It is at once obvious that, excluding fatigue and personal considerations, as far as these two interlocking hand labour units are concerned, the first unit can produce no more than the second unit will allow and vice versa. The two operations have a definite fixed production as a series of operations and are entirely interdependent.

Thus proper unit costs of a concrete paving job depend upon proper recognition of the following rules:—

1. Select the type of labour and equipment best suited for the nature of the operation to be performed.
2. Select the rate of production based on the productive capacity of the most inefficient operation-unit.
3. Arrange the capacity of the remaining operation-units on the basis of rule 2.
4. Select supervisory personnel which will ensure exact maintenance of the production rate decided upon.

The engineer must have an accurate working knowledge of contractors' equipment and organization and must be competent to run the job strictly on the basis of the conditions laid down.

While it is true that concrete pavement practice has been standardized on this continent to a large extent there still remain wide variations in actual practice in various parts of this country and in the United States. This variation has to do principally with field testing and job supervision. Under the jurisdiction of the highway departments, it is variously specified that payment for the work performed shall be made on the basis of work supervised and tested by the engineer in charge; that the finished road shall be paid for on the basis of samples taken from the completed structure and tested in accordance with a prearranged schedule; that the highway department supply certain materials to the work and arrange for independent supervision and testing. In numerous instances the highway department maintains its own construction forces which operate as an independent unit, under the same conditions as private enterprise. In general, however, the highway engineer—here a term to include all members of a department—designs all pavement structures including the sub-grade upon which the slab will rest, selects and tests all materials, supervises and controls all construction methods and with a complete technical record of the work estimates its progress and passes on payments of money for work done.

In this paper, to limit the field of discussion it will be supposed that a concrete pavement, embodying the best of present day practice, is to be built in an imaginary location. It may be assumed that every detail of this imaginary job has a counterpart in actual practice.

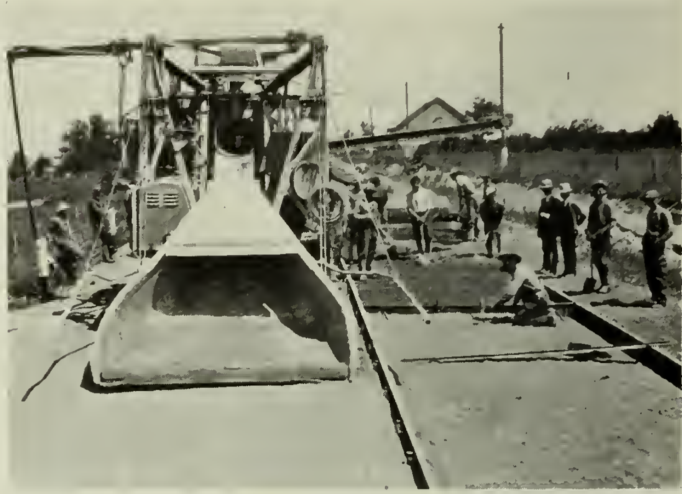


Fig. 1—Mixing and Placing Concrete.

The broad policy of the imaginary highway department with respect to the network of trunk roads under its jurisdiction may be briefly stated as follows:—The importance of any highway or section of highway is determined solely by the character and intensity of the traffic which it may be required to carry. Conversely, it may be said that the principal function of the highway department is to provide, with the revenue derived from motor vehicle taxation, road surfaces which will enable the traffic of the region to be moved from place to place with the greatest possible safety and the lowest possible cost, such cost being properly divisible into two parts: first, the annual cost of the road surface; second, the cost of operating the traffic over the road surface.

The operation of a system of highways requires a good deal of long-time planning in which the more important considerations are as follows:—

1. The continuous operation of an accurate traffic survey system.
2. Intelligent regulation and licensing of traffic.
3. A survey of all construction materials of the region.
4. Research studies of road surfaces in operation.
5. Active field and laboratory research with respect to methods and construction types and the parallel development of trained personnel.

The cross-section of pavement to be used in the imaginary road to be described will be determined from a consideration of, first, the probable load-carrying capacity of the sub-grade, and second, the probable maximum wheel-loads for a period approximating the life of the pavement. The first consideration has become considerably simplified during the past few years because of research on soil investigation, frost heaving, etc., with the result that with a careful field survey of the existing sub-soils materials and proper replacement of doubtful and unstable materials a sub-grade of reasonable stability may be obtained in all but freak conditions of soil disposition. The second consideration has been largely determined in the past by experience with actual conditions of traffic. At the present time rationalized formulæ are available with which to choose a pavement cross-section suitable to the expected intensity of traffic, and which have been developed from a great many experimental studies and field reports of pavements in service.

Plans and specifications for the pavement project will have their beginning at this point commencing with the design of the cross-section proper. It will be necessary to design necessary additional drainage structures, changes in grade or alignment, soil removal and necessary landscaping. Material specifications must be written to include materials available for the project. Earthwork quantities must include the recommendations of the soil engineers for the proper elimination of frost-heaving, etc. The completed plans will indicate the requirements for the preservation or removal of trees, shrubs, etc. When all the information has been co-ordinated and revised as a unit specification and the total quantities of the work determined, a contract form is attached, checked by the legal department and the completed sets of plans and specifications are given to the project engineers who from this point are expected to take full charge of the work.

During the period of advertising for tenders the project engineer will consult with interested contractors regarding sources of material, probable arrangements for maintaining traffic, requirements of equipment and plant layout, schedule of operations and many other details, in order that the contractor may be thoroughly aware of what he will be required to do. The contractor is required on his tender form to state exactly his experience, his resources, the equipment available and a tentative production schedule. He must also supply samples of the material proposed for use in sufficient quantity for adequate testing with full details of their source.

The award of the contract implies that the contractor's experience, cash position and equipment are satisfactory; that the materials he intends to use are satisfactory as to quality and quantity and that he accepts without reservation the plans and specifications attached to his contract.

At the proper season the contractor may begin to move in supplies and equipment to the site of the work and about this time the project engineers appear with their field laboratory. For the contractor this is the all-important time of plant layout and selection of equipment; for the engineer the dual responsibility begins of mix design and job layout.

In the selection of materials for the work, the contractor has a wide choice of plant layout and equipment. If he has elected to use local materials, that is sand and stone occurring naturally near the line of work, his requirements for equipment and yard space will be quite different from those resulting from the use of commercial materials —available at the nearest railway siding, boat dock or truck haul. The use of local materials, that is sand and stone available as gravel or sand pits and stone quarries, will entail the purchase or rental of property and its cleaning and stripping with suitable equipment; the use of excavating and quarrying equipment; the use of a washing and screening plant and a crushing plant and considerable storage space and stock-piling equipment. The location of the sites of raw materials will also influence the location and type of proportioning and hauling equipment and in some cases the rate of production of the entire job. This can be readily understood in the case of a gravel pit situated several miles off the road to be paved, which can be reached only by a road of doubtful bottom. In this case the road will not stand the double traffic of batch-trucks for long periods and therefore provision must be made in the plant layout for doing as much work away from the gravel-pit as possible—a consideration involving loss of capacity at two points—the source of supply and the proportioning yard.

Bearing in mind that the specifications for the job require clean, separated materials, stock-piled to prevent segregation and uneven moisture content and accurately weighed, and supposing further a local source of supply in the form of a gravel pit, the equipment required will be somewhat as follows:—It is supposed that the pit is easy of access from the job and washing water freely available. Depending upon the nature of the pit, removal of the raw material after stripping may be accomplished by either excavation from a vertical face with a power shovel or similar equipment or excavation from a horizontal face by means of a drag line, teams and scrapers, etc. From this point the material is fed to a crushing, washing and screening plant, where all silt, loam, etc., is removed, where oversize material is crushed to meet specification requirements and finally separated to the sizes required as sand and stone or fine and coarse aggregate. It is only essential to plan this unit upon a scale sufficiently large to ensure that at all times there is a stock-pile of ready-to-use material available for at least three days' work.

The equipment of this unit will include an excavating unit, either power or hand, the screening, washing and crushing unit, necessarily a power operation, a stock-piling unit, either a power unit, such as a clam-shell crane or hand-operations such as teams and scrapers, and auxiliary equipment of various kinds such as water-pumps, compressors, etc.

The selection of equipment for the balance of the operations will be determined largely by the job capacity as indicated by the paver. It will be assumed that the specifications require the construction of the pavement in units of 10 feet wide, prohibit the placing of any construction equipment, including the paver, in the sub-grade about to be paved, and require the placing of considerable reinforcing. The volume of concrete to be placed per lineal foot of pavement, together with the limited room available on the sub-grade for handling the paver and the supplying batch-trucks definitely limit the amount of concrete that the organization can place on the sub-grade for every complete cycle of operation of the paver. For the vast majority of concrete paving jobs the standard size of road paver is that known as a 27E, which, allowing for a generally accepted overload of 10 per cent, will mix thoroughly approximately 30 cubic feet of concrete in one minute on a 6 per cent grade. The operating cycle of a late type of 27E paver in which all operations are automatic except those of lowering the charging skip and operating the concrete depositing boom and bucket, requires seventy-

Fig. 2—Delivery of Material by an Industrial Railway.

eight seconds to charge the drum with a batch of material, mix the batch and place it in the bucket ready for placing on the sub-grade. This is the definite capacity of the job for peak operating efficiency, providing for no breakdowns at the mixer and no delays of any sort. This efficiency is never attained for long periods, and for the basis of ordinary job estimation, the mixer cycle is usually set, as an optimum figure, in the neighbourhood of ninety seconds.

It only remains to relate this designated unit capacity to the balance of the equipment required for transportation of the prepared ingredients and the equipment required for their weight measurement in batches. The transportation equipment selected for the majority of concrete pavement jobs is trucks of some sort, gasoline or Diesel operated, with power operated dump bodies and either of single or multiple-batch capacity. An alternative in some favour is the use of industrial railway cars and locomotives, with the prepared materials in batch boxes on flat cars. In this case, the paver is equipped with a power hoist-crane which removes the batch box containing the batch of materials from the flat car, dumps the batch in the skip and replaces the box on the car. The use of this type of equipment involves a higher cost of investment in equipment, gives a slightly lower operating cost and avoids the evil—nearly always present when trucks are used—of bunching the transportation equipment with consequent gaps in the supply of materials to the paver. This type of transportation also requires considerably more room at the side of the work in which to operate than is ordinarily available except in the case of superhighway construction or widening work.

Figuring this imaginary job on the basis of batched material supply by trucks, the most apparent difficulty and the source of most lost time and consequent increase in unit cost lies in the use of multiple-batch trucks—the ordinary 5-ton truck with a power dump body divided into two or three compartments by steel dividing gates, hand operated at the paver for releasing the batch of material. The most logical unit upon which to base a cost is obviously a batch of prepared material — that is, the cost of proportioning, hauling or mixing a predetermined weight of cement, sand and stone. With the use of multiple-batch trucks it is apparent that the cost of hauling one batch of material from the proportioning bins to the skip of the paver is considerably increased by the delays occasioned by loading one or two additional batches of material after one batch is ready for transportation. Similarly at the paver there is an equal or greater delay occasioned by holding one or two batches in the truck while the first batch placed in the skip is being mixed and placed. In fully efficient operation these delays will amount to an increase in the unit hauling cost of at least 25 per cent — including the lost time of the truck and operator unit and the lost time on the batches. There is, of course, an entirely disproportionate rise in the unit cost whenever one of these multiple units is delayed. Disregarding all causes of delays resulting from breakdowns—and the principal value of the multiple-batch truck lies in its greater ruggedness and increased ability to stay on the road—the recent changes in specifications requiring the construction of a pavement in ten-foot lanes and requiring all construction equipment to stay off the prepared sub-grade have made it increasingly difficult to handle this type of equipment at the paver even with the use of turntables.

With the increasing reliability of lighter truck units and increasing refinements in engineering practice it seems reasonable to suppose that one-batch truck operation is worth consideration from the standpoint of lowered operating costs. The effect of length of haul on either type of equipment is not easily understood and remains for the most part a problem of the individual job. The number of trucks operating over a given haul is not directly related to the length of haul except as it concerns the amount of work to be done at the paver, that is, lineal feet of road completed per round trip of all the trucks on the job.

The proportioning equipment consists of two essential parts: a storage bin divided into as many compartments as are required for separate sizes of material above a matching set of weighing hoppers. The accuracy of the scales operating the weighing hoppers is usually 0.4 per cent, and in the later types of weighing equipment the operation is semi-automatic.

With the placing of the proportioning bins comes the problem of yard lay out, for which the prime considerations are adequate storage space for materials and other supplies and convenient access thereto, and the most efficient system of ingress and egress for the batch trucks. The easiest layout to plan is that where materials are supplied from a railway siding; the most difficult that situated at the source of supply of the sand and stone. The common error made in all types of plant layout is insufficient room and poor trucking and hauling surface. This error reappears as part of the problem of truck hauling to the paver — where in a great many cases the use of an inexpensive piece of grading equipment kept in constant use on the grade will pay big dividends in the avoidance of costly truck delays.

The actual job operation may be best described by detailing a full cycle of operation — the history of a prepared batch of material, from the stock-pile to its permanent resting-place as a part of the roadway slab. This also presents the best opportunity for a description of present engineering practice as indicated by the specifications.

Fine aggregate in the stock-pile ready for use must meet the requirements of the daily test routine of the field laboratory. The tests applied are governed by the specifications of the Canadian Engineering Standards Association and the American Society for Testing Materials, and deal with gradation, briquette tests, deleterious substances, sampling, voids, specific gravity, unit weight, organic impurities, decantation, soundness and surface moisture.

In a similar manner the coarse aggregate or stone is subjected to an exhaustive daily routine under the following requirements:—

Tests are made as to gradation, deleterious substances, decantation, wear, soundness, sampling, sieve analysis, specific gravity and unit weight.

Ordinarily no field tests are carried out with respect to Portland cement. Standard methods of sampling are followed (A.S.T.M. Specification C77-32), and the cement must meet the current requirements of the C.E.S.A. Specification A23-1929 Appendix IV and the A.S.T.M. Specification C9-30.

The requirements for the concrete are briefly as follows:—The fresh concrete at the time it is placed on the sub-grade shall contain at least 1.5 barrels of cement per cubic yard, not more than 4.67 imperial gallons of water per 87½-pound sack of cement, and a consistency, as indicated by the slump test (A.S.T.M. Specification D138-32T) of between one and three inches. The hardened concrete must show in compression tests at least 3,500 pounds per square inch at twenty-eight days for each test, at least 650 pounds per square inch modulus of rupture in flexural tests at fourteen days, and when cores are drilled from the finished pavement not more than one-half inch variation from the specified thickness.

The basis of the mix design is the water-cement ratio and the job mix is established by the use of the contractor's machine prior to commencement of operations by successive trials and, except under special conditions, not by calculation. After a satisfactory mix has been obtained, it is of course necessary to calculate the weights of the cement, sand and stone required per cubic yard of concrete and per batch of material suitable for the capacity of the equipment. The weights so established prior to concreting are not fixed, but are dependent upon the uniformity of supply of the sand and stone and it is a recognized laboratory routine to redesign the mix for each day's work or portion of a day depending upon the material tests results and for the satisfactory calculation of completed quantities.

If the stock-piled materials have been properly placed in layers no especial care is necessary to transfer them to

Fig. 3—Setting Side Forms.

the storage bins above the weighing hoppers. The operation of weighing quantities of sand, stone and cement is continuously supervised, the satisfactory operation of the semiautomatic scales frequently checked. When loading the three ingredients into open batch trucks it is customary to load first the quantity of stone required, then the cement, and finally the sand. With this arrangement, the truck bodies are kept reasonably clean and little or no cement is lost en route. A frequent source of trouble in this connection is loose tail gates on the trucks. Further, serious trouble may often be avoided by the use of tarpaulins to cover the loaded bodies. A distance of six or seven miles between the proportioning plant and the paver is not uncommon and in case of a sudden rain or breakdown at the paver, necessitating stoppage of work, loaded trucks already on the way are thus protected for some time. Careful record is made of all shipments of material from the proportioning plant. A typical daily report will show as a principal item the amount of concrete placed as measured in place and also the amount of concrete placed as calculated from the amount of material shipped to the paver. The discrepancy between these two figures is fixed by the specifications as a maximum of three per cent.

The important consideration in the preparation of the sub-grade is to ensure the presence of a cushion of sand or gravel or similar material of uniform thickness and supporting power, perfectly smooth and accurately shaped to the required cross-section. The operation of building this smooth, accurate support for the slab and the parallel operation of setting forms is always carefully supervised. The introduction of special grading equipment, first for cutting the trench for the steel forms and then shaping the sub-grade by a sub-grade planer riding on the forms has done much to eliminate difficulties formerly encountered at this stage. The use of steel forms is compulsory. The specification will detail the recommended type as to weight per foot, quality of steel, method of supporting and staking and supporting width. The usual tolerance for accuracy in form setting is one-quarter of an inch in ten feet.

When all construction equipment outside the slab is placed, it is a comparatively simple matter to instal transverse joints, reinforcing, etc. The use of joints in concrete pavement construction is to prevent the formation of irregular cracks caused by changes in temperature and moisture content of the slab in service, by providing regular separations at predetermined intervals — the length of interval depending upon the local range of temperature, sub-soil conditions and class of aggregates used. To ensure that traffic loads may be properly transferred from one slab to the next without damaging the slab adjacent to the joint it is standard practice to instal steel dowels at specified intervals across the joint. Specification for the imaginary job will require the installation of three-quarter inch round bars, 30 inches long, properly supported on the sub-grade on metal chairs and with a sleeve on one end, spaced at 18-inch centres. The joint used will be of the submerged poured type, at 40-foot intervals, and may be described as follows:—Prior to concreting, a metal bulkhead is installed between the forms the underside of which is properly cut to the pavement cross-section and the top to the pavement crown. It is set just below the top of the pavement so that subsequent finishing operations may be carried on without disturbing it. It is ordinarily made of at least ten-gauge steel in the form of an inverted U and the overall thickness is three-quarters of an inch. Securely staked in place it remains in its position under the slab until all finishing operations have been concluded on the pavement surface. At about this time it is raised slightly above the pavement surface and the edges of the joint so formed accurately rounded with an edger—usually of one-half inch radius. It is left in this position until the surrounding concrete has hardened sufficiently to permit of its removal without damage. This is done and the joint is covered immediately to prevent the intrusion of foreign material. The following morning the joints so constructed the previous day are filled with asphalt or tar of a suitable viscosity. This type of joint is structurally satisfactory providing the dowels are not disturbed when the concrete is placed around them so that slippage is prevented or the dowel is prevented from acting in straight shear. To overcome the difficulty of installing this type of joint, considerable research has been done in the past few years on new joint types. The joint in question has the single handicap of excessive cost; it is easy to fabricate and quickly installed and appears to be quite satisfactory in service.

Reinforcing is ordinarily placed in mats of bars fabricated either in the field by clips or in the shop by spot welding. The amount and position of reinforcing in the slab is subject to wide variations depending upon local experience and soil conditions. The specification will require the placing at designated spots of bar mats of structural steel grade or intermediate grade (A.S.T.M. Specification A15-33) weighing from 40 to 87½ pounds per 100 square feet of pavement. The contractor may either buy his mats ready made or buy loose bars and fabricate the mats on the job. The mats will be placed two inches from the top of the slab. The actual placing of the mat is usually accomplished by placing a layer of concrete to the requisite depth, placing the mat thereon and placing the remaining concrete over it. This method is effective only if the first layer of concrete is accurately struck off so that the reinforcing mat occupies a true horizontal plane in the slab. A more efficient method, if required, is to fasten the mat securely to steel chairs driven into the sub-grade so that the mat is supported at the correct elevation and place the concrete in one operation. This latter method avoids repetitive operations of the paver boom and bucket and possibly the paver over the length of the mat. It has the slight disadvantage that the mat may be seriously disturbed before embedment if the labourers placing the concrete are permitted to walk over it to any extent. In place of using mats of bars for reinforcing, some specifications provide for the installation of what are called shear bars—ordinarily a three-quarter inch round bar placed near all edges of the ten by forty foot bay of pavement. The bar is greased and painted prior to installation to destroy the effect of bond and to provide for its complete action in shear. This type of reinforcing is also dependent upon accurate and secure placing for its effectiveness.

The linking up of these auxiliary operations such as grading, form setting, joint and reinforcing installation to the rate of capacity of the principal equipment units is

Fig. 4—Removing Joint Plate.

accomplished by proper provisions in the specifications. The contractor is required to provide sufficient forms, etc., for at least two days' run of pavement and the amount of sub-grade and forms at all times complete during concreting operations is variously specified as between 500 and 1,000 feet. This is necessary from the engineers' standpoint to provide for complete inspection of sub-grade forms, etc., and to allow time for the correction of possible errors in grade or alignment.

It is proposed to describe now the actual mechanics of the system in operation. With the rated capacity of the paver in mind, it is necessary that enough trucks be placed in service to accommodate this capacity at all times. This number is subject to variation as a normal adjustment with varying lengths of truck haul as the paver occupies daily a different position on the road. The number of trucks required for optimum operation at the paver takes into consideration two factors. The first of these is the length of time required for a round trip haul; the second the length of time required for loading and unloading a truck—including the time required to manœuvre the truck into position at the proportioning plant, receive a load and get out of the plant, do the necessary backing and turning at the paver and deposit batches there and get free of the paver. The time for actual haul is dependent upon a good many things, chief of which are the mechanical condition of the hauling units, the grade, alignment and surface condition of the road, the length of haul and the amount of foreign traffic permitted on the road. With defective equipment or a grade in bad condition the calculated haulage time may easily be doubled with consequent dire effects upon the expected haulage costs. The second factor—that amount of time spent by a truck on the job when not actually hauling pay loads, loading, turning, unloading, etc.—is the one which demands in practice the most attention, simply because valuable minutes of operating time are spent overcoming obstacles usually within the power of the contractor to remove. An inefficient yard layout, the result of an apparent saving of a few dollars rent or surface treatment of the turning area, may easily add two minutes to the time of a round-trip haul of every truck for the entire length of the job—a clear loss of hundreds of dollars.

Hauling costs either as a part of the general contract or as a sub-contract amount to 20 per cent of the total cost for most paving jobs. It is therefore vitally important to exercise extreme caution when designing or operating this branch of the job.

The paver is expected to produce a batch of concrete properly mixed at intervals of ninety seconds. The manner in which this is accomplished is as follows:—The mixing time of one minute, as required by the specifications, is controlled by the operation of a clockwork arrangement called a batchmeter, set and locked by the mixer inspector. At the completion of the required minute of mixing, the batchmeter rings a bell and releases the previously locked discharge chute. The concrete is thus automatically discharged into the spreader bucket at the correct instant. At the same instant as the batchmeter unlocks the discharge chute, the power clutch for raising the charged skip engages and the skip bearing the next batch of materials is raised to its discharging position. The operation of discharging the batch of concrete from the drum is concluded shortly before the skip is raised to the discharging position and in this interval water to the correct amount is automatically fed into the now empty drum. Immediately the drum is empty and before the water is introduced the discharge chute is returned to its closed and locked position. The skip reaches the charging position, the batchmeter is engaged and begins a fresh cycle of time, the dry materials drop into the drum and the cycle is repeated. It will be evident that the interval of time as measured by the batchmeter must include one minute of mixing time plus the length of time necessary to discharge all the dry materials into the paver drum. The amount of water introduced is controlled by a calibrated gauge also set and locked by the mixer inspector. The amount of water thus introduced at the paver is the theoretical amount as required by the specifications less the amount of water present in the aggregates. Since moisture content determination of the aggregates is a routine test at the laboratory at the proportioning plant, it only remains for the project engineer to make the necessary subtraction and advise the mixer inspector as often as necessary to what figure the paver water gauge must be set. Manually controlled operations on the paver consist of lowering the skip to the charging position, the operation of the spreader bucket on its boom to place the concrete on the sub-grade—late type pavers perform this operation by power—and the movement of the paver as a vehicle down the road on its caterpillars.

At the risk of becoming tiresome, attention is called again to the fact that under the above described conditions of operation, delays resulting in increased mixing costs cannot be compensated for. The cheapest operation of the paver is at its rated capacity and time once lost cannot be regained.

With the concrete deposited on the sub-grade, the time element becomes less important and the new problem of craftsmanship appears, coupled with the hazard of weather conditions. Under normal conditions of weather and pavement cross-section there is a direct relation between the amount of fresh concrete produced by the paver and the amount of finished pavement that must be worked on by the organization behind the paver per working day, but the same relation does not hold true from hour to hour during that working day. This is because certain related operations must be performed on the pavement surface at a time depending upon the condition of that surface as influenced by temperature and humidity and wind. For example, the specifications require the final belting of the pavement surface after the water sheen has disappeared from the surface. Depending upon whether the day is bright and warm or cold and dull, the time at which the operation of belting may be performed will vary as much as three-quarters of an hour—an interval of time during which the section of the organization behind the paver has been idle even though the concrete has been deposited for them to finish at the same rate as before. A concrete pavement 20 feet wide is widened around curves sometimes as much as four feet. Here then is an extra surface of concrete to be handled by the finishing organization while the rated capacity of the mixer is unchanged. To further explain the operating of caring for the concrete from its plastic condition as it comes from the mixer until it hardens, a complete schedule of finishing operations is herewith presented. The ideal specifications, to which we have so often referred, require machine finishing with vibration, a final pavement surface true to within one-quarter inch in ten feet and having an evenly roughened texture obtained with a broom.

The concrete is deposited on the sub-grade by the spreader bucket in layers parallel to the centre line of the pavement with the ends of the layers as nearly as possible at right angles to the centre line. It is shovelled by hand to approximate position slightly higher than the final position and is struck off and consolidated by a power finishing machine. A late type of this machine is powered by electricity generated by a gasoline motor and consists of a steel frame mounted on four flanged wheels riding on the steel forms supporting an adjustable steel strikeboard. As the machine is driven forward the strikeboard is driven from side to side and the combined forward and sidewise motion compacts and strikes off the concrete to its true position. The forward speed of the machine is adjustable between 20 and 60 feet per minute while the stroke of the strikeboard resting on the steel forms is about 8 inches.

Fig. 5—Earth Curing.

For vibrated concrete the vibrating units are mounted on the steel strikeboard and the vibration is thus transferred directly to the concrete. The operation of the finishing machine is repeated as often as necessary within limits defined by the specifications as to length of travel and time of finishing. Ordinarily two passages of the machine are sufficient to secure a true surface. The adjustable strikeboard is set to carry a crown slightly in excess of that required in the surface of the completed pavement.

After the true surface has been established in this manner, it is floated longitudinally by hand with a wooden float usually about 14 feet long and 8 inches wide. This float is operated by two men from two bridges placed across the slab and is moved slowly from side to side with a wiping motion. The effect is to eliminate ridges and depressions in the surface resulting from irregularities in the forms, etc., and to remove excess water from the surface. The operation of the longitudinal float is repeated for the entire length of the slab and each successive operation is lapped one-third of its length. The pavement surface is then tested with 10-foot straightedges longitudinally and if irregularities in the surface are discovered the two previous operations are repeated with fresh concrete in the faulty areas. The conclusion of this operation is followed by raising the transverse joint bulkheads and establishing the tooled edges of the joint. As previously described no further work is done on the surface until the water sheen has disappeared, when the entire surface is belted. This is performed by a length of canvas rubber belting six or eight inches wide moved with short strokes transversely to the centre line of the pavement and rather rapidly advanced parallel to the centre line by two men one on either side of the slab. This operation is repeated if additional water appears at the surface of the slab.

The final texture of the pavement surface is obtained after belting by drawing a fibre broom of proper thickness across the surface at right angles to the centre line of the pavement to form a succession of ridges and hollows. Successive passages of the broom are permitted to slightly overlap and each passage of the broom across the slab must be a single stroke from the centre of the pavement towards the edge. The depth of the hollows and the height of the ridges thus formed is about one-eighth inch. This type of pavement surface texture provides probably the best insurance against future scaling or dusting of the surface, provides an ideal non-skid surface and, for night driving, provides a surface of maximum visibility. As a last operation all slab edges and joint edges are tooled with edgers which gives the slab a neat appearance and helps to prevent spalling and ravelling.

The imaginary specification, it may be remembered, required a compressive strength to be developed in test specimens of 3,500 pounds per square inch at twenty-eight days and a flexural strength of 650 pounds per square inch at fourteen days. In order to ensure that the pavement slab shall develop this strength for which the mix was designed it must be properly cured. Concrete hardens because of chemical reactions between Portland cement and water and the process continues indefinitely under favourable temperature conditions and the presence of moisture necessary to complete the hydration. The critical period is during the early life of the concrete. Consequently any method of curing which prevents the evaporation of water usually present in excess at the time of mixing is satisfactory. The most common method at present in use for concrete highway construction requires the use of burlap and earth. Immediately upon completion of the final finishing operation the slab is covered with strips of burlap and both are kept thoroughly soaked with water for twenty-four hours. At the end of this time, the burlap is removed and at least two inches of earth is placed over the entire slab including the sides of the slab exposed after removal of the forms and is kept continuously wet for at least fourteen days, when, if the flexural test specimens, stored at the edge of the slab, show strengths equal to or above 650 pounds per square inch, watering may be discontinued, the earth removed and the pavement opened to traffic. An alternate method in considerable use in flat country, provides for dykes to be thrown up at the pavement edges after removal of the burlap and the pavement then flooded with water—the ponds thus created being kept full of water until satisfactory flexural tests are obtained. A third method in use where suitable earth covering is not available or where sufficient water is not available for both mixing and curing, is to seal the surface of the pavement—without penetration—with a compound either before or after the use of the burlap. Asphalt emulsions are used for this purpose. If this type of curing is used it is necessary to apply the same treatment to the test specimens stored in the field. Additional methods

Fig. 6—Curing by Ponding.

of curing at present under development provide for the use of water-soaked cocoa matting covered with rubberized sheets applied directly after finishing.

On rural highway construction water supply is an important consideration. For this type of work water for mixing and curing purposes must be pumped considerable distances and the equipment of pumps, valves and pipe line represents a considerable outlay. In nearly all specifications where it is anticipated that this type of equipment will be used, it is customary to specify the capacity of the pump and the size of pipe line that must be used as well as sufficient valves and outlets to insure correct operating water pressure for mixing and curing. In addition stringent rules are embodied in the specifications regarding the quality of the water supplied and the maintenance of the source of supply in a safe, clean condition.

The curing operation satisfactorily concluded and the pavement having attained its specified strength it remains now to clear the slab of the debris of curing, etc., inspect all joints and refill those which are not flush with the adjacent slab. Shouldering operations are now usually begun—the road being opened to traffic and final tests are made on the structure in service. The first of these is a check on the riding quality of the surface and involves checking the pavement with a straight edge, profilometer or similar equipment. Areas of pavement with variations from the true profile of smoothness greater than the minimum permitted are marked with paint to be ground off before the project is completed. At this time core specimens are drilled at intervals from the slab and the resulting thicknesses of slab exposed are made the basis of payment for the work. A generally accepted rule for procedure for payment on the basis of core thickness is as follows:—Core samples are taken at the rate of one core for every 1,056 lineal feet of pavement. For every mile of pavement therefore five cores are available and the basis of payment for that particular mile of pavement is

$$\frac{(\text{Average thickness of five cores})^2}{(\text{Specified thickness})^2} \times \text{Contract price per sq. yd.}$$

This rule applies for every section of pavement in which the core thicknesses are not more than one inch less than the thickness specified. Sections of pavement in which cores are drilled and found to be more than one inch less than the thickness specified are required to be removed and replaced at the expense of the contractor. Core samples more than one-half inch longer than the required thickness are not included in the formula given above.

Compression cylinder tests made in the field and tested in the field are an accurate guide as to the quality progress of the work. They are made in some cases in groups of two or three once or twice per working day, part stored in the field similarly to the flexural test specimens and the remainder cured in damp sand or water at the field laboratory. They are tested in groups as made at seven and twenty-eight days. For Canadian practice it is usual to assume the seven-day strength as roughly 80 per cent of the twenty-eight day strength.

At the close of the working day the work stops at a regular transverse joint so that no irregularly spaced construction joints appear in the work. The following day work is resumed and the joint constructed in the regular way. Forms are stripped from the previous day's work if the concrete is sufficiently hardened, carried forward, cleaned and oiled ready for another installation. Similar practice obtains for the joint bulkhead plates, the burlap and other items of equipment requiring daily use. A supply of hand finishing tools and tarpaulins should be kept on the paver at all times, the first to provide against a breakdown of the finishing machine and the second to protect the newly placed pavement from sudden rains.

It has been stated before that each of the work operations here described is a separate full time study and this paper is intended as nothing more than an outline of a workable organization and a few of the many acceptable methods at present in use. In conclusion it may be said that, in the opinion of the author the most valuable item of equipment that a present day concrete road contractor can possess is an accurate stop-watch. Profits to-day lie in the seconds that slip by when breakdowns and delays occur.

Lightning in the Transmission Problem

A. C. Monteith,

Central Station Engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

Paper presented before the Montreal Branch of The Engineering Institute of Canada, February 21st, 1935.

SUMMARY:—Recent experimental work on the characteristics of insulation structures is noted, with a brief discussion on the use of the direct stroke theory in protecting transmission lines against surges due to lightning.

It is an unfortunate fact that the whole design of a power system must be based on its ability to cope with trouble. The earliest circuit breakers passed load current very satisfactorily, but it was soon found that on short circuits they were not adequate. From then on short circuits became the dominating factor in breaker design. In the same way machine windings developed a habit of twisting themselves out of shape on short circuit and a whole technique of bracing windings was developed. In more recent years the operating people began to object to their systems collapsing when a severe fault occurred, and as a result what has become known as quick response excitation was brought out. Now finally that a knowledge of lightning is beginning to take shape, thanks to the klydonograph and cathode ray oscillograph, the whole philosophy of line construction is undergoing a change. It is this latter problem that will be reviewed.

The subject "Lightning in the Transmission Problem" can logically be covered under three headings:

1. What is the present understanding of the characteristics of natural lightning?
2. What is the understanding of the characteristics of insulation structures?
3. How can this knowledge be used to improve the design of transmission systems?

Space will not be taken to review the first two in detail. Natural lightning as it appeared on transmission systems has been measured by means of the klydonograph and cathode ray oscillograph. This has given considerable data on magnitude and duration of surges on lines. The highest surge, having a crest of 5,000,000 volts, was recorded in 1930 on a 110 kv. wood pole line of the Arkansas Power and Light Company. Also direct evidence in the form of photographs and observations indicated that lightning could strike near a line and yet harmful voltages did not appear.

As a result of field work, Dr. Fortescue advanced his direct stroke theory according to which all surges on a high voltage transmission line that cause flashover are the result of a direct hit to the line from the main stroke or from a streamer, and there is now pretty general agreement that direct strokes should dictate the design of transmission lines and substations. In the lower voltage classes, which for economic reasons cannot be so well insulated as the high voltage lines, induced surges may occasionally cause trouble. If this new theory is accepted, then the ground wires instead of being located for maximum coupling, as dictated by the induced stroke theory, should be installed to obtain maximum shielding primarily and then as a secondary consideration should be located to obtain as good coupling as possible.

Surge generators have been built and wave shapes simulating those of the recorded natural lightning have been applied to different insulation structures. Considerable information is therefore available on the characteristics of insulation structures. For convenience the time lag curves of rod gaps and insulators are shown in Fig. 1.

Having briefly outlined the characteristics of natural lightning and the characteristics of insulation as obtained in the laboratory, the use to which the data can be put will be considered.

Line Design

Dr. Fortescue has prepared certain fundamental curves for line design based on the direct stroke theory and these data have been made up by the author into a series of convenient curves for use in designing a line.

The electrical design of a transmission line based on the direct stroke theory is practically independent of operating voltage, just as the application of an oil circuit breaker is almost independent of operating current. When a stroke hits the tower top the potential rises, due to the tower surge impedance and the tower footing impedance. Calculations and tests have been made on the potential at the top of the tower for various assumed ground resistances. For example with a 1,000-foot span and 10 ohms tower footing surge impedance, for every thousand kv. in the stroke, the potential at the tower top will reach 170 kv. For 5 ohms it will reach 137 kv., all of these figures being based on a wave with one microsecond front, and a stroke impedance of 200 ohms. The potential at the tower top is seen to depend on the tower footing surge impedance.

There is a further major factor to consider. When the tower is struck, a surge of like polarity appears on the line conductors. This reduces the stress across the insulation

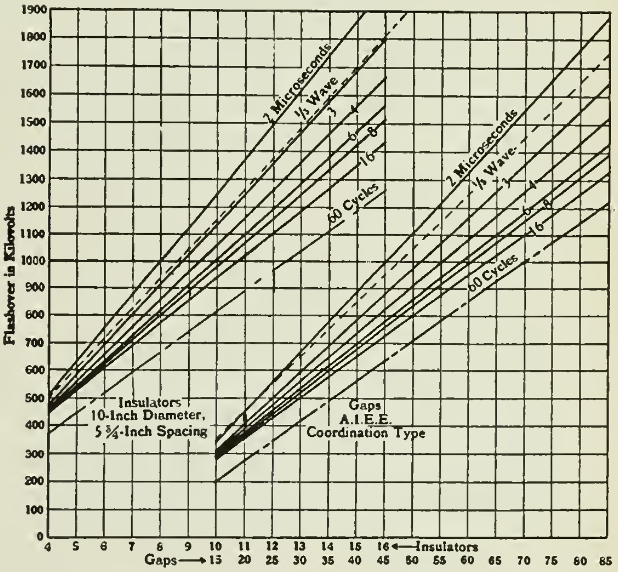


Fig. 1—Characteristics of Insulators and Gaps. All values are corrected to 6.5 grains per cubic foot absolute humidity, 760-mm. barometer, and 25 degrees C. Solid Curves represent volt-time values for 1.5/40 wave; dotted curves 1/5 wave; and broken curves, 60-cycle crest flashover.

and is known as coupling. Curves have been prepared for varying conditions both for actual diameter and dimensions as a result of corona. A good average value for coupling factor is from 30 to 40 per cent which means that for 100 volts on the ground wire there will appear 30 to 40 volts on the conductor and the stress on the insulation will be the difference between these two potentials. These are the major factors in line design based on the direct stroke theory and their use is illustrated as — Stress on

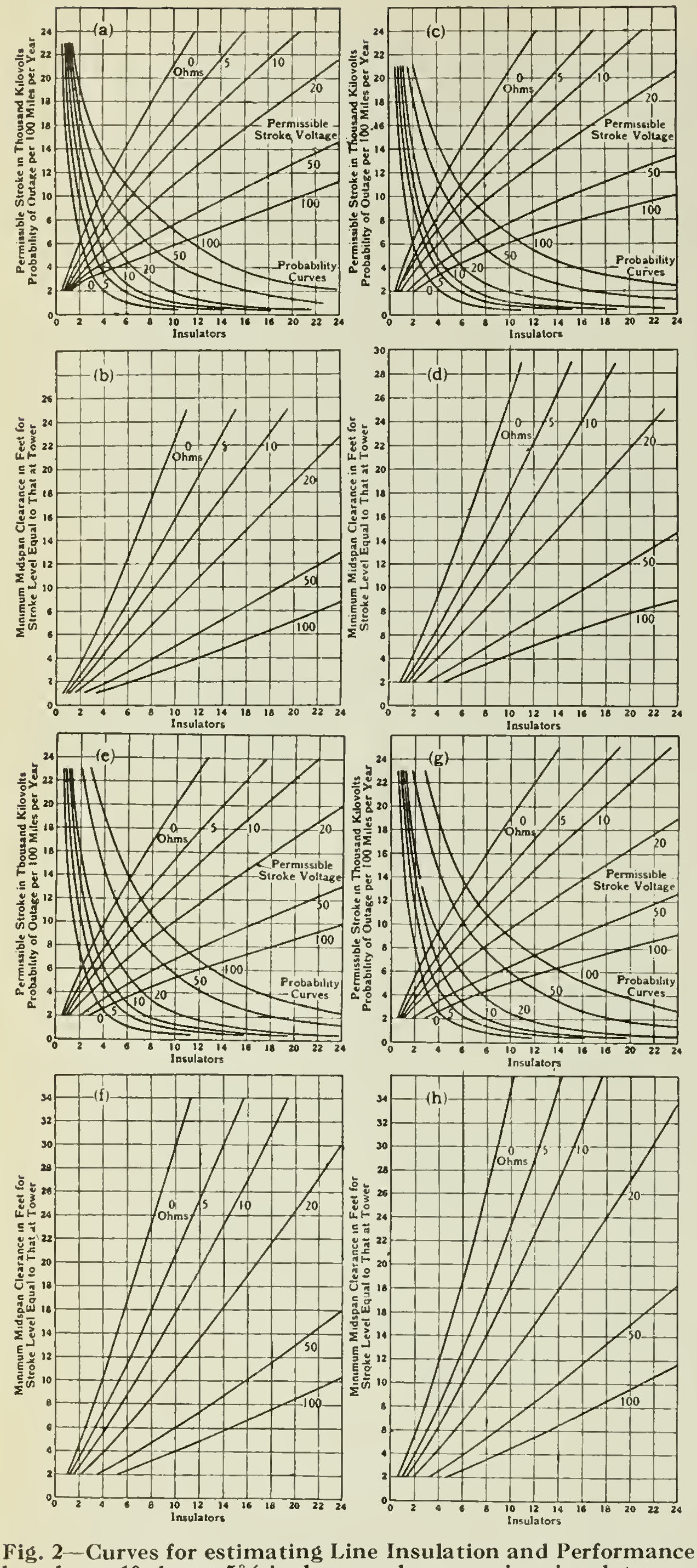


Fig. 2—Curves for estimating Line Insulation and Performance, based on 10-dram 5¾-inch spaced suspension insulators or equivalent and an isoceraunic level of 30 storms per year. The numbers on the curves indicate the tower-footing surge impedance.

(a) and (b)— **400-foot span.** (e) and (f)— **800-foot span.**
(c) and (d)— **600-foot span.** (g) and (h)—**1,000-foot span.**

insulators = (Tower top potential per 100 kv. in stroke) × (1 − Coupling factor) × (Stroke voltage). Assume 10 ohms tower footing resistance, 40 per cent coupling and 20,000 kv. in stroke. Stress on insulators = $\frac{17}{100} \times (1 - 0.4) \times 20{,}000 = 2{,}040$ kv. Reference to data presented in Fig. 1 will give the number of insulators necessary for this design when the proper time lag is considered. This latter is a variable depending on tower footing surge impedance and span length, but an average value is about two microseconds. Curves (Fig. 2) have been prepared giving the results of a general study of the problem. Likewise for a stroke at mid span the reduction due to tower footing surge impedance, span length and coupling must be considered. The voltage thus calculated used in conjunction with characteristic curves of gaps, determines the necessary clearance at the mid span. For convenience, curves (Fig. 3) have been prepared incorporating these factors.

These facts allow the design of a line for a protection level but do not give weight to economic considerations. For example, it might be assumed that as the protection level increases the outages would decrease in direct proportion to the increase in this level. On the other hand the probability of obtaining the surge of 20 million volts is only one fourth as great as obtaining one at 10 million volts. A probability curve (Fig. 4) obtained from actual operating data is combined with the protection level curve. It is of interest to note from Fig. 2 that when this probability is incorporated, there is very little gain in actual performance of a line in adding over 14 insulators for 5 ohm tower footing surge impedance and 20 insulators for 20 ohm tower footing surge impedance. Span length can be seen to play a large part in this co-ordination and curves have been prepared for various span lengths.

An examination of these curves shows that for a high degree of reliability low tower footing surge impedance with considerable insulation must be used regardless of operating voltage. Thus for one outage per 100 miles per year, the design would be the same for 13.8 kv., 44 kv. or 230 kv.

It can be seen that the greatest usefulness of insulation is obtained when the tower footing surge impedance

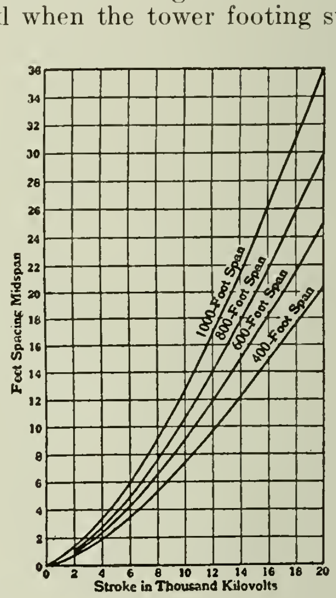


Fig. 3—Minimum Midspan spacings for different Protection Levels.

is low. Quite often special precautions have to be taken to obtain tower footing surge impedances of 10 ohms or less. When the earth resistance is low, no special precautions need be taken as the tower foundation structures provide the necessary leakage. Where the earth has fairly low resistance a normal tower footing surge impedance may be reduced economically by the use of driven grounds. Where the resistance of the earth is high, driven grounds have been found to be inadequate and sometimes impractical. For such cases, the remedy is now indicated to be the use of counterpoises.

There are two general classes of counterpoises; namely those consisting of wires radially or at right angles to the direction of the line, and those consisting of wires parallel to the direction of the line. The use of either type of counterpoise lowers the tower footing resistance by increased leakage from the tower. The length and number of counterpoises necessary will depend on soil conditions. The parallel counterpoise, as compared to the radial counterpoise, has the added effect of lowering the stress on the

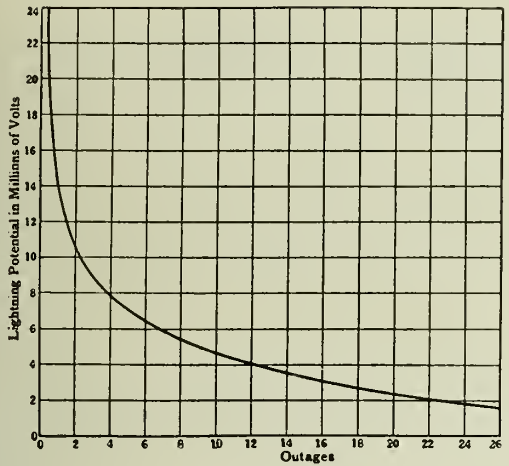


Fig. 4—The number of Outages that can be expected in a year for a line of given protection level. This curve can also be used to give the probable magnitude and frequency of strokes per year by doubling the abscissæ scale. (Steel tower line, two ground wires, isoceraunic level, 30.)

insulator string by coupling between the counterpoise and the line conductor. The relative effect depends on soil conditions, spacings, and length of counterpoise, but will probably never lower the stress on the insulator string more than 10 per cent.

To obtain the optimum effect with the given length of wire, where the earth resistance is not very high but too high to be taken care of by driven grounds, it may be advantageous to extend the counterpoise for only a portion of the distance between towers. Where the resistance is very high, however, the counterpoise should be extended for the whole distance. It may even be necessary to use two buried counterpoises connecting between towers and separated the distance of the outside conductors. In making calculations it is at least practical to use 10 ohms tower footing surge impedance. At the time of running line surveys it is recommended that measurements be taken of soil conditions and from these a good idea can be obtained of the extent to which special precautions must be taken to reduce the tower footing surge impedance to 10 ohms.

There are a number of lines designed on the direct stroke basis which are giving very good operating results. The Indianapolis Power and Light Company have a double circuit 132-kv. line with a maximum of 10 ohms tower footing surge impedance and a clearance of 12 feet at the mid span installed around the city of Indianapolis. This line has been in service for approximately four years and there has been one outage directly traceable to lightning. A single circuit 230-kv. line installed by the Pennsylvania Water and Power Company has been in operation for three years with only one outage traceable to lightning.

The protection level is not high for normal insulation structures on low voltage circuits, so that the probability of outage is comparatively large. When a reliable low voltage circuit is desired Deion protector tubes will give practically an outage-proof line at considerably less expense than providing insulation and shielding. These tubes as applied have a lower voltage breakdown characteristic than the insulator string and yet can quench the power follow current without producing an outage.

The best experience on an application of Deion protector tubes is found on the Clinton Dubuque 66-kv. line of the Interstate Power Company (Fig. 5). This steel tower line built without ground wires and insulated with four standard units had 30 to 60 outages per year on a 55-mile length previous to the installation of the tubes. It was 80 per cent protected in 1932 and the outages were reduced to four. It was completely protected in 1933 and the outages were reduced to three, two of these being directly traceable to very severe direct strokes and in 1934 this line operated without an outage. These tubes have further been used quite extensively for protecting pole top disconnecting switches. There are a large number of applications on lines ranging from 2.3 kv. to 138 kv.

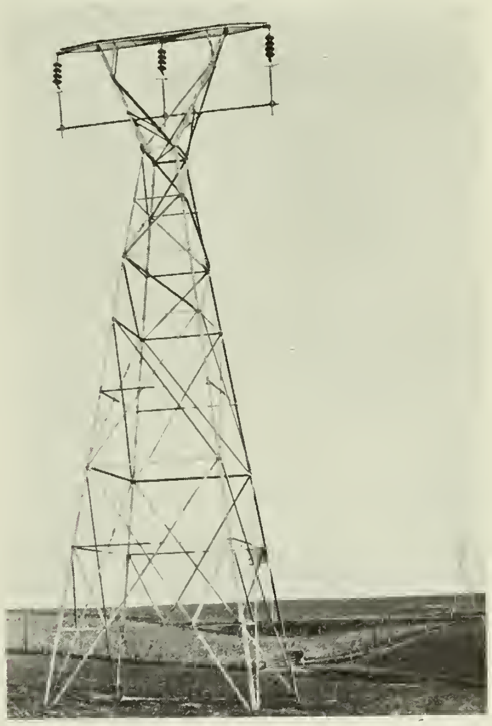


Fig. 5—Steel Tower on Clinton Dubuque 66-kv. Line.

It is therefore seen from this brief discussion that considerable knowledge has been gained on characteristics of natural lightning and insulation structures. It is also seen that great strides have been made in the application of this information to the age-old operating problem of combating lightning. Lines are built which have outage factors thought impossible five years ago.

Notes on Anti-Friction Bearings

H. Little, S.E.I.C.,
R and M Bearings Canada Limited, Montreal.

Paper presented before the Junior Section of the Montreal Branch of The Engineering Institute of Canada, February 17th, 1936.

SUMMARY:—The kinds of duty for which the different types of ball bearing are suitable are discussed with reference to thrust and radial load capacity and possible operating troubles. Notes on roller bearings and lubrication are given.

Before mentioning the many different types of anti-friction bearings, it will be worth while to draw attention to the fact that modern machinery would not be so efficient, and in many cases would actually be impracticable, were it not for the successful application of anti-friction bearings.

For example, imagine plain sleeve bearings in the hubs, rear axle and differential of a 1936 automobile, with the resulting loss of efficiency; or plain bearings on a modern paper machine with the newsprint coming through at 1,200 feet per minute, or an airplane engine supercharger running at 25,000 r.p.m. As a matter of fact the last two examples are only rendered practicable by the use of anti-friction bearings.

A definition of anti-friction bearings might be given as "any bearing in which the load is transmitted by rolling contact, as opposed to sliding contact." Accepting this definition, it would seem that, there being no friction, no lubrication will be necessary. Theoretically this is true but in practice lubrication is very important. First, because the ball or roller cage is usually carried on the inner race which involves sliding contact. Secondly, the contact of the balls with the cage causes a small amount of friction, and thirdly, because the highly polished surfaces of the balls or rollers and the races need protection from the air and possible moisture in order to prevent corrosion.

With these introductory remarks it is possible to proceed and to point out the particular duty of the different types so that those who may find it necessary to apply anti-friction bearings may be enabled to select the most suitable type for any particular job. Of course, if there is any doubt it always pays to get in touch with the bearing manufacturers and obtain their recommendations.

The Single Row Deep Groove Ball Bearing

The commonest of all anti-friction bearings is the single row deep groove ball bearing. This is manufactured in two types: the "notched" and "notchless" or "filling slot" and "non-filling slot," as they are sometimes called. The notched type, as the name implies, has a notch in the inner and outer races, this allowing more balls to be inserted in the races and so increasing the radial capacity. The notches, however, limit the thrust capacity of the bearing and for this reason the notched type has gone out of favour, since present day requirements seem to be for a bearing which is capable of carrying both thrust and radial loads and the bearing which covers this range of service is the notchless type. (Fig. 1.) Incidentally, the balls in a notchless bearing are inserted by eccentric displacement of the inner race, which obviously limits the number of balls.

Now a feature of deep groove ball bearings which is not commonly known is that they are manufactured with varying diametric clearance between the inner and outer races and the balls. These clearances are controlled in manufacture so that the bearing will serve its particular purpose. The necessity for different diametric clearances is apparent since it has been found that 60 per cent of the interference between the shaft and the inner race is transferred through the race to the tracks. To illustrate this consider an anti-friction bearing fitted to a railroad axle-box. This is heavy duty with big shock loads and in order to be sure that the inner race does not turn on the shaft a heavy interference is used—about three thousandths of an inch for a five-inch shaft. Now if the diametric clearance in the bearing used on this application were only one and one half thousandths it is obvious that the balls would seize in the tracks.

Another point to remember is that the greater the diametric clearance the greater the thrust capacity of the bearing, due to the greater angle of contact.

Most manufacturers supply bearings in three different fits:—

The X or 1 dot fit have the smallest diametric clearance which may be as low as one ten-thousandth of an inch. These are used in applications which demand perfect rigidity of the shaft. Woodworking spindles are a good example since the least radial slackness results in a chatter mark on the wood.

The Y or 2 dot fit have a medium amount of diametric clearance and are in most general use. This, of course, is the commonest of the three fits and is the one usually supplied when a definite fit is not specified.

In the Z or 3 dot fit the diametric clearance varies from 4 ten-thousandths to 23 ten-thousandths according to the shaft size. This is the slackest fit and they are used on railroad axle-boxes, large electric motors and pump shafts subject to high temperature. As previously stated the Z fit ball bearing has the greatest thrust capacity of the three different fits due to the greater angle of contact.

The Angular Contact Ball Bearing

Another common type of bearing is the double purpose or angular contact ball bearing. In the bearing which has just been described, that is, the deep groove ball bearing, the angle of contact between the balls and the tracks is at right angles to the axis. The angular contact ball bearing has, as the name implies, angular contact of the balls on the tracks. Obviously, the ideal angle of contact would be in the same direction as the resultant of the radial and thrust loads. This angle varies with varying load conditions so the bearing manufacturers chose the angle which experience has shown to be the best for the average application, that is, an angle of about 25 degrees. (Fig. 2.)

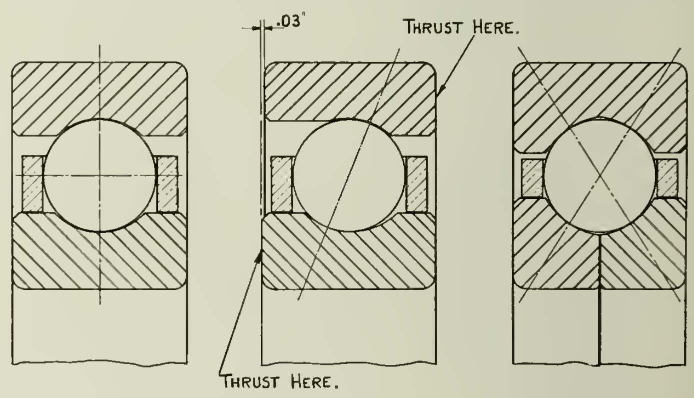


Fig. 1. **Fig. 2.** **Fig. 3.**

It should be noted that the construction of the angular contact bearing allows the use of a one piece cage, and as space does not have to be allowed for rivets between the balls, the maximum number of balls can be inserted. There is a deep groove on one side only of the outer race, the lip on the other side being merely sufficient to ensure the bearing being a one piece assembly. The load carrying capacity of these bearings is therefore the maximum that can be obtained owing to the use of a greater number of balls

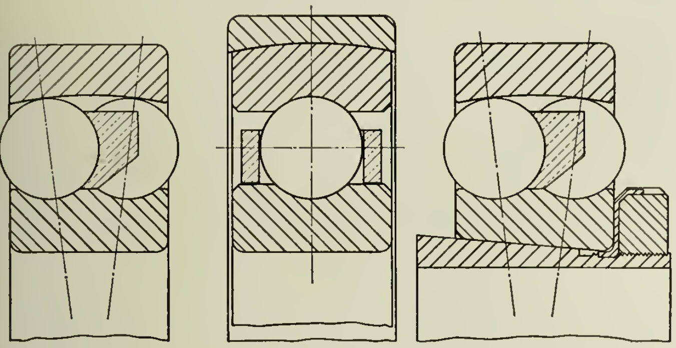


Fig. 4. Fig. 5. Fig. 6.

than in the corresponding sizes of deep groove ball bearings. This capacity can be carried as pure journal load, pure thrust load or any combination of journal and thrust loads up to the capacity of the bearing.

It is obvious that these bearings can accommodate thrust in one direction only and care should be taken when mounting to see that the thrust is taken in the right direction. Also it is necessary that all side play be taken up, at the same time taking care that no initial thrust load is imposed on the bearings. This adjustment can be achieved by accurately machining the housings and end caps. This is expensive however and a more common method is the use of shims or a screwed end cap.

This type of bearing has been extensively and very successfully applied in the past few years and its adoption has made practically obsolete the old type of ball thrust bearing. To take a typical example; formerly, the worm shaft of a worm reduction gear used three bearings, two deep groove ball bearings and a double thrust bearing. Using angular contact bearings saves the cost of the double thrust bearing and at the same time simplifies the housing arrangement and so cheapens the machining costs.

Other typical applications are: vertical shaft electric motors, pinion and differential shafts on automobiles and machine tool applications. However, the necessary adjustment of these bearings is to a certain extent a disadvantage, in that the successful application depends upon the skill and experience of the mechanic. This opinion is supported by the recent introduction of the duplex double purpose or double angular contact bearing which calls for, and admits of no adjustment in mounting. (Fig. 3.) These duplex double purpose bearings, of course, must be used in conjunction with either two deep groove ball bearings or two roller bearings since they are designed primarily for carrying thrust.

The Self-Aligning Double Row Ball Bearing

The next type to be considered is the self-aligning double row ball bearing. (Fig. 4.) These bearings have a spherical ball track on the outer race and, of course, the self-aligning feature has the great merit of simplifying the housing and cheapening the machining costs, since the accurate alignment of the housings is not so necessary as when using a deep groove ball bearing. The thrust capacity of these bearings is definitely limited since the tendency, once a thrust load is applied, is for all the load, both radial and thrust, to be carried on one row of balls only. These bearings, however, give excellent service when the thrust is nothing more than light location duty and the best example of their successful application is on power transmission line shafting.

When used for this duty they are invariably fitted with a split adapter sleeve, which really introduces a new type of bearing. Adapter sleeve bearings can be either single row deep groove ball bearings or roller bearings or self-aligning double row ball bearings, the latter being by far the most common. (Fig. 6.) They consist of a standard bearing with a tapered bore, into which is fitted a split screwed sleeve having the same taper on its outside diameter as is on the bore of the bearing. When the bearing is forced up the taper by tightening the locknut, the sleeve is compressed and grips the shaft firmly. Their utility on line shafting is obvious, since they do away with the accurate machining of the shaft necessary for a straight bore bearing. It should be borne in mind, however, that they have not the same capacity for thrust as has a bearing which is a good fit on the shaft and tightened up against a substantial shoulder, since they are located on the shaft by frictional contact only.

While on the subject of self-aligning bearings there is one other type which should be mentioned. This is the single row deep groove ball bearing, notchless of course, with a spherically ground outside diameter on which is fitted a spherically bored outer shell. (Fig. 5.) It combines the feature of self-aligning with all the desirable features of the deep groove ball bearing, that is, combined radial and thrust capacity. This type of bearing is not as popular in Canada as it deserves to be, mainly because, for a given inside diameter, it has a slightly greater outside diameter than a standard bearing, that is, American standard. Consequently it cannot be used as a replacement without boring out the housing to suit. However, it is well worth while for engineers to investigate the merits of this type when making designs for new machinery.

The Roller Bearing

Having briefly described the commoner types of radial ball bearings, the next type to consider is the roller bearing. Generally speaking, for every size of deep groove ball bearing, there is a roller bearing of the same dimensions. (Fig. 7.) The roller bearing has line contact as opposed to the point contact of the ball bearing. Consequently, the radial capacity or safe working load of the roller bearing is roughly 80 to 100 per cent greater. On the other hand, the standard roller bearing with a straight bore on the outer race has no thrust capacity at all, although it is possible for them to perform light location duty by putting a lip on the outer race. But for the most part they are used for their radial capacity.

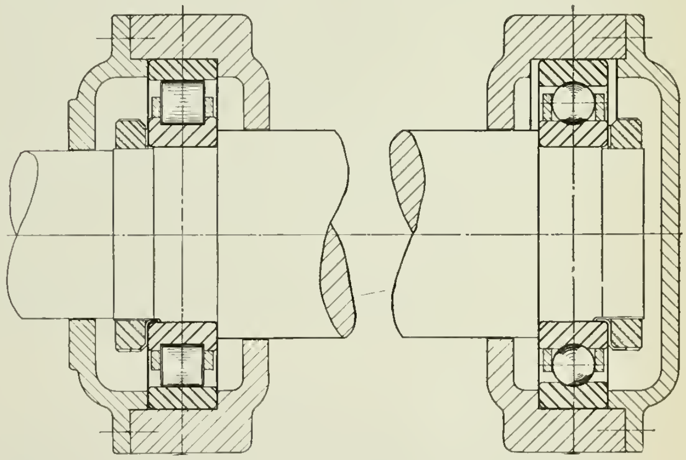


Fig. 7. Fig. 8.

Perhaps it would be worth while at this point to give the most important rule which applies to the mounting of ball bearings, that is, that the inner races being definitely located on the shaft, only one outer race shall be located against lateral movement. This applies if there are only two bearings, or if there are twenty bearings as on a long line-shaft. The reason is obvious, if two bearings are located and the shaft has to expand or contract due to changes in temperature, it is restrained by the bearings, causing at the least a heavy thrust load, or at the worst a broken bearing. Take a typical application, an electric motor of say 50 h.p. At the driving or pulley end will be mounted a roller bearing (Fig. 7), since that is where the greatest radial load will come. At the commutator end will be mounted a deep groove ball bearing to carry both radial and thrust loads. (Fig. 8. Below centre-line.) The roller bearing, having a straight bore on the outer race allows the rollers to move laterally if necessary. This explains the statement that roller bearings are not designed to carry thrust loads. In a smaller electric motor using two ball bearings the end caps at the pulley end of the shaft would be machined so that there would be a small space between the end cap and the outer race. (Fig. 8. Above centre-line.) These two examples illustrate the rule of one locating bearing and one non-locating bearing on the shaft.

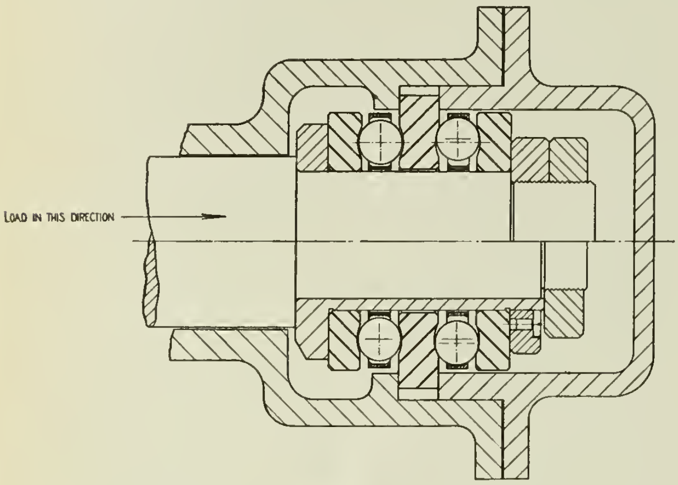


Fig. 9.

Roller bearings are also manufactured with a spherically ground outside diameter and fitted with a spherically bored outer shell. Their utility is obvious for any application where there may be mis-alignment or deflection of the shaft.

Roller bearings are supplied with varying diametric clearance, that is, X, Y, or Z fits; the correct fit being selected according to the interference on the shaft, just as is done with ball bearings.

The Simple Ball Thrust Bearing

The last type of bearing which will be considered is the simple ball thrust bearing. This type has in many instances been superseded by the deep groove or angular contact type of ball bearing, which have ample thrust capacity without the speed limitations to which the simple ball thrust bearing is subject. It is obvious that the depth of groove in a thrust bearing does not offer adequate support to the balls to resist the centrifugal force resulting from high speed. This fault is particularly marked in a double thrust bearing. Naturally only one row of balls can be carrying the load at a given moment and this row of balls will be kept in the ball track and give satisfactory results, whereas the row of balls not under load are thrown outward by centrifugal force, resulting in uneven tracking and ball spin which cause the bearing to fail. (Fig. 9.)

However, there are still instances where simple thrust bearings may be successfully applied; such as on crane hooks, and many machines having slow speed vertical shafts such as paint mixers and foundry sand mixing machines.

The Lubrication of Bearings

The essential functions of a lubricant for anti-friction bearings are:

1. To eliminate cage friction as far as possible.
2. To protect the finely polished surfaces of the balls and races from corrosion.
3. To act as a seal and so prevent the intrusion of moisture or dirt into the housing.

Generally speaking, grease lubrication is the most suitable for normal speeds and conditions. It is easy to apply, is readily retained in the housing and lends itself to sealing the housing against moisture and foreign matter. Such grease should have a mineral base and contain no trace of acid, resin, salt or any other corrosive matter. It should have a high separating point and a fairly high melting point and must not separate or harden out in service.

It is worth noting that different types of grease should never be mixed as the blending of greases having different chemical bases is liable to set up a chemical reaction. It follows that a housing should be thoroughly cleaned out prior to using a grease of different grade or different manufacture.

As a general rule the housing should be one third full of grease. Cases are common of a mechanic finding a bearing tending to run hot, putting more grease into the housing and continuing to put more and more in, all the time aggravating the condition, since the churning of the grease generates heat. In dusty atmosphere or dirty conditions it may be desirable to completely fill the housing with grease but to do this the speed must be low.

It is difficult to say at what speed it becomes necessary to use oil as it depends on the size of the bearing. As a rough guide 8,000 r.p.m. is the maximum safe speed using grease lubrication for bearings up to 1½ inches in the bore and of course oil must be used for larger bearings at a proportionally lower speed. The whole question of lubrication of anti-friction bearings is very involved and the final factor is the quality of the lubricant used. The author recalls a case of a vertical spindle running at 7,500 r.p.m., the ball bearings being about 2¼ inches in the bore, and using oil lubrication. There were a number of bearing failures and finally grease lubrication was tried, a very high grade grease being used, and no further trouble occurred. Actually, the trouble in this instance was caused, not by oil lubrication but by the use of the wrong grade of oil. In the final analysis, it is usually found that "cheap oil" is the trouble maker.

There are several methods of applying oil lubrication. If the oil is applied periodically provision should be made to ensure that the oil level is not higher than the centre of the bottom ball in the bearing. Another method, is by the fitting of flingers to the shaft which dip into the oil, the splash causing an oil mist. The best method of all is the wick or drip feed, which ensures a constant and regulated supply of clean oil.

Rainfall Intensities at Saskatoon, Saskatchewan

C. J. Mackenzie, M.E.I.C., Dean of Engineering,

and

E. K. Phillips, A.M.E.I.C., Lecturer

University of Saskatchewan, Saskatoon, Sask.

Where long term records of rainfall intensities are not available to the designer of storm-sewers that factor in the "rational method" equation presents an uncertainty and if in addition the local yearly rainfall distribution is far from uniform the uncertainty is exaggerated. Such a situation exists in western Canada where, although total rainfall records are available for many decades, intensity records are being kept at comparatively few stations and the best of such records go back only a few years.

Early in 1926 through the co-operation of the Dominion Meteorological Service a Friez automatic-recording rain gauge was installed at the University of Saskatchewan at Saskatoon, and there are now available the records of ten years. While ten years is a very brief period for such readings the writers felt that as few, if any, studies of such intensities for western Canada have been published, a study of these brief records for one locality in Saskatchewan might be interesting to engineers concerned with run-off problems and the report of such a study is herewith presented with a full realization that the curves offered must be considered as tentative and subject to modification as future data become available.

From the rain-gauge records there was first prepared a chronological tabulation showing the amounts of rain which had fallen in definite intervals of time. Some 349 storms were considered in the preliminary tabulation but, as designers of storm sewers are concerned with the maximum rainfall intensity to be expected in various periods of time, storms of minor intensity were eliminated and Table I was constructed giving records of the twenty heaviest storms in the 1926-35 period.

Table I

Chronological Records of Heavy Rainfalls, 1926 to 1935 inclusive, University of Saskatchewan Gauge, Saskatoon, Sask. Rainfall in Inches for Durations Shown.

Date			Duration, in minutes									
			5	10	15	20	25	30	40	50	60	90
1926	July	2	.20	.27	.30	.31	.33	.36	.36	.36	.37	.38
	"	7	.16	.31	.40	.51	.62	.73	.88	.92	.93	.95
	"	30–31	.13	.25	.34	.45	.50	.55	.61	.63	.67	.81
1927	July	4	.21	.36	.50	.65	.73	.79	.85	.88	.95	1.05
1928	July	10	.20	.26	..	..	..	..	..	..	..	..
	"	20	.18	.23	..	..	..	..	..	..	..	..
	"	25	.23	.33	.45	.60	.78	.91	1.04	1.11	1.15	1.18
	Aug.	11–12	.35	.68	.80	.87	.93	.98	1.01	1.01*	1.01*	1.01*
1929	June	12	.23	.38	.41	.44	.44*	..	..	..	..	..
	July	14	.19	.32	.43	.49	.55	.57	.59	.60	.62	.64
1930	June	11	.55	.76	.89	.99	1.07	1.14	1.15	1.15*	1.15*	1.15*
	"	28	.15	.20	.27	.30	.32	.36	.42	.51	.57	.70
1931	June	29–30	.15	.24	.29	.34	.38	.46	.55	.62	.84	1.09
1932	June	23	.17	.31	.34	.35	.35	.36	.37	.39	.41	.48
	Aug.	12	.15	.30	.37	.43	.47	.50	.54	.57	.63	.73
1934	June	26–27	.15	.22	.26	.30	.35	.41	.50	.58	.69	.93
1935	June	15–16	.13	.21	.25	.30	.35	.40	.50	.58	.66	.70
	July	4	.10	.20	.28	.35	.45	.51	.65	.73	.77	.82
	"	5	.21	.25	.26	.27	.27	.27	.27	.27	.28	..
	"	6	.10	.19	.27	.34	.41	.48	.53	.56	.60	.67

*Indicate amounts falling in shorter periods.

Table II was then prepared directly from Table I. For each duration (five minutes, ten minutes, etc.) the greatest rainfall was listed, the second greatest and so on down to the tenth greatest. Since the records cover a ten-year period, the intensities of first magnitude, for all the durations considered, may be taken to represent the intensity-duration of a storm to be expected once every ten years. The second magnitude figures likewise may be taken to represent a storm to be expected once every five years, the fifth magnitude once every two years, and the tenth magnitude once every year.

Table II

Inches of Rainfall for Durations as shown, arranged in order of Magnitude. Ten Year Period 1926-1935 inclusive. Saskatoon, Sask.

Order of Magnitude	No. of Storms per Year	Duration, in minutes									
		5	10	15	20	25	30	40	50	60	90
1	0.1	.55	.76	.89	.99	1.07	1.14	1.15	1.15	1.15	1.18
2	0.2	.35	.68	.80	.87	.93	.98	1.04	1.11	1.15	1.15
3	0.3	.23	.38	.50	.65	.78	.91	1.01	1.01	1.01	1.09
4	0.4	.23	.36	.45	.60	.73	.79	.88	.92	.95	1.05
5	0.5	.21	.33	.43	.51	.62	.73	.85	.88	.93	1.01
6	0.6	.21	.32	.41	.49	.55	.57	.65	.73	.84	.95
7	0.7	.20	.31	.40	.45	.50	.55	.61	.63	.77	.93
8	0.8	.20	.31	.37	.44	.47	.51	.59	.62	.69	.82
9	0.9	.19	.30	.34	.43	.45	.50	.55	.60	.67	.81
10	1.0	.18	.27	.34	.35	.44	.48	.54	.58	.66	.73

From Table II a further tabulation was made from which could be plotted intensity-duration curves covering probability of occurrence of once in ten years, twice in ten years and so on to ten times in ten years or once a year. The figures in the body of Table II representing inches of rainfall for the durations stated were converted to the corresponding rates in inches per hour. For the purpose of this paper it was decided to present only the data representing the probable maximum storms that will occur once in ten years, once in five years, once in two years and once a year. Table III shows the tabulation referred to and from these data the curves shown in Fig. 1 were plotted. It should be noted that the graph shows the actual points as taken from Table III and the curves represent only the writers' opinion as to how these points should be connected.

Table III

Intensity of Rainfall, in inches per hour, having a probability of occurrence as indicated, for the durations shown. Based on rainfall records at Saskatoon, Sask., 1926-1935 inclusive.

Order of Magnitude	Number per Year	Corresponding Probability of Occurrence	Duration, in Minutes									
			5	10	15	20	25	30	40	50	60	90
		Once in:										
1	0.1	10 years	6.60	4.56	3.56	2.97	2.57	2.28	1.73	1.38	1.15	.79
2	0.2	5 years	4.20	4.08	3.20	2.61	2.23	1.96	1.56	1.33	1.15	.77
5	0.5	2 years	2.52	1.98	1.72	1.53	1.49	1.46	1.28	1.06	.93	.67
10	1.0	1 year	2.16	1.62	1.36	1.05	1.06	.96	.81	.70	.66	.49

Reliable records of the total rainfall in each twenty-four-hour period at the University of Saskatchewan station are available for the past twenty years. Although such data are of little value in a study of this nature a perusal of these records was made in order to obtain a general comparison of the relative "wetness" of the two ten-year periods 1916-25 and 1926-35.

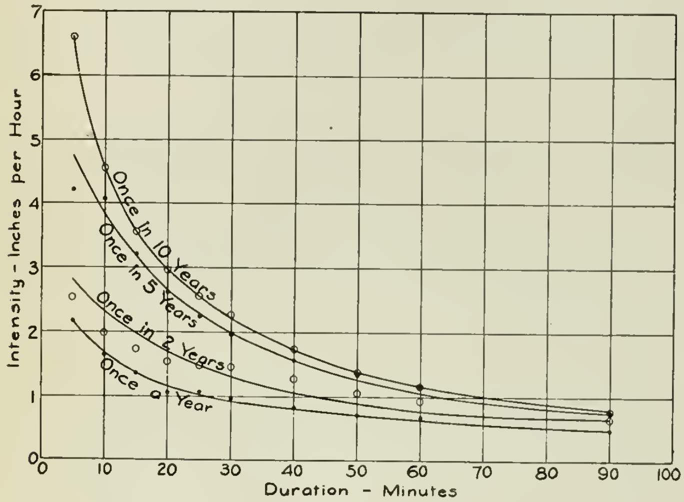


Fig. 1.

For the ten-year period 1916-25 it was found that on thirteen occasions more than 1.0 inch of rain fell during twenty-four hours. Eight times 1.5 inches was exceeded and twice the fall exceeded 2 inches. The average of the thirteen storms was 1.58 inches. For the ten-year interval 1926-35 (the period covered by the curves in Fig. 1), it was found that sixteen storms exceeded 1.0 inch of rain in twenty-four hours. Only three storms exceeded 1.5 inches and one was in excess of 2 inches. The average of the sixteen storms was 1.35 inches. There were, it will be noted, more 1.0 inch storms during the 1926-35 period, but on the other hand in the earlier decade there were more of the 1.5 and 2 inch storms and the average quantity of water, falling during storms that exceeded 1 inch of rainfall, was much greater in the 1916-25 period than in the following decade.

It seems quite possible then that if intensity-duration records were available for the past twenty years the intensities indicated by the curves in Fig. 1 would be raised somewhat. At any rate there is nothing to suggest that the curves presented give intensities that are excessive and the writers feel that until further data become available engineers might well accept these curves as indicating minimum expectations of rainfall in the Saskatoon locality.

Winter Operation of Barriere Hydro Plant

Kamloops Power System of B.C. Electric Railway Company Limited

E. E. Carpenter, M.E.I.C.,
Consulting Engineer, B.C. Electric Railway Co. Limited, Vancouver, B.C.

The winter just past has been the severest in point of low temperatures and duration of cold weather that has been experienced during the life of the Barriere hydro plant of the Kamloops system. The experience of keeping a flume conduit operating under these conditions has been so favourable that an account of it may be of some general interest and value.

The severest weather of the winter occurred November 1935, and February 1936. During the latter period the extreme cold continued practically through the whole month. Except for the last two days, the maximum temperatures were below the freezing point, and for twenty-three days of the month the minimum temperature never reached above zero and ranged as low as 40 degrees below. On two days the maximum temperatures were 12 degrees and 8 degrees below zero respectively.

Conditions in February are reproduced on page 376.

In spite of the above condition the timber flume, more than 3 miles long, was kept in operation continuously and although the auxiliary steam plant was put in readiness it was not called upon for any energy except for a nominal 150 kw.hrs.

This most favourable and somewhat remarkable showing was made possible by a number of improvements which were carried out in 1932 for the express purpose of increasing the operating economy of the plant particularly with respect to winter operation under ice conditions.

The Kamloops power system is supplied by the Barriere hydroelectric plant supplemented by a steam generating plant at load centre in the city of Kamloops, B.C. The hydro plant utilizes the water of Barriere river, a tributary of the North Thompson river. The essential features are a low diversion dam of the log crib type, a timber flume

Table I
Kamloops System
Kw.hrs. developed by Steam Power to Meet Hydro Outages

Year	Due to Ice	Flume maintenance	Flume breaks	Moss	Regulation	Line and plant outage	Flume capacity	Total
1926	153,090	129,160	349,690	.....	15,000	35,800	74,930	757,670
1927	536,780	655,230	424,670	84,180	.....	1,700	193,360	1,896,010
1928	271,555	219,940	10,790	155,000	.....	14,350	.....	671,635
1929	529,800	236,730	.....	.....	740	16,960	.....	784,230
1930	460,330	218,980	.....	.....	10,660	12,610	.....	702,580
Total	1,951,535	1,460,130	785,150	239,180	26,400	81,420	268,290	4,812,125
Mean	390,307	292,026	157,030	47,836	5,280	16,285	53,658	962,425
Per cent of total kw.hrs. developed by steam	40.6	30.3	16.3	4.9	.6	1.7	5.6	100
Per cent of total kw.hrs. developed (hydro and steam)	6.4	4.7	2.5	.8	..	.3	.9	15.6

Table II

Kamloops Division

Barriere Hydro and Kamloops Steam Plants.
Hydro and Steam Outputs 1926 to 1935 Inclusive.

Year	Minimum winter temperature	Kw.hrs. Generated			Steam kw.hrs. generated to make up for loss of capacity due to ice
		By hydro power	By steam power	Total	
1926	− 8°	4,526,800	757,670	5,284,470	153,090
1927	−28°	4,048,300	1,896,010	5,944,310	536,780
1928	−12°	5,448,700	671,635	6,120,335	271,555
1929	− 6°	5,624,100	784,230	6,408,830	529,800
1930	−28°	6,263,220	702,580	6,965,800	460,330
1931	− 8°	6,645,688	18,585	6,664,273	3,250
Total		32,556,808	4,830,710	37,387,518	1,954,805
Mean		5,426,135	805,118	6,231,253	325,801
Per cent of total		87.1	12.9	100	5.2
1932	−14°	6,259,500	222,870	6,482,370	214,910
1933*	−20°	6,856,458	23,640	6,880,098	....
1934	−24°	7,109,910	14,950	7,124,860	....
1935	−40°	6,975,309	38,130	7,013,439	2,720
Total		27,201,177	299,590	27,500,767	217,630
Mean		6,800,294	74,897	6,875,192	54,407
Per cent of total		98.9	1.1	100	.8

*Conditions were improved by changes in flume made during summer and fall of 1932.

5 feet 8 inches by 8 feet 1½ inches box, 17,700 feet long, two wood stave penstocks 42 inches in diameter 380 feet long leading to the power station on the river bank and supplying under 190 feet head two 750 kv.a. generating units. The grade or slope of the flume is 1 foot in 1,000 feet and the calculated velocity at peak load is about 4.75 feet per second. Only a very limited pondage is afforded by the diversion dam and practically no forebay capacity is available at the head of the penstocks.

Fig. 1—Barriere Power House.

A transmission line 45 miles long carries the power to a substation in the city of Kamloops from which it is distributed for general light and power service of the city and the surrounding district.

The plant was built in 1915 by the city of Kamloops and operated by the Municipal Utility until 1930 when the entire system and its properties were purchased by the B.C. Electric Railway Company, Limited. After its acquisition a thorough investigation was made of all the conditions surrounding its operation. As a result, it was revealed that for six years of its history previous to 1930 the costs of steam generated power made necessary by outages to the flume were excessive.

Table I shows the relation between steam and hydro output for this period.

Fig. 2—Diversion Dam at the Head of the Barriere Flume.

In spite of the fact that there was no real lack of water at the diversion for power generation it had only been possible to obtain about 84.4 per cent of the total output by this means, the remainder 15.6 per cent being made up from steam generation.

The causes for this heavy percentage of steam generated power were found to be, in order of their importance:—

Fig. 3—Flume Wasteway discharging into Barriere River.

Ice conditions; flume maintenance; flume breaks; moss in flume; limitations of flume carrying capacity due to poor condition of structure; transmission line and generating equipment outage; and lack of regulation at diversion. These factors are also shown in Table I.

In searching for remedies for these unfavourable operating conditions, the following improvements were decided upon:—

Log Sheet of Barriere Power House for Feb. 1936, Showing Water Conditions

Date	Output Kw.hrs.	Peak Load	Steam Plant in Parallel Cause	Hrs.	Mins.	Height at Dam Inches	Height at Flume Inches	Clear Ice Sand	Temperature Max.	Temperature Min.	REMARKS
1	17,300	1210				10.50′	2.90′	C.	22°	4°+	Partly cloudy.
2	15,400	1125				10.50′	2.80′	C.	18°	2°+	Partly cloudy.
3	17,800	1210				10.50′	2.90′	C.	16°	2°−	Light snow early. Cloudy.
4	17,800	1240				10.48′	2.90′	C.	16°	6°−	Snowing early. Cloudy.
5	17,600	1210				10.30′	2.90′	C.	15°	19°−	Snowing early. Cloudy. Snowing late.
6	17,800	1220	Diverting water from syphon to new section of flume.	1	53	10.50′	3.80′ / 2.90′	Ice.	12°−	40°−	Clear and cold. West wind.
7	18,900	1210				10.50′	4.40′ / 2.70′	Ice.	8°−	40°−	Clear and cold. Snow later.
8	19,100	1380	Maximum hour output 1,200 kw. between 17 and 18 k.			10.50′	4.00′ / 2.70′	Ice.	10°+	10°−	Snow early and clearing.
9	16,000	1200				10.70′	3.70′ / 2.70′	Ice.	20°	0°	Cloudy.
10	17,800	1300				10.60′	3.60′ / 3.00′	Ice.	20°	0°	Light snow.
11	18,000	1300				10.60′	3.40′ / 3.00′	Ice.	16°+	20°−	Snow early and west wind.
12	17,200	1180				10.50′	3.20′ / 2.75′	Ice.	6°+	32°−	Snow early. West wind. Clear and cold later.
13	19,000	1120				10.20′	3.70′ / 2.70′	Ice.	2°−	35°−	Windy early. Clear and cold.
14	18,700	1200				10.00′	3.70′ / 2.70′	Ice.	2°+	37°−	Clear and cold.
15	19,600	1200				10.00′	3.90′ / 2.70′	Ice.	0°	38°−	Clear and cold.
16	18,500	1220				10.00′	3.90′ / 2.70′	Ice.	0°	38°−	Clear and cold.
17	17,800	1080				10.00′	4.00′ / 2.70′	Ice.	4°+	38°−	Clear and cold.
18	19,900	1220				10.10′	4.00′ / 2.70′	Ice.	10°+	26°−	Cloudy and cold.
19	18,100	1210				10.30′	3.90′ / 2.70′	Ice.	12°+	20°−	Partly cloudy and warmer.
20	18,600	1220				10.70′	3.70′ / 2.70′	Ice.	15°	12°−	Cloudy.
21	18,700	1250				10.60′	3.60′ / 2.70′	Ice.	15°	12°−	Partly cloudy. Snow later.
22	18,200	1300				10.60′	3.60′ / 2.70′	Ice.	23°	5°+	Partly cloudy.
23	16,400	1120				10.00′	3.50′ / 2.60′	Ice.	18°	2°−	Sunshine and windy.
24	17,700	1100				9.80′	3.60′ / 2.70′	Ice.	14°	20°−	Winds early. Clear and cold.
25	20,700	1300				9.00′	3.80′ / 2.70′	Ice.	8°+	16°−	Snowing.
26	19,0[illegible]0	1210				9.00′	3.80′ / 2.70′	Ice.	18°	0°	Snowing.
27	16 000	1000	Flume, cleaning out of ice and assisting over peak load, as water in flume —cut down to	1 4.85′ / 2.20′	10	9.20′	4 85′ / 2.70′	Cleaning out of Ice.	30°	12°+	Cloudy.
28	18,6[illegible]0	1100				9.30′	Normal / 2.85′	C.	36°	12°+	Snow early. Cloudy. Rain later
29	17 [illegible]00	1120				8.30′	2.75′	C.	42°	20°	Sunshine.
			Total	2	63						

Total output to line.. .... 524,600 kw. Total local service output....... 2,732 kw.

1. To cover the flume, thereby alleviating ice conditions.

2. To build a second storage reservoir in the upper reaches at the north fork of the river to afford a more liberal water supply during the winter season. By this means it was hoped to improve the regulation of flume flow at diversion and to maintain a more constant pond level, thus avoiding the frequent and periodic breaking up of the ice cover and the loss of its insulating effect on the water drawn through the flume intakes.

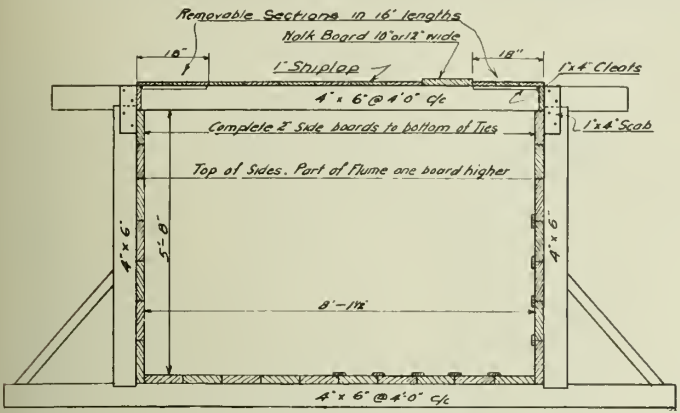


Fig. 4—Covering for Experimental Purposes.

3. Raising of the flashboards in the wasteway of the diversion dam from 2½ feet to 5 feet during the winter season, and—

4. A gradual but continuous improvement in the standard of maintenance in the flume structure itself.

In 1931 an experimental section of the flume one-half mile in length was covered with one-inch shiplap cover extending over the top of the flume only, and connecting to the side planking. Observations on this section during the ensuring winter demonstrated that this would be of essential value in correcting ice troubles. During the summer and fall of 1932 all the above improvements were made and there are now available four years of operating experience under the improved conditions. A comparison of the six-year period preceding the improvements with the four subsequent years shows a remarkably favourable result. (See Table II.)

The percentage of steam power has been reduced from 12.9 to 1.1 and the corresponding percentage attributable to ice trouble has been reduced from 5.2 to .8. The average annual kw.hrs. of steam power have been reduced from 805,000 kw.hrs. to 75,000 kw.hrs.

As a matter of interest the cost of the improvements was:—

North Barriere storage dam, log crib, rockfill with spillway	$26,900
Covering flume with one-inch shiplap cover and raising flashboards in spillway	5,500
Construction 2,200-foot Barriere by-pass flume	22,110
	$54,510

The last item had little to do with the questions under discussion as it concerned merely the rebuilding of a section of flume which was washed out and abandoned in 1915, the first year of the plant's operation. Owing to the unstable formation of glacial clays, sands and silts traversed, this section of the flume was not replaced, but the gap was filled with a 66-inch wood stave pipe inverted siphon which is still in service. After ice troubles in the flume had been remedied by the cover, it was found that the siphon was affected by low temperatures which did not then bother the flume. The so-called by-pass flume was rebuilt in 1934, and has since functioned as an alternative conduit principally for winter service.

The cost of steam generated power at this plant is about 2¼ cents per kw.hr. It is readily apparent that the savings made possible by the improvements have been substantial.

In the studies of this problem and the determination of the corrective measures described the valuable co-operation and assistance of C. E. Blee, principal assistant engineer, E. H. Hatch, construction engineer, and C. North, manager of the Kamloops Division of the B.C. Electric Railway Company, Limited, are acknowledged.

Welding of Light Walled Tubing

R. J. Anderson,
District Service Engineer, Dominion Oxygen Company Limited, Montreal, Que.

Paper presented before the Aeronautical Section of the Ottawa Branch of The Engineering Institute of Canada, April 30th, 1936.

SUMMARY:—A study of the flame welding processes in which an excess of acetylene creates a carburizing atmosphere so as to avoid the formation of oxide and consequent deleterious effect on the physical properties of the completed weld—a matter of great importance in thin-walled tubing.

Welding of light walled tubing has been widely used in aeroplanes. Most of the developments of welded tubular design have been in conjunction with aircraft. Recently it has found wider use in other transportation fields and has been used on passenger cars for light weight streamlined railroad coaches and in automobile design.

Welded tubular design has a high ratio of strength to weight, permitting greater payloads. Welded joints are highly efficient and rigid, and, at the same time, light in weight. This type of assembly permits great flexibility of design and is economical to fabricate and to maintain. It will probably be used more extensively in the future. In the meantime the aircraft industry provides the best history of the development of welded tubular construction and the best indication of trends in design and materials.

When metal first replaced wood in aircraft members, carbon steels were employed. These are still used, as represented by the S.A.E. 1025 steels or their equivalent. Joint design and welding technique for this material were thoroughly investigated both in the field and in the laboratory. As the industry developed, higher speeds were attained in aircraft and greater stresses resulted. In the search for lighter or stronger materials, alloy steels were introduced. S.A.E. 4130 and S.A.E. 4130x or their equivalents have been widely used.

There are a number of specifications written to cover carbon steels and chrome molybdenum steels in various industries, and particularly in the aircraft industry. The following table is representative of these steels. It will be of assistance in making a comparison of the physical properties of the chrome molybdenum and the carbon steels.

Chemical Composition

	Carbon	Manganese	Chromium	Molybdenum
S.A.E. 1025....	0.20—0.30	0.30—0.60	......	......
S.A.E. 4130x...	0.25—0.35	0.40—0.60	0.80—1.10	0.15—0.25

Physical Properties

	Minimum Tensile Strength Pounds per square inch	Elongation Per cent in two inches
S.A.E. 1025.............	55,000	22
S.A.E. 4130x normalized	*90,000—95,000	*5—15
Oil quenched, approximate tempering temperature Degrees F.		
1,100	125,000	11
900	150,000	9
800	175,000	7
600	200,000	5

*Light gauges—minimum ductility—maximum tensile strength.

Chrome molybdenum steels have physical properties quite different from those of carbon steels. This is most noticeable in the relative tensile strength and ductility. These alloy steels also offer greater possibilities of heat-treatment. The fact that they may be heat-treated and that they air-harden should be taken into consideration when welding. An explanation of some of the significant factors in welding and a comparison of welding procedures may indicate how this may best be done.

The simplest phenomenon which happens when steel is heated, as in welding, is expansion. At the same time the steel becomes increasingly soft, ductile and weak. This has the advantage that stresses are dissipated over a wide area. On the other hand, the low strength at high temperatures makes it necessary that the piece be free to move so that undue load is not placed on the hot steel.

As additional heat is applied, the temperature rises to the recalescent point. In plain carbon steels this is about 1,400 degrees F. The metallurgical changes which take place here have a very practical significance. The carbon, which at lower temperatures has existed as discrete particles of iron carbide mixed with pure iron, goes into solution in the iron and remains in solid solution at temperatures above this point. On cooling slowly through this temperature, the carbon is again precipitated or thrown out as iron carbide. More rapid cooling tends to retard the reaction and to retain the carbon in solution.

Recrystallization takes place at about the same temperature as recalescence. When heated much above the recalescence point, steel crystals tend to grow in size to an extent depending on the length of time at the temperature and the amount the temperature exceeds the recalescence point. The shorter the time that the steel is held above the recalescence point and the lower the temperature, the finer the crystals will be and the better the physical properties.

Steel reacts with oxygen at all temperatures as illustrated by rusting at ordinary temperatures and by the adherent oxide scale which is found on hot rolled or forged stock. When reheated, the carbon in the adjacent steel begins to react with the iron oxide. The oxide is reduced and the products of the reaction escape as a gas. Migration of carbon is rapid and decarbonization may be to a considerable depth. The reaction is accelerated as the steel becomes molten.

In oxy-acetylene welding, the surface of the base metal and the welding rod both become coated with iron oxide or scale while heating up to welding temperature. Further, the iron oxide has a lower melting point than steel and must be removed to secure a sound weld.

These physical, metallurgical and chemical factors in welding are becoming more significant with the wider use of alloy steels. They are of considerable importance in welding light walled chrome molybdenum tubing. The air-hardening qualities and resulting high tensile strength and reduced ductility indicate that more attention has to be given to expansion and contraction of the steel, and to making certain that undue stress is not placed on the metal while hot. Though molybdenum is present to inhibit grain growth, it is desirable to reduce the temperature and the time that the steel is held above the recalescence point to a minimum. Further, with thin walled tubing, decarburization of a very small portion of the wall thickness affects an appreciable percentage of the area of the cross section. To obtain efficient joints, the welding rod must have a tensile strength comparable to that of the chrome molybdenum tubing and it must react favourably to heat-treatment.

The first oxy-acetylene welding rods which gave good quality welds were low in carbon and contained a minimum of other elements. This was reflected in the welding technique used. To obtain adhesion between the added metal and the base metal, a considerable amount of the latter was melted to make sure the oxide was removed. To eliminate the iron oxide from the weld, the weld metal

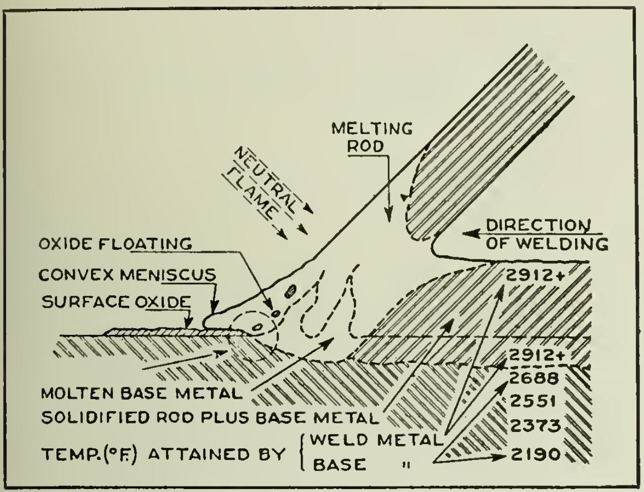


Fig. 1—Diagrammatic Sketch showing roughly what takes place during Neutral Flame Welding.

was heated well above melting temperature to obtain fluidity. As a result the weld was reduced in carbon and low in tensile strength as compared with the results obtainable today. The carbon content of the rod had to be low in order to avoid excessive reaction between it and the copious amounts of iron oxide that were present.

As the welding industry developed and knowledge of the needs and problems increased, new welding rods have been devised in which manganese and silicon have been added to reduce the iron oxide. With these, the products of the reaction are solids which form a fluid slag that floats to the top of the molten puddle. This effectively cleans the weld metal and protects it from further oxidation. The elimination of the carbon-iron oxide reaction in the weld makes it possible to increase the carbon content of this type of rod. Consequently the strength of the weld metal is increased and a sounder deposit is obtained. The active reducing agents readily remove the oxides, making excessive melting of the base metal or temperatures much above melting point unnecessary. The welding technique, however, is still very similar and a neutral flame adjustment is used.

Figure 1 illustrates the action of the welding puddle. The temperatures are representative of those obtained in a cross-section of a weld.

This type of welding rod and welding technique is widely used in the fabrication of tubular members. It is very satisfactory when used on straight carbon steels as with S.A.E. 1025 and good results are obtained with some chrome molybdenum steels, particularly if care is taken to allow for expansion stresses and heating held to a minimum to inhibit grain growth. A recent advance in welding procedure has further assisted in the welding of chrome molybdenum tubing.

This new process for oxy-acetylene welding utilizes certain distinct but co-operating properties of carbon and iron. The underlying principle of the process is comprised of the following relations: carbon is soluble in iron; carbon lowers the melting point of the mixture; this melting point is in the feasible welding temperature range; carbon reduces iron oxide; the non-metallic product of the reaction is gaseous and escapes.

If a piece of steel is heated to somewhat below welding temperature and is exposed to a carburizing influence, the surface layer of the white hot steel will absorb carbon and will spontaneously melt as the carbon approaches the eutectic mixture of 4½ per cent. This carbonaceous film does three things essential in welding. It prevents oxidation and reduces oxides. It promotes intimate contact by acting as a flux and causing the molten metal to run out over the melted surface. It acts as a temperature indicator denoting by its formation the proper time to add weld metal.

Fortunately from the standpoint of commercial feasibility, the carburizing agent is available in the standard oxy-acetylene welding equipment by proper adjustment and manipulation of the flame. As a weld progresses, carbon is absorbed to a depth of one or two thousandths of an inch on the surface of the steel and melts spontaneously. The blowpipe is manipulated so that the carbonaceous film covers the base metal adjacent to the welding puddle.

This film has certain unique features. It is metallic. It is produced automatically. It melts spontaneously, and it disappears by dissolving into the weld metal as soon as its functions are fulfilled. The action may be termed "self-fluxing."

The process known as Lindewelding is a typical example of this excess-acetylene welding. Figure 2 shows a weld being made using this process.

The flame high in acetylene coming from the tip (bottom of cut) melts the rod (top of cut), conditions the metal surface, and anneals the completed weld (not visible) behind rod.

Considered in terms of its application to welding on chrome molybdenum tubing, the process offers a number of advantages over the neutral flame method. It is faster. The indication of proper welding temperature by the spontaneous formation of the carbonaceous film permits more attention to be given to rod manipulation and the rod may be deposited more rapidly. Welding is carried on at a lower temperature.

Fig. 2—A Weld in the Making.

Figure 3 shows representative temperatures of various sections of a weld using the excess-acetylene technique.

The combination of faster welding and welding at a lower temperature reduces the tendency towards grain growth, as the time and the temperature at which the steel is held above the recalescence point are both reduced to a minimum. Reduced grain growth means improved physical properties.

The amount of expansion varies with the speed of welding. In general, the faster the weld the less the expansion that takes place, and the lower the resulting stresses. A backhand technique will result in slightly less expansion stresses than a forehand technique. The process thus assists in overcoming expansion and contraction problems.

The carburizing or reducing atmosphere properly controlled by the excess-acetylene type of flame tends to eliminate a decarburized surface on the tubing at the weld.

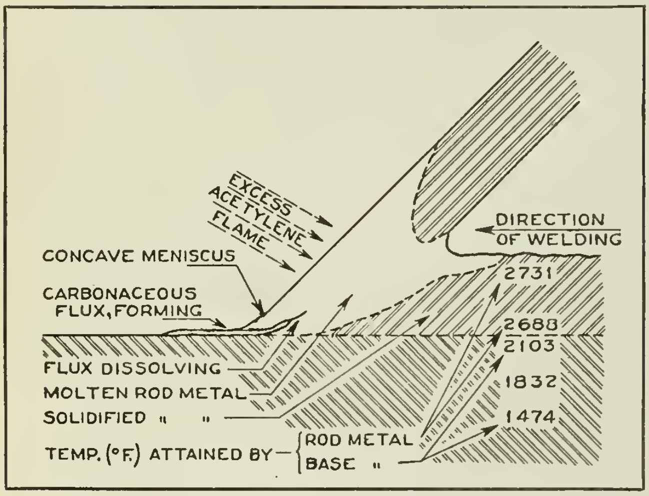


Fig. 3—Diagrammatic Sketch showing important points regarding Excess-acetylene Welding.

The external supply of carbon tends to maintain the carbon in equilibrium in the steel as it is not required to reduce the surface oxides. Carbon loss by migration is avoided.

This welding process reduces the probability of disturbing the chromium-manganese-carbon ratio of the steel immediately adjacent to the weld. The balanced composition proportioned to give optimum relationship between strength and ductility is maintained. Using a suitable rod and this technique, physical properties may be obtained by heat-treatment equivalent to those of the original material. On fittings and small assemblies, heat-treatment is desirable with the chrome molybdenum steels. On larger assemblies it is often impracticable. In either case the process assists in obtaining better welds.

One other item may be mentioned. Due to the semi-automatic features of the process it may be used readily with either a forehand or backhand technique. The physical properties of chromium molybdenum tubing in the normalized condition vary somewhat. Very light walled tubing tends to cool rapidly and with the air-hardening properties of the steel, a higher tensile strength and lower ductility is obtained. A backhand technique may be utilized to reduce the quenching effect where it is desirable to do so.

In the discussion which followed, the author supplied additional information of interest.

An inexperienced man may be trained to use the new procedure more quickly than neutral flame welding.

A welder may become proficient in a few days' practice on test pieces.

The author believes that on light gauge tubing the process described has not been used extensively in Canada up to the present, although many use a modified technique. When used on S.A.E. 4130x better physical properties are obtained than with the previous methods. This is due to the reduction of grain growth and of carbon loss.

The practice of heating the joint with the oxy-acetylene blowpipe after welding is for the purpose only of relieving Internal stresses. Full heat-treatment is a more precise operation.

In the actual Lindeweld procedure:—

A tip one size larger than shown on blowpipe manufacturer's standard charts may usually be used by experienced operators.

A special alloy steel welding rod is used.

The excess-acetylene flame is not usually more than one and a half times the length of the inner cone when welding on light wall tubing.

The blowpipe is inclined to form a very acute angle with the seam being welded.

When the carbonaceous film is formed, which causes the metal to flow over the melted surface, the weld metal is added.

The blowpipe is manipulated so that the carbonaceous films covers the base metal in advance of the welding puddle.

The backhand method should be used for gauges under 16 (.065) and is preferable for larger gauges. The forehand technique may be used satisfactorily on the larger gauges.

While neutral flame welding may be used on S.A.E. 4130 the same reactions take place as in S.A.E. 4130x, though not necessarily to the same degree. Therefore excess-acetylene welding is preferable on S.A.E. 4130.

Similarly, when welding S.A.E. 1025 to S.A.E. 4130, it is advisable to use the technique and rod applicable to the greater strength member.

The heat effect from welding will be evident to a distance as much as ⅞ inch from the weld in proportion to the gauge, i.e. ⅞ inch for very heavy aircraft tubes.

MARITIME GENERAL PROFESSIONAL MEETING

OF

THE ENGINEERING INSTITUTE OF CANADA

In Co-operation With

The Association of Professional Engineers of the Province of New Brunswick

SAINT JOHN, N.B.

AUGUST 27th to 29th, 1936

City of Saint John, with Admiral Beatty Hotel Right Centre

Headquarters: Admiral Beatty Hotel, Saint John, N.B.

Dinner - Dance - Smoker - Golf

Technical Sessions

Visits to Saint John Harbour Reconstruction Work

and

Passamaquoddy Tidal Project

THE
ENGINEERING JOURNAL
THE JOURNAL OF
THE ENGINEERING INSTITUTE
OF CANADA

VOLUME XIX AUGUST 1936 No. 8

Highway Obsolescence

The automotive vehicle has now such a dominant influence in our daily life that its proper utilization, its development and the provision of suitable and safe roads for its operation have become questions of major economic importance. The general use of motor vehicles has in many places completely changed the aspect of the countryside, has directed the growth of our cities, and has opened new avenues of recreation to thousands of people. But it has also introduced a new and formidable life-hazard, largely because the vehicle has developed and improved much more rapidly than the roadways upon which it has to run. Thus, the problem of modernizing existing highways and city streets, and providing new arteries to take care of increasing motor traffic and the development of new areas, is a pressing one, the more so because it is complicated by difficulties of finance.

In a recent article, the President of General Motors Research Corporation drew attention to the economic effect of the obsolescence in automobiles which is the result of the continual improvement in their design and performance. He believes that the expansion of the motor industry and its technical advance, even during the depression years, have largely been made possible because that industry has offered the public, year by year, a series of products, each so much improved that previous models are rendered obsolete and a general demand for the new product arises. In Mr. Kettering's opinion, if a similar progressive policy were generally carried out by other industries, our unemployment problem would be solved. An army of people would be occupied in manufacturing all kinds of improved products, while another host of men would be busy in scrapping and disposing of the discarded equipment.

Even those who do not agree with this rather wide generalization will admit that there are other cases where it would apply, and one of the most obvious of these would appear to be the construction and improvement of the highways, without which the modern motor vehicle is useless.

Many highways as they exist to-day are actually dangerous when used by cars of the power and speed now usual. "The undeniable truth is that the highway is dangerous" — says The Engineering News-Record — "the most dangerous of all the structures that engineers have designed and constructed for the service of man. No purpose is served by holding up speed and careless driving as prime objects of censure, for, whatever may be the sins of the motor vehicle and its operatives, the fact remains that the modern road does not permit of safe driving; the average improved highway offers hazards to any driver, at any speed greater than the crawl of the horse and buggy."

As far as the engineer's work is concerned, much has already been done towards developing an improved technique of building highways. The paper on Modern Concrete Pavement Construction, printed in this issue, exemplifies this, and gives a picture of the responsibility falling upon the highway engineer to-day, at all events as regards main roads. It will be obvious that highways built to such standards of construction as those indicated by Mr. Robinson cannot be provided to-day in many parts of Canada. We have as yet few main roads which carry traffic comparable in density with that upon those main highways in the United States where surveys have shown an average daily traffic of nearly twenty-five thousand vehicles. None of our highway bridges is traversed by crowds approaching in number the forty thousand vehicles per day which have crossed the George Washington bridge. But our automobiles are as fast and heavy, and they need roads as safe and durable as it is possible to provide with the funds available. Thus our highway engineers have, in some ways, a more difficult task than exists in more densely populated countries, and have proportionately less money at their disposal for its performance.

Take, for example, the problems of providing adequate road communication with the new mining areas in western Quebec and northern Ontario, or the filling of the 300 mile gap in the Trans-Canada Highway north of Lake Superior. The development of an adequate highway system in the prairie provinces is rendered difficult in many places by the lack of suitable material at reasonable cost. Road building and maintenance is a pressing problem in all parts of Canada, and it is a credit to the provincial governments concerned that much of the pioneer construction now proceeding has been so well thought out in relation to territorial development.

But the roads now being built, like our existing main highways, will require continual maintenance and improvement. The gravel road to-day, as soon as traffic grows and maintenance becomes heavy, must be paved. The two-lane paved highway has to be widened to three or four lanes. The narrow and tortuous thoroughfares entering our cities must be modernized, and the necessity for doing these things arises not only from the natural growth of traffic, but from the continual increase in the speed and power of cars. A road which was just reasonably safe in the days of the Model T Ford is useless for traffic moving at fifty miles an hour.

No small part of the obsolescence of our highways has been caused by the complete change in safety requirements during the past ten years. The highway authorities no longer look with complacency on deep ditches for draining the right-of-way; these must be replaced by tiled drains and there must be wide shoulders. In many cases safety requires that the highway must be lit. The pavement itself must have a non-skid surface, and be kept at a standard of smoothness previously unheard of. All these things cost money, even more money than is provided by the motorist in the form of levies on car licences, drivers' licences, and gasoline taxes.

As regards the future, straight thinking is needed. The scale of expenditure even for the one million motor vehicles in Canada is considerable. On the present basis of taxation some $55,000,000 per year are available from licence fees and gasoline taxes, provided none of the money is diverted to other channels. In 1933 the provincial expenditure for highway construction and maintenance was just over $40,000,000. This does not seem right, particularly since it is generally agreed that more money spent on highway improvement would be good business for this country. Improved major roadways would undoubtedly lead to a considerable increase in the stream of tourists who, last year, are believed to have spent some $200,000,000 during their Canadian trips.

The highway engineers are doing their part in the development of good and economical methods of construction. They should be supported by public opinion in urging that these methods be more generally utilized in dealing with our obsolescent highways.

A.S.M.E. Meeting

September 16th to 19th, 1936

The Niagara Falls, N.Y. meeting of the American Society of Mechanical Engineers will be held on September 16th to 19th, 1936. Technical sessions dealing with power have been especially arranged to co-ordinate with the study tours of the World Power Conference which will visit Niagara Falls during the meeting.

Members of The Engineering Institute of Canada have been cordially invited by the Council of the A.S.M.E. to attend this meeting, and it is hoped that as many as possible will avail themselves of this opportunity.

Because of the presence in the United States of many engineers from abroad, who will be in attendance at the World Power Conference to be held in Washington, D.C., September 7th to 12th, the opportunity has been seized to secure papers on foreign as well as American practice, and to build up a programme that will draw out discussion from engineers of all countries.

At present the papers and topics under discussion for the two-day meeting are as follows:

Thursday, September 17

Current Practice and Trends in American Power Plants, A. G. Christie.
Superposition, E. H. Krieg
Trend of Design for Pressures From 500 to 800 Lb. Pressure Steam-Electric Generating Plants, James A. Powell
German Boiler and Turbine Practice, Otto Schoene, University of Berlin
Discussion of British boiler and turbine practice
Performance of Diesel-Electric Locomotives in the Buffalo Area, J. C. Thirlwell
Mechanics of the Car Retarder, N. C. L. Brown
Latest Developments in Aircraft Power-Plant Accessories, S. W. Webster
Piston Friction in High-Speed Engines, Louis Illmer
Drum and Vacuum Drying, G. N. Harcourt
Discussion of drying equipment
Economics of Grain Handling, G. F. Butt
Safe Handling of Dangerous and Irritant Materials, M. A. Kendall.

Friday, September 18

Design and Operating Problems When Using Gas- and Oil-Fired Boilers for Standby Steam-Electric Stations, V. F. Estcourt
German Furnace Design and Combustion, Dr. Frederic Schulte, University of Berlin
American Hydraulic-Laboratory Practice, Leslie J. Hooper
Laboratory Research Projects of the Corps of Engineers, U.S. Army, Francis H. Falkner
American Hydroelectric Practice, A. C. Clogher
Canadian Hydroelectric Practice, Dr. T. H. Hogg, M.E.I.C.
Grinding and Maintenance of Tungsten-Carbide Saws and Woodworking Knives, C. M. Thompson
Effect on Economy and Performance of Speed and Pressure in Sanding, H. P. Kirchner
Material Waste Reduction in Woodworking Plants, F. R. Hassler
Factors to Be Considered in Substituting One Wood for Another, E. P. A. Johnson
Recent Developments in Paints and Varnishes, R. J. Moore
Symposium on local processing industries.

Members' Fields of Work

It is an interesting, though not an easy task, to examine the changes which take place in The Institute membership as regards the numbers occupied in various branches of engineering work. The difficulty in doing so is largely caused by the apparent reluctance of some of our members to keep us informed of their changes of location and occupation, or even of the kind of work in which they are normally engaged. The figures given below, which have been estimated from an analysis of The Institute membership list, are thus only approximate, but since the desire to avoid publicity is presumably not confined to any one group, it is believed that they present a reasonably accurate cross section of the whole membership:

	1936		1931
Civil, Municipal and Structural	36	per cent	39
Mechanical and Manufacturing	21	per cent	18
Electrical	15	per cent	19
Mining, Metallurgical and Chemical	7	per cent	7
Executive	11	per cent	10
Miscellaneous and Undergraduates	10	per cent	7

From the information which is available it appears that during the past few years there has been a marked reduction in the ranks of those who originally formed a majority in the organization, the consulting engineers and those practising on their own account; this has been accompanied by a substantial increase in the proportion of our members employed by industrial and commercial companies and by governmental and other public bodies.

The Engineering Institute of Canada Prize Awards 1936

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 1936:—

University of British Columbia	Donald Campbell Macphail
University of Alberta	John E. Poole
University of Saskatchewan	Geo. Mihm
University of Manitoba	Arthur Giles Teskey
University of Toronto	J. V. Leworthy
Queen's University	M. D. Isbister
Royal Military College	Jos. Hope Ross, S.E.I.C.
McGill University	Wm. Anderson Duckett, S.E.I.C.
Ecole Polytechnique	Yvon Cousineau, S.E.I.C.
University of New Brunswick	Robt. F. Peacock
Nova Scotia Technical College	Angus Francis Young, S.E.I.C.

Recent Graduates in Engineering

Congratulations are in order to the following Students of The Institute who have recently completed their course at the Royal Military College, Kingston, Ontario, and have been awarded Diplomas of Graduation:—

Honours and Prizes

Bodwell, Geoffrey Lionel, Kingston, Ont. Silver medal for the Gentleman Cadet obtaining the second highest aggregate of marks throughout the entire course. The W. M. Carleton Monk Memorial Scholarship; The silver medal of the Dept. of Public Instruction, Province of Quebec; First Class honours in Modern Languages and History.

McKibbin, Kenneth Holdsworth, Port Arthur, Ont. Bronze Medal for the Gentlemen Cadet obtaining the third highest aggregate of marks throughout the entire course. Corps of Guides Prize; Special Prize Award presented by (College No. 900) Lt.-Col. W. F. Hadley to the Gentlemen Cadet graduating, who stands highest in mathematics and all branches of engineering over the four years' course.

Oxley, William Morrow, Toronto, Ont.

PERSONALS

M. A. Erickson, S.E.I.C., who graduated from Queen's University this spring with the degree of B.Sc., is now on the staff of the Chrysler Corporation at Detroit, Mich.

W. H. Munro, M.E.I.C., general manager of the Ottawa Electric Company and the Ottawa Gas Company, was elected President of the Canadian Gas Association for the year 1936-1937, at the twenty-ninth annual convention of that body which was held in Vancouver, B.C., at the beginning of July.

Jules A. Duchastel de Montrouge, M.E.I.C., has been appointed assistant manager for the port of Montreal. Mr. Duchastel de Montrouge was born in New York, N.Y., and received his early education in France and Holland. He graduated from Mount St. Louis College, Montreal, in 1897, and from the Ecole Polytechnique in 1901. Following graduation he was for a time draughtsman with the Phœnix Bridge and Iron Works, Montreal, and in 1902 worked in the chief engineer's office of the Canadian Pacific Railway Company, at Montreal. In 1902-1903 Mr. Duchastel de Montrouge was inspector on construction of steel elevators for the Canadian Pacific Railway at Fort William, Ontario, and from 1903 until 1906 was assistant engineer with the late H. E. Vautelet, M.E.I.C., on the design of steel bridges and structures. From 1906 until 1924 Mr. Duchastel de Montrouge was town engineer of Outremont, Que., resigning in 1924 to become general manager of the Quebec Forest Industries Association Limited, Quebec, Que., which position he is now resigning.

Jules A. Duchastel de Montrouge, M.E.I.C.

J. N. Finlayson, M.E.I.C., formerly professor of civil engineering at the University of Manitoba, Winnipeg, Man., was recently appointed Dean of the Faculty of Applied Science of the University of British Columbia, Vancouver, succeeding the late Dr. R. W. Brock, M.E.I.C., who was killed in an aeroplane accident in July 1935.

Dean Finlayson graduated from McGill University in 1908 with the degree of B.Sc., receiving that of M.Sc. in 1909. From 1908 until 1911 he was a lecturer at McGill University, and in 1910-1913 Dean Finlayson was with the firm of Waddell and Harrington, consulting engineers of

J. N. Finlayson, M.E.I.C.

Kansas City and Vancouver, as detailer, inspector and resident engineer on the erection of bridges. From 1913 until 1919 he was professor of civil engineering at Dalhousie University, Halifax, and at the same time carried on a private practice, designing and superintending the construction of steel and reinforced concrete structures. In 1919 Dean Finlayson accepted the appointment at the University of Manitoba from which he now resigns.

A. Langlois, A.M.E.I.C., has been appointed Assistant Commissioner of Patents, at Ottawa. Mr. Langlois received his early education at the College de Ste. Anne de la Pocatiere, Quebec, and following graduation he engaged in a four-year practical course in machine work. In 1902 and 1903 he was engaged as assistant on the construction of the Canadian National Railway bridges at Bout de l'Isle, Montreal, and later worked as draughtsman for the late Emile Vanier. Mr. Langlois was also for some time draughtsman for Marion and Marion, patent solicitors of Montreal. In 1909 he graduated from the Ecole Polytechnique, Montreal, with the diploma of Civil Engineer, and the degree of Bachelor of Applied Science. Upon leaving the university, Mr. Langlois moved to northern Quebec, and entered partnership with the late T. Simard. In January 1911 he became assistant engineer on the chief engineer's staff of the Department of Public Works, Ottawa, and while he was with that department was entrusted with a complete survey of the Rainy river from its source to Lake of the Woods, together with the survey of some of the lake's tributaries situated northwest of Lake of the Woods. Mr. Langlois also prepared plans in connection with shore protection at North Bay, Lake Nipissing. In 1919 he prepared plans and supervised the erection of complete sewage disposal systems for the two military hospitals at Kingston, Ont. From 1915 to 1921 Mr. Langlois was the district engineer's principal assistant, and on different occasions he was acting district engineer for the Department. In January 1921 he was transferred to the Patent Office as Examiner in charge of Division, which position he held until he received his present appointment.

Committee on Consolidation

Report for July 1936

It appears advisable at this time to make a short review of the activities within The Institute and the progress made by its Committee on Consolidation for closer co-operation between the engineering organizations in Canada and the establishing of a national engineering body representative of the whole profession.

The Committee on Consolidation was appointed by the annual general meeting of The Institute held in Toronto on February 7th, 1935, and commenced work on the day of its appointment. During that year fifteen meetings were held and a questionnaire was issued to all organizations of the profession in Canada. The replies to the questionnaire were overwhelmingly in favour of the carrying out of such co-ordination and indicated the broad principles on which it should be based.

At the annual general meeting of The Institute held in Toronto on February 5th, 1936, the Committee on Consolidation presented a report which covered the history of this movement in detail, the returns to the questionnaire, a report of the work of the Committee for the year and its recommendations as to the further steps to be taken in promoting such proposals.

This report, containing complete information on this movement, appeared in the January and February issues of the "Journal" of this year and was also published in pamphlet form and circulated to the membership. It is available to members of The Institute on application to the General Secretary.

As stated in the report, it has been the policy of the Committee to keep the profession fully informed as to its activities and progress and it may safely be said that no committee of The Institute has adhered to this policy more consistently than the Committee on Consolidation, through its reports appearing in the "Journal."

After discussion by the annual general meeting, which lasted for a day and up to eleven o'clock in the evening, and was recorded in detail by the Secretary in the March issue of the "Journal," the report and its recommendations were adopted as a progress report by unanimous resolution.

Following the annual general meeting, a conference was held between the Dominion Council of Professional Engineers, representatives of the Provincial Professional Associations, (and Corporation), and the Committee on Consolidation, which lasted for the whole day of February 7th, and resulted in the drafting of the "Memorandum" which appeared in the June issue of the "Journal."

This "Memorandum" was approved by the Committee at its meeting of March 21st, 1936, and again considered on May 30th. A joint meeting of the Council and the Committee on Consolidation held on May 30th, recommended the "Memorandum" for approval by Council with a modification that the Councillors referred to in Clause 5 (*d*) should be corporate members of The Institute. This was finally adopted by Council at its regular meeting of June 12th, 1936.

At the same time the joint meeting of the Council and the Committee had before it tentative revisions to the By-laws of The Institute as prepared by Mr. C. C. Kirby. These were discussed and held for further detailed study.

The eighteenth meeting of the Committee on Consolidation was held on Wednesday, July 8th, 1936, at 8.30 p.m. there being present: Messrs. O. O. Lefebvre, J. B. Challies, R. E. Jamieson, R. F. Legget and G. McL. Pitts. The meeting reviewed the minutes of the joint meeting with Council; approved a statement regarding the consolidation movement prepared by a special committee of Council to be forwarded to certain engineering organizations in Ontario; considered the proposed revisions to the By-laws submitted by Mr. C. C. Kirby, and adjourned to meet on July 21st.

The nineteenth meeting of the Committee was held on Tuesday, July 21st, 1936, at 8.30 p.m., there being present: Messrs. O. O. Lefebvre, J. B. Challies, R. E. Jamieson, R. F. Legget and G. McL. Pitts. Following the routine business arising out of the minutes and correspondence, the Chairman presented a draft of proposed revisions to the By-laws for the consideration of the Committee. These were discussed generally and the meeting adjourned until August 4th, for further study of By-law revisions.

In the meantime the revisions referred to have been circulated to members of Council and the Committee on Consolidation for study, in order that the Committee may have the benefit of every suggestion before preparing its final recommendations for submission to the Council.

These proposed revisions to the By-laws of The Institute are based on,

(*a*) The existing By-laws.

(*b*) The report of the Committee on Consolidation as unanimously adopted as a progress report at the annual meeting of The Institute on February 5th, 1936.

(*c*) The "Memorandum" of the joint conference of the Dominion Council of Professional Engineers, representatives of the Provincial Professional Associations and Corporation, and the Committee on Consolidation of February 7th, as approved by a joint meeting of the Council of The Institute and the Committee on Consolidation held on May 30th, 1936, and formally adopted by Council at its regular meeting of June 12th, 1936.

(*d*) Resolution by the Corporation of Professional Engineers of the Province of Quebec at its annual meeting of March 27th, 1935.

(*e*) Resolution by a joint meeting of the Winnipeg Branch and the Association of Professional Engineers of the Province of Manitoba on November 7th, 1935, and the proposals referred to therein.

(*f*) By-laws suggested by Mr. C. C. Kirby.

(*g*) Suggestions submitted to the Committee on Consolidation by interested organizations and members.

The proposed revisions provide that,—

(*a*) The fundamental structure of The Institute and its function are maintained.

(*b*) Its possibilities as a national organization are definitely increased.

(*c*) The legal status of the Provincial Associations (and Corporation) is maintained.

(*d*) Every facility is afforded the Provincial Professional organizations to co-operate with The Institute for economy and the advancement of the interests of the profession as a whole, through the provisions governing entrance requirements and the establishing of Provincial Divisions.

(*e*) Participation in the proposed co-ordination and co-operation within the profession, as provided under these By-laws, is wholly voluntary on the part of any Provincial organization.

A plenary meeting of the Committee on Consolidation has been tentatively set for August 21st and 22nd, to give detailed study to By-law revisions. It is hoped that the Council and the Committee will be in a position to report definite progress on the occasion of "The Maritime General Professional Meeting of The Engineering Institute in co-operation with the Association of Professional Engineers of the Province of New Brunswick," which is being held in Saint John on August 27th, at which Mr. R. F. Legget will represent the Committee.

Gordon McL. Pitts,
Chairman.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Institution of Civil Engineers: Proceedings 1934-35 Vol. 239. Part I.
Institution of Mining and Metallurgy: Transactions 1934-35.

Reports, etc.

Quebec (Prov.) Bureau of Mines: Preliminary Statement on the Mineral Production of the Province of Quebec, during the year 1936.
Nova Scotia: Report of the Royal Commission on Transportation, January 27th, 1936.
International Nickel Co. Inc.: The Properties and Applications of Quenched and Tempered Nickel Alloy Steels.
The Properties and Applications of Heat-Treated Wrought Nickel Alloy Steels.
Canada, Dominion Water Power and Hydrometric Bureau: Water Resources Paper No. 70. Surface Water Supply of Canada, St. Lawrence and Hudson Bay Drainage.
Canada, Civil Service Commission: 27th Annual Report, 1935.
Hydro-Electric Power Commission of Ontario: 28th Annual Report, 1935.
Alberta, Dept. of Lands and Mines: Annual Report 1935.
Institution of Mechanical Engineers: List of Members, May 1st, 1936.
Saint John Harbour Commissioners: Annual Report 1935.
Quebec, Bureau of Mines: Annual report 1934, Part E.

BULLETINS

Compressors.—An 8-page bulletin published by Worthington Pump and Machinery Corporation, Harrison, N.J., describes their types V3-A2 and V6-A2 3 and 6 cylinder vertical two-stage compressors, air cooled, with piston displacement varying from 82 to 445 cubic feet per minute, requiring 15 to 75 h.p. motors.

Gas Engines.—The Worthington Pump and Machinery Corporation have issued an 8-page pamphlet describing their Type AG vertical four-cycle gas engines, in sizes of from one to 6 cylinders with from 15 to 105 h.p.

Turbine Pumps.—Turbine pumps of the vertical type for cofferdam dewatering and mine sinker service are described in a 4-page leaflet received from the Worthington Pump and Machinery Corporation.

Blowers.—The Roots-Connersville Blower Corporation, Connersville, Ind., have published a four page folder describing and illustrating various types of blowers for ice plants.

Ball and Roller Bearings.—Catalogue No. 36 issued by R and M Bearings Canada Limited, Montreal, gives particulars of ball and roller bearing transmission equipment, dealing with pillow blocks, hanger blocks and special grease for ball and roller bearings. Dimensions, sizes, and prices of this equipment are included.

Sheet Piling.—A 4-page leaflet received from the Canadian Sheet Piling Co. Ltd., Montreal, contains notes on tie rod and waler design.

BOOK REVIEW

Sewerage

By A. Prescott Folwell. John Wiley and Sons, New York (Renouf Publishing Company, Montreal). 1936. 6 by 9¼ inches. 412 pages. Cloth. $4.50.

Reviewed by E. M. Proctor, M.E.I.C.*

This is the eleventh edition of this well-known work by Mr. Folwell, In this new edition, the previous edition is followed very closely with the exception of several revisions to bring the work up-to-date.

The book is divided into two parts—Part I, dealing with the design and maintenance of sewerage systems, and Part II, with the design and operation of sewage disposal plants.

Part I follows almost exactly the tenth edition with the exception of the treatment of forecasts for population, which has been re-written in several parts to bring the information up to date.

This section of the books gives in a concise detailed manner information and data necessary to calculate the size of storm and sanitary sewers. There is a chapter which deals with the very important matter of flushing and ventilating sewers—the phase of operation of sewerage systems that is too often forgotten or neglected by municipalities. Other chapters deal with the design of sewer appurtenances, house connections, intercepting sewers, pumping stations, etc. These chapters dealing with the design and maintenance of a sewerage system contain a great deal of information that should be very valuable to an operating engineer as well as those who are engaged in the design and layout of sewerage systems.

Part II of the book deals with sewage disposal plants. This section of the book has been re-written to bring the book up to date with reference to various advances in the process of sewage disposal. The sections dealing with the activated sludge process, the utilization of gas, vacuum filters, centrifuges and incinerators, have been revised. Chapter 20, which deals with "Chemical and Mechanical Aids," has been completely re-written and contains up-to-date information in connection with these matters, which have advanced very rapidly in the last few years.

There is a large amount of detailed information contained in this part of the book which will aid the operator and designer of sewage disposal systems in the proper solution of such problems. The information contained in this chapter is based on recent results of operation of sewage disposal plants.

In dealing with the matter of sewage disposal, the writer outlines very carefully and fully the different methods of treating sewage in its various phases, the use of chemicals in connection therewith, and details of construction and design, but does not enter into any discussion as to the relative merits or the advisability of using any particular system. This, of course, is the natural method of treating such an involved problem as sewage disposal. The operator or designer will find a great deal of very useful information in a clear and concise manner in this section of the book.

There are numerous cuts and drawings throughout the book which are well done, the book is printed on good paper, and the reviewer has no hesitancy in recommending the book to those interested in this subject.

**James, Proctor and Redfern, Limited, Toronto.*

List of New and Revised British Standard Specifications

(Issued during April and May, 1936)

B.S.S. No.

11—1936. *Flat Bottom Railway Rails.* (Revision.)
Modifications are the introduction of a medium manganese quality of rail with the appropriate analysis and tests, and the omission of the lower of the two carbon qualities previously specified. Modifications have also been made in the chemical composition of the carbon rails.

160—1936. *Slate and Marble Slabs for Electric Power Switchgear up to and including 660 Volts, A.C. and D.C.* (Revision.)
Relates to slate and marble slabs used for mounting the apparatus pertaining to electric power switchgear for use on low and medium pressures. Includes electrical tests, dimensions and finish.

670—1936. *Welded Mild Steel Drums.*
Construction and dimensions of three weights of cylindrical drums, of nominal capacities from 5 to 150 gallons, for liquids which do not flash below 73 degrees F. or develop a vapour pressure of more than 20 pounds per square inch absolute below 45 degrees C.

673—1936. *Pneumatic Tools and Accessories.*
Standardizes the shanks of pneumatic tools and accessories. Includes under a separate section standard nomenclature and definitions for pneumatic tools and appliances.

677—1936. *16 mm. Sound Film.*
Is based on the S.M.P.E. specification and relates to the dimensions for the camera aperture, projector aperture, sprocket holes and sound track. The position of the sound track and the emulsion side of the film relevant to the light source are also specified.

Copies of the new specifications may be obtained from the British Standards Institution, 28 Victoria Street, London, S.W.1, England, and also from the Canadian Engineering Standards Association, 79 Sussex Street, Ottawa.

The Rackham Engineering Foundation and The Engineering Society of Detroit

An endowment of $500,000 has recently been created in Detroit for the benefit of the engineering professions and allied arts and sciences in the Detroit area, and for the assistance of the public in meeting engineering problems. This fund will be administered by the Rackham Engineering Foundation, and the greater part of its income will go to the Engineering Society of Detroit, a body which has just been incorporated.

The purposes of this society are educational and scientific. Its aims will be to aid the public to solve civic questions involving engineering problems, to encourage research in the investigation of engineering questions of public interest, and finally to provide in its headquarters library service, lectures, publications and instruction on subjects tending to increase the technical skill and social usefulness of the members. It is expected that all of the local societies and groups in the engineering and allied fields will become affiliated with The Engineering Society of Detroit.

The Foundation will also have power to assign a portion of the income of the fund to pay the expenses of studying, investigating and exploring the practicability or wisdom of any proposed, contemplated or partially constructed public project in Detroit or vicinity involving engineering skill, judgment or knowledge, and of reporting to or advising any public body, commission or authority thereon.

The late Horace H. Rackham accumulated his fortune as a director of the Ford Motor Car Company and as a result of engineering skill applied to the automotive industry. It was a recognition of this fact that prompted the Board of Trustees of the Horace H. Rackham and Mary A. Rackham Fund to create this endowment.

CORRESPONDENCE

The Editor,
The Engineering Journal.

Dear Sir,

I note the letter from Mr. T. C. Thompson, A.M.E.I.C., published in the July issue of The Engineering Journal, and I would like to point out that in my opinion Mr. Thompson draws attention to the greatest weakness of the Consolidation Committee's tentative plans when he asks "In addition, should not the question of Consolidation embrace not only the means of consolidation of The Institute and the Provincial Associations, but also other associations of particular activities in engineering or allied fields, such as the Canadian Institute of Mining and Metallurgy for example?"

In England, the Engineering Joint Council was established in 1922. It was formed originally by the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects, and the Institution of Electrical Engineers, which are called the founder Institutions. Since that time three other Institutions, namely the Institution of Municipal and County Engineers, the Institute of Marine Engineers, and the Royal Aeronautical Society have joined the Joint Council.

The Constitution of the Council is short, covering about one page, and the By-Laws only three more pages. It provides for other Institutions which have examinations or equivalent qualifications for admission to their corporate membership. Such Institutions, known as Grade A, to which the three mentioned above belong, have one representative each on the Joint Council, while the Founder Institutions have two representatives each.

Provision is also made for Affiliated Institutions, (Group B), "whose interests are already represented in the Joint Council (by reason of a large proportion of their members also belonging to the Institutions represented on the Joint Council) or Institutions whose membership is not necessarily confined to Engineers". This would cover the C.I.M.M. "These Institutions, while having no representative on the Joint Council, may refer questions to the Joint Council, who will invite a delegate (such delegate, however, not having a right to vote) to attend the Meeting of the Joint Council at which such questions are under consideration."

Institutions in Group B may be transferred to Group A (with one representative with voting powers) when the standard of examination and the number of corporate members justify such transfer in the opinion of the Joint Council.

In Canada six of the eight Associations of Professional Engineers have a Dominion Council of Engineering consisting of one representative from each of the six Associations. Unity in the Profession of Engineering in Canada could be obtained by enlarging the Dominion Council, taking in representatives from other technical bodies with equal standards of admission, and others could be affiliated as in the Joint Council. This could be accomplished without awaiting the tedious process of amending By-laws which has to precede amalgamation. It would in no way prevent amalgamations taking place later so that it would not interfere in any way with the work of the Committee on Consolidation.

If the Associations and the E.I.C. were to amalgamate later, it is probable that the E.I.C. could then take over the work of the Dominion Council. Such a scheme provides for "the other associations of particular activities in engineering" mentioned in Mr. Thompson's letter.

Yours truly,

J. B. de Hart, M.E.I.C.

Lethbridge, Alberta,
July 24th, 1936.

The Editor,
The Engineering Journal.

Dear Sir:—

My attention has been called to the excellent paper by Mr. Robert F. Legget, A.M.E.I.C., on Steel Piling which appeared in the June issue of your Journal. The third last paragraph of this paper reads as follows:—

> "The author believes that there is no real competition between timber and steel piling in future civil engineering work in Canada. In the past, timber has been so plentiful that little thought was given to the economics of its use, and it was often the only material considered for many structures such as have been described. That state of affairs has gone and with it much of the great heritage of timber which Canada possessed, leaving a situation so serious that quite recently the National Research Council have appointed a special committee to consider all aspects of research in connection with reforestation. When it is realized that in many parts of eastern Canada it is impossible to obtain local 10-inch by 10-inch timbers in any useful lengths, it will be appreciated that the sooner engineers and others grapple with the problem of timber conservation, the better it will be for the good of the country. In such conservation work the judicious use of steel piling for permanent structures can be of real assistance."

In this paragraph the author, no doubt inadvertently, has made statements which conceivably might leave an entirely erroneous impression of the situation with respect to sources of timber for piles in Canada. For some of the smaller wharves very frequently locally-cut piles are used, but for large works in nearly every case piles and other timber used in construction must be brought to the site, just as steel piles would have to be delivered on the job if they were used. While it is true, as the author says, that "in many parts of eastern Canada it is impossible to obtain local 10-inch by 10-inch timbers in any useful lengths," nevertheless, it should be borne in mind that it is not necessary to depend on local supplies of timber any more than it is necessary to depend on local supplies of steel piles.

Several species of eastern timber are used for piles, either treated or untreated. Where very large timbers are required such as are not available in eastern Canada, they may be obtained readily in British Columbia in practically any size or dimension desired.

Again, in referring to the National Research Council's Associate Committee on Forestry, the author has made a statement which conceivably might create an erroneous idea of the forestry situation in Canada. This Associate Committee has been set up not because there is an immediate serious danger of timber shortage in Canada, but rather for the purpose of assisting in laying plans so that such a situation may never occur, and that the splendid forest heritage of Canada may be so managed as to yield the greatest possible benefits to the country as a whole and to afford to those industries depending on the forests a continuous supply of timber. As a matter of fact, the chief concern of the timber industry during the past few years has been to find a market for its timber, rather than to find timber for its market.

Yours very truly,

T. A. McElhanney, A.M.E.I.C.,
Superintendent,
Forest Products Laboratories of Canada.

Forest Service,
Department of the Interior,
Ottawa,
July 16th, 1936.

To The Editor,
The Engineering Journal.

Dear Sir:—

Among the objects of The Engineering Institute are included those of encouraging original research and facilitating the acquirement and interchange of knowledge. I have been occupied for the last four years entirely on original research in relation to the fundamental problems of physical science, and have succeeded in solving many which have never been understood before. My results will all be published in due course, but there are two items which can be checked against predictions and are therefore of distinct interest in advance of the statement of the long lines of reasoning which led to their discovery. The first relates to the cause of earthquakes and the times of their occurrence. The cause has been definitely found, and the approximate dates of major events can be predicted at any time in advance. The disasters in Szechuan and at Patna in May were the worst to be expected this year and happened close to the peak of seismic stress. The next events in order of severity this year may be expected within ten days before or after a stress peak on November 1st. Tremors and pre-shocks in October should be taken as warnings in the localities affected, and the inhabitants can take what steps they wish in their own interest.

The second item relates to the cause and dates of occurrence of auroras and magnetic storms. In flat contradiction to the seventy-seven-year old pet theory of many astronomers and physicists, I find that sunspots and solar eruptions have nothing whatever to do with these events. Since last October I have successfully predicted the dates of auroras without taking any notice at all of the sunspot situation. The last success was the brilliant show seen in Vancouver and all across Washington, Idaho and Montana on June 18th, which I predicted at an engineering meeting on February 3rd. No sunspot theorist could have done that.

There are certain details, however, that I wish to clear up, and which need further data for elucidation. These relate to the character of the display, and I desire to enlist the co-operation of members of The Institute in taking notes of these points if they have the opportunity, and I would greatly appreciate any such information that may be sent to me.

To avoid unnecessary watching for the displays I append a table (prepared in May) giving the dates when the groups are due during the rest of the year and the relative strengths expected.

Notes are desired on the following points:—

1. The direction of the meridian of the arches.
2. The speed and range of angular movement of rays (such as 11 seconds to move through 90 degrees; counting 5 rapidly to time one second).
3. The number of angular moving rays seen in action at one time.
4. Whether the brightest rays start at the east or west end of the arch.

5. Whether equally bright, or less bright rays travel in the opposite direction.
6. Whether apparently dark shadow rays appear on bright diffused light.
7. Whether any swishing or crackling sound is heard.
8. Any general features which might be of interest.
9. Dates and times of observation and approximate latitude and longitude of observation station.

The exact dates are essential. Many recorded notes have lost their value by not being dated.

Our members are scattered all over the country and can be relied upon to give more accurate notes than the general public, if they will kindly oblige.

The groups predicted in May were as follows:—

A. May 10th to 18th	K. August 8th to 18th
B. May 20th to 30th	L. August 18th to 23rd
C. June 2nd to 12th	M. August 30th to September 7th
D. June 4th to 14th	N. September 5th to 20th
E. June 14th to 24th	O. September 22nd to December 31st
F. June 24th to July 4th	P. October 7th to 12th
G. July 4th to 9th	Q. October 17th to November 6th
H. July 14th to 19th	R. November 11th to 26th
I. July 14th to 19th (2nd)	S. December 11th to 21st
J. July 24th to 29th	

The strength of the groups is roughly estimated according to the classes here stated, Class 1 being the strongest, including groups E, M, R; Class 2, B, F, G, S; Class 3, D, N, Q; Class 4, A, C, H, I, J, K, L, O, P.

Where the dates of the groups are simultaneous or overlap the strengths will be superposed. Some of the groups in class 4 may only produce auroras north of latitude 50, and group O only north of latitude 55.

Weather may prevent auroras being seen on all these occasions, but they give indications of their identity by differences in the range and shapes of compass diurnal variation curves.

Edgar C. Thrupp, m.e.i.c.

Vancouver,
June 30th, 1936.

Editor's Note: Members who have the opportunity and desire to co-operate with Mr. Thrupp will please send their observations to him at 2626, 13th Avenue West, Vancouver, B.C.

BRANCH NEWS

Border Cities Branch

C. F. Davison, A.M.E.I.C., Secretary-Treasurer.
F. J. Ryder, S.E.I.C., Branch News Editor.

Mining Development in Canada

The regular monthly meeting and dinner of the Border Cities Branch was held in the Prince Edward hotel, April 24th, 1936. Twenty-four persons were present to hear Mr. A. D. R. Fraser, b.a.sc., f.c.i.c., science master at the Windsor-Walkerville Technical School, present an illustrated lecture on "Mining Development in Canada."

Mr. Fraser first gave a short talk on gold mining and next discussed the fuel problem in Ontario and the various attempts to make a commercial article from the lignite deposits that are found in that province. Samples of the various types of products that had been experimented with were passed around. None of them had been a commercial success.

A short survey of the development of the petroleum industry in Canada, noting the use of underground storage tanks as a fire precaution, was given.

Through the courtesy of the Associated Screen News, Mr. Fraser was able to show two reels of moving pictures entitled "Gold in Canada." The pictures covered all stages in the recovery of gold from prospecting to mining and the final refining processes. There also followed one reel on the petroleum industry, covering the development from mapping to drilling, refining and marketing.

At the conclusion of the pictures, the meeting was thrown open to discussion.

It was moved by H. J. Coulter, a.m.e.i.c., and seconded by E. M. Krebser, a.m.e.i.c., that a hearty vote of thanks be extended to Mr. Fraser.

The Performance Limits of the Four-Cycle Engine

At the conclusion of the dinner meeting held at the Prince Edward hotel on May 26th, 1936, Mr. R. N. Janeway, research engineer of the Chrysler Motor Corporation, Detroit, presented a paper on "The Performance Limits of the Four-Cycle Engine."

This was a problem which Mr. Janeway and his assistants set out to solve, or in other words they were looking for a par value for an ideal engine. In checking actual tests against then known existing formulae erroneous results were obtained. Then, with practically nothing to start with except their knowledge of thermo-dynamics, the group went ahead and constructed their own formula which gives results that are favourable to actual engine performance.

Following Mr. Janeway's paper, those present were introduced to Mr. T. P. Pullinger, j.p., c.b.e., chief engineer and designer of many early British and French cars. He was also co-designer of the B.H.P. airplane engine of war time fame.

Mr. Pullinger expressed his pleasure at being present and mentioned that in his younger days there was not so much theory and that they just experimented with this or that, often with some very startling results.

H. J. A. Chambers, a.m.e.i.c., moved a vote of thanks to both Mr. Janeway and Mr. Pullinger, which was extended to them by T. H. Jenkins, a.m.e.i.c. The meeting then adjourned.

Quebec Branch

Jules Joyal, M.E.I.C., Secretary-Treasurer.

Le 4 mai dernier, lors d'un déjeuner causerie au Château Frontenac, monsieur Alfred Marois, i.c., président de la Chambre de Commerce de Québec et président de la Fédération des Chambres de Commerce de la Province de Québec, a donné une brillante conférence intitulée

Le Rôle de l'Ingenieur dans l'Industrie

Le conférencier, après quelques mots de remerciements à l'adresse du président, monsieur Larivière, commença sa causerie en insistant sur l'importance de la Corporation des Ingénieurs.

"Parler de l'ingénieur, dit-il, c'est un peu faire l'histoire de la science avec toutes ses aridités, mais aussi c'est toucher du doigt les énormes succès remportés par les techniciens d'une corporation qui prend de jour en jour une ampleur extraordinaire."

Nul ne voudra contester que le génie industriel a droit de cité dans les activités de la société et qu'il est devenu un facteur nécessaire au bon fonctionnement de toute entreprise industrielle solidement établie; le conférencier estime que c'est l'ingénieur qui est la cause immédiate des progrès accomplis et que c'est grâce à ses méthodes scientifiques que l'industrie a pris la première place dans l'organisme économique. C'est lui qui a favorisé les moyens de communication, qui a trouvé les machineries destinées à intensifier considérablement la capacité productrice, et qui a découvert les méthodes scientifiques qui ont placé l'industrie au tout premier rang. M. Marois a déclaré ne pas voullir entreprendre d'établir si la machinerie a été néfaste ou non à la classe ouvrière; il a toutefois dit que par la force des circonstances, la machinerie était devenue nécessaire au développement économique.

Les agences de l'industrie et de la consommation dit-il, n'étaient plus possibles; il fallait une intervention quelconque pour établir le lien dont l'absence menaçait la structure industrielle. Dès lors, ce fut la fièvre de l'invention et les machines naissaient avec une rapidité extraordinaire. Cette répercussion fut favorable.

Les ingénieurs ont trouvé la formule pour rendre possible la fabrication hâtive qui était devenue nécessaire. Leurs inventions ont produit des résultats intrinsèques fort appréciables et ici le conférencier ajoute que, pour sa part, la machinerie moderne ne constitue pas une obstruction dangereuse pour la classe ouvrière; elle ne fait que modifier les fins immédiates de la classe ouvrière, la forçant pour ainsi dire à se spécialiser sur des instruments modernes, alors que précédemment elle agissait sur des moyens dont la valeur devait être reconnue mais qui ne répondaient plus aux besoins de la consommation.

M. Marois déclare que l'ingénieur s'est rendu indispensable à l'industrie et au commerce par les formules nouvelles et les expériences qu'il a données; par sa science il a présidé à tous les mouvements qui ont été la cause de progrès et aujourd'hui l'ingénieur occupe une place prépondérante dans la société.

En terminant monsieur Marois déclare que l'ingénieur devrait se lancer plus ouvertement dans le vaste champ d'action que lui offrent maintenant l'industrie et le commerce et qu'il ne devrait plus chercher, comme dans le passé, à restreindre ses activités dans les services publics.

Le conférencier fut présenté à l'auditoire par monsieur Alex. Larivière, président de la section de Québec, et remercié par monsieur A. B. Normandin.

The S.B.A.C. Display

The fifth annual flying display and exhibition of aeronautical equipment organized by the Society of British Aircraft Constructors was held at Hatfield aerodrome on June 29th, 1936.

The flying capabilities of some twenty-five different machines were demonstrated during the display. It was noticeable this year that the number of civil machines exhibited outnumbered those of a military character and that most of the civil aircraft were of a small light type. On the military side three aircraft were outstanding, the Supermarine "Spitfire" single-seater fighter, the Fairey "Battle" medium bomber and the Hawker single-seater fighter. All three machines are monoplanes, are fitted with Rolls-Royce "Merlin" engines, have retractable undercarriages, and can travel at speeds in excess of 300 miles per hour. The "Merlin" engine shown in the static exhibition is a liquid-cooled supercharged motor with twelve cylinders arranged in two banks of six each. Its power rating has not been published, but it has been suggested that it is over 1,000 h.p.—*The Engineer.*

The First International Conference on Soil Mechanics and Foundation Engineering

Cambridge, Mass., June 22-26, 1936

(Abstract of a report contributed by R. F. Legget, A.M.E.I.C.)

The first International Conference on Soil Mechanics and Foundation Engineering, held at Harvard University, Cambridge, Mass., U.S.A., from June 22nd to 26th, 1936, was attended by about two hundred and fifty engineers and research workers, representing almost twenty different countries The conference assembled for the first time the results of soil research work at present proceeding in many parts of the world, and correlated at least to some extent the studies of soils necessitated in many of the various branches of civil engineering work.

The President of the conference was Dr. Karl von Terzaghi, of the Technische Hochschule in Vienna, Austria, and presently a visiting professor at Harvard University, to whom is due very largely the progress which has already been made in the scientific study of soils. In his addresses, Dr. Terzaghi sketched the development of what has now generally become known as the science of Soil Mechanics, using the word in its true geological sense, as denoting all unconsolidated materials found as constituents of the earth's crust. It was recalled that about twenty-five years ago, in three different countries, the attention of engineers was forcibly directed to close study of sands and clays by reason of certain disastrous failures. In America, the Panama canal slides; in Sweden, the severe slides on the state railroad system which resulted in the appointment of the Royal Swedish Geotechnical Commission of Landslides; and in Germany, the construction of the Kiel canal led to such serious difficulties that careful studies were necessarily initiated. The incidence of the war impeded progress, but in the years immediately prior to 1920 it was finally demonstrated that geological observation of such phenomena was not enough, and physical soil tests, planned in a general manner, were soon begun, although with primitive apparatus. Thereafter, soil research work commenced in many laboratories and universities throughout the world.

Studies of soil problems had been made from the start of modern engineering, and due tribute was paid to the many records of observed data in connection with such engineering works which are to be found in older engineering publications, especially those of Great Britain, dating up to the year 1880. Subsequently, empirical rules, based on these observations, seemed to become generally accepted and records gradually became more fragmentary. This condition persisted until more scientific study of soils began, when these older rules were often found wanting. Although at the start of recent investigations it had been hoped to develop a tool as definite as (say) structural analysis, such hopes had been abandoned, but gradually a new mass of evidence was being assembled, and on this foundation it was being found possible to erect the framework of a useful science.

Chairmen of national committees had been appointed prior to the conference, in addition to four vice-presidents, one Italian, one English, and two American, and the resulting preliminary work led to nineteen countries being represented at the proceedings. American engineers naturally predominated in number, but both Mexico and Germany sent relatively large delegations, and six engineers were present from Canada. Two engineers travelled to the conference from the East Indies, one from Java, and the other from the Federated Malay States. A member of the staff of the Building Research Station of the British Government represented recent British research work.

The free interchange of ideas between engineers of so many nations, both in formal discussion and outside the conference rooms, was perhaps the most notable feature of the conference. Eight half-day technical sessions were held, each starting with either one or two illustrated lectures on engineering work in one of half a dozen countries.

The papers submitted to the conference number over one hundred and fifty. All were printed either in full or in abstract form and distributed to participating members prior to the opening session. A volume, to be issued later in the year, will contain a record of the proceedings and will present an invaluable collection of data of actual records from construction, and of theoretical analysis.

Contributions were classified under fifteen sections, to which reference is made in the following notes.

Section A. Reports from Soil Mechanics Laboratories.

Twenty five papers were presented, describing the equipment and research work of twenty soil mechanics laboratories in America, Europe, and Japan. Members of the conference were enabled, in the evening sessions, to visit the soil mechanics laboratories of Harvard University and of the Massachusetts Institute of Technology, seeing there several of the types of testing equipment described in the papers. Humid rooms to assist in the correct determination of moisture content of clays etc., are a standard feature of the larger laboratories. Grain size is usually determined by means of standard sieves and the hydrometer method developed by Casagrande. Compression, consolidation and permeability are mechanical properties the study of which is now almost standardized. Several different methods were described for the testing of the fourth fundamental mechanical property of soils and their shear strength.

Section B. Exploration of Soil Conditions and Sampling Operations.

The eight papers in this section gave many useful references to standard types of sampling equipment, the development of which has been mainly the work of engineers who have had to adapt standard drilling methods so that, with little trouble or expense, relatively "undisturbed" samples of soils can be obtained from any desired depth, below ground level. The basic idea of all the main types of sampler is to drill first a fairly large diameter drill hole, case it if necessary, and then insert a special sampling tool which is forced into the ground at the bottom of the hole, rotated to isolate the core, and then withdrawn, the sample obtained being sealed, with either a part of the metal casing left in place, or with paraffin wax, to prevent change of moisture content, etc. The developments of this idea are generally designed to reduce the necessary disturbance to a minimum. Examples were given of the evident distortion, within the sampling tool, of various sizes of samples, due to the friction between the metal of the sampler and the soil. Examples were also given of the swelling of even small clay samples obtained from great depths. The use of "undisturbed" samples has been generally confined to those of clayey strata, cohesionless materials such as sands and gravels being usually tested by means of loose disturbed samples.

Section C. Regional Soil Studies for Engineering Purposes.

A group of six papers dealing with regional soil surveys demonstrated the extent to which soil studies have been applied to preliminary civil engineering work. Of special interest was a description of a complete soil survey of an area of 900 acres near New York, to be used initially for the 1939 World's Fair, and ultimately as a public park, but at present low lying marsh and swamp land. By means of extensive sampling and subsequent laboratory work, a complete knowledge of subsurface conditions has been obtained from which predictions regarding probable foundation settlements, data for foundation design, and methods for filling procedure have been worked out.

Section D. Soil Properties.

This section was concerned with general considerations presented in thirteen widely different papers. Work at present being carried out at the Building Research Station of the British Government on the shearing strength of clays, following up Professor Jenkin's initial studies of granular materials, was described by L. F. Cooling and D. B. Smith, the former amplifying the paper in discussion by demonstrating the utility of the shear strength of clays at zero normal load as a means of obtaining the constant in the basic shear equation. Research work carried out in France on the effect of the speed of loading on soil properties was described in another paper. The important influence of the chemical nature of clays on their physical and mechanical properties was demonstrated in a paper by K. Endell and U. Hoffman (Germany). This fundamental aspect of the subject was reflected in a paper describing Russian research work on the influence of scale-like particles (such as mica) on soil properties.

In general discussion, little attention was devoted to the properties of granular materials (sands and gravels) as there appears to be general agreement on at least their main characteristics. With regard to clays and cohesive soils, it was generally admitted that research on the shear strength of such materials is still incomplete.

Section E. Stress Distribution in Soils.

This branch of study is complicated by the fact that although theoretical analyses can be made of stress distribution in homogeneous materials, soils as encountered in practice are always far from uniform. The classical theory of Boussinesq therefore formed the basis of much of the analytical presentation and in some of the eleven papers included in this section, was in sharp contrast with records obtained from actual observations. Of special interest to practising engineers is a paper (E9, by G. M. Rapp and A. H. Baker) describing the measurement of soil pressures on the lining of the new mid-town tunnel under the Hudson river, at present under construction in New York, in which details of the gauges used are given and a summary of the records so far obtained.

Section F. Settlement of Structures.

In this section, the explanation of and the predetermination of the settlement of structures attracted much attention. Fifteen papers were presented, many of these being actual records of settlement, and one of the illustrated lectures was given by Dr. Hanna and Mr. Tschebotareff, amplifying data they had given in papers regarding the settlement of structures in Cairo, Egypt. The poor subsoil conditions there encountered were contrasted with the underground formation of volcanic ash and fine sand found at Mexico City, which in the past has caused serious settlement of many large buildings there. Other papers gave data on settlements from Shanghai, Vienna, and Texas, as well as from three American bridges. One of the latter was the new bridge over the Mississippi river at New Orleans, which had to be founded on unconsolidated strata over 2,000 feet thick. Subsurface exploration was very carefully carried out and settlement calculations made in connection with all pier design; these were checked as construction of the piers proceeded, and as a result certain valuable modifications were introduced into the completed bridge design. An interesting observation made was that during flood period on the river, with a rise of water level of 15 feet, a temporary settlement of one and a half inches took place, which disappeared on resumption of normal water level.

In discussion it was stressed that the main purpose of settlement studies is to enable foundations to be so designed that settlements can be predicted with a fair degree of accuracy. Small scale loading tests may be potentially dangerous unless carefully correlated with other test data, and with records of the geological formation at the building site. Theoretical considerations are beginning to take definite shape, but they must be checked by actual observation. There is need for the collection by engineers of all possible settlement records.

Section G. Stability of Earth and Foundation Works and of Natural Slopes.

There were nine papers in this section, a number of these being theoretical analyses based on the idea of a cylindrical sliding surface, first developed by Petersen of Sweden. Some valuable data on actual slips on the Whangpoo river of China were given in a paper by Wang Chen. Another notable contribution was a review of Indian research work on uplift pressures under weirs presented by the Irrigation Research Institute of the Punjab. Stability calculations for the important closure section of the Fort Peek dam (U.S.A.) were outlined, and in another paper the importance of ground water tension was emphasized and details of research work were given.

Section H. Bearing Capacity of Piles.
Section I. Pile Loading Tests.

These two subjects are closely linked, at least in the minds of engineers, although during discussion the necessity for a distinction between the two was emphasized. Six papers had been submitted in each of the two sections, and contained valuable practical data. In discussion details were given of the results of driving over ten thousand bearing piles in Nebraska, records of all of which had been carefully analysed. Several of the papers were of Dutch origin including a description of an experimental device for determining the necessary length of bearing piles and the toe resistances, developed by the Soil Mechanics Laboratory at Delft. Professor P. E. Raes of Belgium presented an interesting theory of the lateral bearing capacity of piles.

The dangers which may be created by driving piles into certain types of clay and the ambiguous meaning of the term "the safe bearing power" of a pile were brought out in discussion.

One of the papers outlined the requirements for piled foundations in the newly formulated Building Code for the city of Boston, drafted by a joint committee of engineers and research soil workers. A leading feature of the code is the abandonment of the usual static type of pile formula and its replacement by a dynamic formula.

Section J. Earth Pressure Against Retaining Walls.

This important subject did not attract the attention which might have been expected, only six papers being submitted. These, however, included three new contributions from Dr. Terzaghi, to some extent supplementing his previous outstanding work in this field. One of these papers, "A fundamental fallacy in earth pressure computations" (reprinted from the Journal of the Boston Society of Civil Engineers) was an illuminating review of the assumptions inherent in the Rankine and Coulomb formulae, and a demonstration of the fact that the normal pressure distribution due to granular soils is not hydrostatic in nature, the application of Coulomb's formula being limited to the case where the lateral yield of the wall exceeds certain minimum values. Another paper, from the Iowa Engineering Experimental station, presented the results of some interesting tests on the normal pressures on retaining walls due to concentrated surface loads.

Section K. Ground Water Movement and Seepage.

Three papers only were submitted in this section, two from the University of Bandoeng, Java (Mr. Steevens, one of the authors, attending the meetings) describing work being carried out on the electrical investigation of underground water flow nets. The subject was naturally mentioned in the several descriptions of earth dams presented to the conference, and research work at Harvard University was seen in progress in which dyes were used to indicate underground flow (similar to Indian work).

Section L. Soil Problems in Highway Engineering including Frost Action in Soils.

This important application of soil studies bears on such problems as the design and construction of embankments, the control of natural slopes, the survey and design of subgrades, and the design of stabilized soil road surfaces. Intensive study of frost action in soils now proceeding at Harvard University was described, and an important illustrated lecture on the same subject was given by Dr. Breskau, of Sweden, who has been a pioneer in this branch of study. Standard methods of soil survey as practised in the states of New Hampshire, Michigan and Texas were described, and mention was also made of the standard soil classification and standard soil grouping adopted for these and other purposes by the United States Bureau of Public Roads.

At the end of the conference a special two-day excursion was arranged for those delegates specially interested in highway work, during which modern American practice was inspected. An interesting lecture by Dr. Wm. Loos of Germany described the many different methods tried in Germany for the consolidation of newly placed fill material, in attempting to obtain stable subgrades in a short space of time for the new motor highways now being constructed in that country.

Section M. Methods for Improving the Physical Properties of Soils for Engineering Purposes.

In this essentially practical section, four papers described examples of soil consolidation. A newly developed electro-chemical method, invented by L. Casagrande, was described in a paper from Germany, the basic idea of the method being the passage of direct current electricity through clays between aluminum anodes and copper cathodes. Tests which are described in the paper suggested that the method has great possibilities. In one of the illustrated lectures Mr. G. Rodio of Milan, Italy (whose firm were responsible for the underpinning of the leaning Tower of Pisa), described a remarkable example of chemical consolidation in the completion of the foundation for the building "La Basilese Vita" in Lugano.

Section N. Modern Methods of Design and Construction of Foundations.

In the nine papers of this section, in the introduction and discussion by Lazarus White of New York, and in two outstanding illustrated lectures, many interesting foundation methods were described. As one example there may be mentioned the use of a reinforced concrete rigid frame basement for the new Telephone building in Albany, N.Y., where unequal settlement could not be avoided but could be predetermined. Further work in Mexico City was described and also an unusual foundation study by American engineers for the Palace of the Soviets in Moscow, Russia. One of the two lectures, by C. S. Proctor of New York, described briefly the foundation work necessary for the San Francisco-Oakland bridge across San Francisco bay now approaching completion. The other lecture was by A. E. Bretting of Copenhagen and described some of the foundation work for modern bridges in Denmark, one being the Sorstrom bridge, the soil studies for which were described in a paper submitted by Mr. Bretting. The foundation work was notable for the use of an elliptical floating steel caisson which was used as a ring support for steel sheet piling, being floated away for use on other piers when one pier had been completed up to ten feet below water level

Section Z. Miscellaneous.

Some of the papers submitted could not be classified in the regular sections. Among these may be noted one entitled "Practical Soil Mechanics at Muskingum" (a reprint of four articles in the Engineering News Record issues of March 26th, April 9th and 23rd. and May 7th). This communication dealt with the application of soil mechanics studies to the design and construction of an extensive programme of flood control works on the Muskingum river, involving the construction of fourteen earth dams of different sizes and on sites of varying compositions. Thorough study of all soils available for use at each site has obviated the need for the use of older empirical methods of design. A point of special interest in this contribution is the presentation of detailed costs of all soil studies and equipment, the total operating and construction cost of the project soils laboratory up to the end of the design period being $32,000. Core borings and test pits cost $225,000 and $12,000 was spent on geological studies, making a total of $269,000 for preliminary work, which may be compared with the estimated total cost of $40,000,000 for the fourteen reservoirs included in the project.

A film of the construction of the Fort Peck dam was shown, in connection with papers on the extensive soil studies carried out on this project, which when completed will be the largest hydraulic-fill dam in the world.

A lecture was given by Dr. A. Agatz of Germany on the construction of harbour works at Bremen and at Bremerhafen, dealing with the investigations of sheet pile wharf walls which had been made in connection with this important harbour development. Another lecturer gave a description of the start of construction of the new dams for the water supply of the Metropolitan District of Boston, the last day of the conference being devoted to a visit to these works, located about eighty miles west of Boston. The two dams are hydraulic-fill structures designed to form the Quabbin storage reservoir, each being located in a valley filled with glacial drift necessitating the use of rectangular concrete caissons to form the necessary cut-off-walls. Material adjacent to the site is being used for dam construction in each case, and extensive soil studies have developed striking features of design and construction which were well seen when the two dams were visited by those attending the conference.

Conclusion.

On Friday, June 26th, the conference met for its closing dinner and valedictory speeches at the Wayside Inn, Sudbury, Mass., made famous by Longfellow, and now carefully preserved by Henry Ford. With its old-world air, the inn is a relic of the past in a country that is still called new and seemed a fitting meeting place for a conference which marked the public recognition of a new science.

The evident enthusiasm of all participants and the efficient preliminary secretarial work made the success of the conference certain. Any doubts which may have existed as to the reality of the science of Soil Mechanics were finally dispelled for all who were privileged to attend, while the records of the conference will furnish a similar assurance to all engineers who study them.

On the other hand, the discussions indicated that there still exists an appreciable gap between the scientist, carrying out laboratory research into the properties of soils, and the practising engineer who has to use those materials. For example, some research workers stated that, at present, no accurate knowledge as to the shear strength of clays could really be obtained, whereas this is a property on which some reliance must be placed daily by engineers in construction. The geological aspects of soil studies were not often mentioned: they, too, will probably play a greater part in future development. Discussions also showed that the science is still in an early stage of development, and is not the finished product some of its more enthusiastic advocates might seem to suggest. The proceedings clearly indicated the need for a more extensive interchange of experience and ideas between engineers of different countries to avoid duplication of effort and to enable the best use to be made of records obtained from practice. For this reason the decision to continue the conference in some permanent form, to be decided upon later, was welcomed. The words used by Mr. Schmitt, the Editor of Engineering News Record, sounded a fitting keynote for such future action—"a science is evolving: an art is being revolutionized."

The German Airship "Hindenburg"

In designing and constructing the Hindenburg, which is now in satisfactory commercial service between Germany and America, the Luftschiffbau Zeppelin G.m.b.H., Friedrichshafen a.B., utilized to full advantage the experience accumulated during thirty-five years. In particular, a good deal of useful data was obtained from the operation of the new ship's immediate predecessor, the Graf Zeppelin, which, since being put into service in 1928, has flown more than 800,000 miles and has carried about 12,000 passengers in 505 flights without mishap. It is interesting to note that the Graf Zeppelin was originally intended for research and experiment and was only subsequently utilized for passenger work. The Hindenburg is therefore actually the first airship to be designed for public transport purposes.

This explains why the passenger accommodation has been arranged on two decks within the ship, thus giving a large amount of space to the 150 passengers that can be carried by day, while the control cabin forms a projection from the lower part of the frame, thus giving a better look-out and separating the official from the non-official portions. Other interesting points are the employment of undercarriages below the control cabin and the edge of the lower tail fin, additions which should facilitate ground landing, especially as they are fitted with spring struts. Diesel oil is being employed as a fuel, instead of the Blaugas used on the Graf Zeppelin, and though this may mean some sacrifice of range, the reduction will be partly counteracted by the greater economy of the engines. Provision has been made for the use of both hydrogen and helium as lifting gases. If this arrangement is adopted, the latter will be mainly employed. The small quantity of hydrogen necessary for trimming will then be carried in bags placed inside those containing the helium. This will enable the hydrogen to be entirely surrounded by inert gas and thus make for safety, while, as fuel is consumed, it can be valved and the more expensive helium conserved.

The maximum gas capacity of the Hindenburg is 200,000 cub. m. (7,062,951 cubic feet). She has an overall length of 245 m. (813.67 feet), a maximum diameter of 41.2 m. (135.17 feet) and a maximum height of 44.7 m. (146.65 feet). Her capacity is therefore nearly double that of the Graf Zeppelin. Both her diameter and her length are also 10 m. (32 feet 10 inches) more than that of her immediate predecessor. Generally speaking, the constructional methods adopted do not differ greatly from those which have been employed by the firm for the past thirty-five years. Thus, trussed girders made up of light metal sections are used; the hull is divided by ring frames into separate compartments in which the gas bags are accommodated; the load is taken up by a keel, which also provides communication between one end of the ship and the other; the hull is covered with a skin of appropriate contour; and the engine nacelles are arranged outside both the hull and this skin—*Engineering*.

Canadian Pacific "Jubilee" Locomotive

The first of the five semi-streamlined locomotives constructed at the Montreal Locomotive Works for high-speed passenger service for the Canadian Pacific Railway has just been placed in service.

This locomotive is what is known as the 4-4-4 type, and is the first of its kind to be operated in Canada. The construction is such that it can be operated at high rates of speed without throwing undue strains in the running gear and in the track.

The designing of the locomotive was carried out with the idea of preserving as nearly as possible the general outline of the steam loco-

New 4-4-4 Jubilee Type Locomotive.

motive as it has been known to the general public, with the exception that all exposed piping and protuberances were to be eliminated wherever practical. With this alteration, a slight change in the design of the front end, the camouflaging of the back of the tender, and the introduction of an air duct in the front of the smokebox to assist in lifting the smoke, it is believed that the locomotive as actually produced, meets the modern demand for streamlining and is, at the same time, practical from a maintenance point of view.

The general particulars of the locomotive are as follows:

Type	Canadian Pacific 4-4-4 Jubilee
Number of locomotives	5
Road class	F-2-A
Road Nos	3000 to 3004
Service	High Speed Passenger
Cylinder dimensions	$17\frac{1}{4}$ inches by 28 inches
Driving wheel diameter	80 inches
Boiler	
Outside diameter, 1st course	$69^{7}/_{16}$ inches.
Outside diameter, largest course	75 inches
Firebox	$114^{1}/_{16}$ inches by $70^{3}/_{16}$ inches
Length over tube sheets	19 feet
Wheel base, driving	7 feet 8 inches
Wheel base, engine	37 feet 3 inches
Wheel base, total engine and tender	70 feet $8\frac{3}{4}$ inches
Weight in working order	
Total engine and tender	461,500 pounds
Maximum tractive effort	26,500 pounds
Capacity of tender, water	7,000 Imperial gallons
Capacity of tender, coal	12 tons

An interesting comparison may be made between this type of locomotive and that shown in the lower photograph picturing the arrival of the first through trans-continental train at the seaboard of British Columbia on July 4th, 1886. This jubilee was recently celebrated by the Canadian Pacific Railway.

Arrival of the first Through Train at the Seaboard of British Columbia, July 4th, 1886.

Building in Canada

Although there are no statistics which would constitute the basis for a detailed comparison with what is going on in the United States, it is plain that the durable goods industries are also making progress in Canada. Government enterprise is giving place to private enterprise in Canada as in the United States. At first glance, the building statistics for the first five months of 1936 may not seem encouraging. The total value of building contracts let in that period as compiled by MacLean Building Reports, Limited, amounted to $56,905,000 as compared with $57,073,000 in the same months of 1935. In the total then, building contracts did not quite hold their own. More closely analysed, however, it will be noted that government contracts have declined by about $23,000,000 and that industrial, business and private building has increased by a like amount. Where private building amounted to about $20,000,000 of the total of $57,073,000 in the first five months of 1935, it has amounted to $46,000,000 out of $56,905,000 in 1936. Private building has more than doubled. New investment is beginning to carry the load. Consumers' goods recovery is yielding to that more substantial improvement which results from the creation of new durable goods.

Where the ordinary statistics show that business building has declined in value by some $10,000,000, a closer analysis would indicate that, in Canadian statistics, the heading, "Business Building" includes public buildings and schools. The decline is confined almost entirely to these two classifications. New factories and extensions have been responsible for improvement of $3,389,000. Business building proper, including in this classification office buildings, warehouses and theatres, has shown an improvement of $1,709,000; garages, the only other item which should be included under this heading, declined by $15,000. Residential building has expanded by $500,000 as compared with the corresponding months of last year. If we lump together the other classes of private buildings, i.e., hotels, clubs, churches and hospitals, the improvement amounts to more than $400,000. While hospitals show a slight decline, this is more than offset by the improvement in other items under this general classification.

Under the heading, "Engineering Contracts," are included such items as bridges, dams and wharves, sewers and water mains, roads and streets and general engineering. While most of the items under this heading usually represent government building, this is not always true, particularly of general engineering. Engineering contracts amounted to $21,204,000 in the first five months of 1935, and to $24,589,000 in the corresponding months of the present year; thus the gross figures show an increase of $3,400,000 in this classification. In point of fact, however, private building, including such large projects as those of the International Nickel Company at Copper Cliff and the Ontario Paper Company at Comeau Bay, Quebec, amounted to $16,500,000 in 1936, while private initiative was responsible for projects having a value of only $3,500,000 in 1935.

Where building contracts in Quebec for the first five months of 1935 amounted to $9,000,000, they amounted to $18,000,000 in 1936. In Nova Scotia, building contracts jumped from $1,890,000 to $3,399,000. There was a decline of $5,000,000 in the province of Ontario. For the first five months of this year the value of building contracts in Toronto and suburbs amounted to $8,000,000 as compared with almost $5,000,000 on the Island of Montreal.

The index of the price of building materials at its low point in July 1932 amounted to 76. This index number is now 85. While this represents an increase of about 11 per cent, it is by no means as large an increase as that which has taken place in the United States. To some extent at least, building costs are being kept at more reasonable levels in Canada.

In Halifax, Sydney, Three Rivers, Westmount, Peterborough and Vancouver the value of building permits in 1936 is more than double that for the corresponding months of 1935.

From what has been said above, it follows that the classification of building contracts as accepted in Canada makes no proper distinction between government building and private building. To include such items as schools, post offices, warehouses, office buildings and stores in the same classification leads to a serious misunderstanding at a moment when the country is changing over from private building to public building, or the reverse. For the sake of clarification, we suggest that it would seem wise to analyse such building statistics more closely and we hope that the time will come when items under the heading "Engineering," will be shown separately to indicate whether or not they are private or public projects. Certainly, at the present moment, a closer classification gives ground for the belief that greater recovery is making headway in the building industry than is indicated by the gross figures which have been published.

INDUSTRIAL, BUSINESS AND PRIVATE BUILDING
(000 omitted)

Class	1935 $	1936 $	Increase $	Decrease $
Apartments	1,286	1,317		
Residences	10,883	11,355		
	12,169	12,672	503	
Office buildings	588	1,463		
Warehouses	1,047	1,731		
Stores	1,942	2,591		
Public garages	870	855		
	4,447	6,640	2,193	
Hotels and Clubs	783	782		
Theatres	494	644		
	1,277	1,426	149	
Churches	396	820		
Hospitals	659	583		
	1,055	1,403	348	
PUBLIC AND PRIVATE BUILDING				
Total industrial	4,258	7,474	3,216	
*Total engineering	21,204	24,589	3,385	
PUBLIC BUILDING				
Public buildings	11,216	1,992		
Schools	1,454	710		
	12,670	2,702	—	9,968

*Under the heading engineering, private and industrial construction amounted to approximately $3,500,000 in 1935, and to $16,500,000 in 1936.

Royal Bank of Canada—Monthly Letter.

Electrical Precipitators for Boiler Flue Gases

A successful electrical precipitation plant installed at the new central heating station for public buildings at Washington, D.C., was recently described by C. W. Hedberg before the American Society of Mechanical Engineers. The gases dealt with are from stoker-fired boilers and carry a relatively smaller amount of suspended matter compared with those from pulverized fuel-fired boilers; hence the required percentage of removal gives a very low absolute concentration in the cleaned gases.

With regard to the essential features of these precipitators, two of which were installed, each unit is divided into fifteen vertical gas ducts formed by handing sixteen collecting electrode assemblies from structural members in the upper portion of the shell. The ducts are about 10 inches wide by 11 feet 6 inches long and 17 feet high, and have a capacity of approximately 5,700 cubic feet per minute per duct. Each collecting electrode assembly consists of six separate hollow sections or boxes 17 feet long and about 2 feet by 1½ inches inside. The two outer and inner boxes of the assembly are drawn in near the bottom to give the effect of a double hopper. Pockets are formed in the two side sheets of each box which provide louvrelike openings to the interior, and there are forty-six horizontal rows of six pockets on each side sheet, projecting approximately ½ inch with openings ½ inch by 3¾ inches.

Fly ash usually adheres to the surface of the electrodes, but cinder and soot attach themselves less firmly and the loose material finds its way through the pockets into the electrodes, where it settles rapidly. The material which adheres to the outside is loosened by means of a rapping mechanism which raps each electrode assembly every three minutes.

The gases enter the precipitator below the bottom of the electrodes and two sets of intermediate hoppers are provided for removing the dust from the lower end of each box, the dust being taken away by a vacuum system. The discharge electrode system provides twenty high-tension discharge-electrode wires per duct, each weighted at its lower end to keep it taut.

Tests of the plant, with gas volumes ranging from 36,000 to 160,300 cubic feet per minute and the dust concentrations varying from 0.0952 to 0.476 grains per cubic foot at standard temperature and pressure, showed efficiencies of 93.3 to 94.9 per cent, the dust concentration in the outlet gas being 0.0063 to 0.0249 grains per cubic foot. In one test with gas volume of 125,000 cubic feet per minute, and dust concentration of 0.872 grains per cubic foot, the efficiency of precipitation fell to 89.2 per cent. The pressure drop with a flow of 164,000 cubic feet per minute was 0.708 inch of water, of which drop only 0.395 inch had to be accommodated by the induced draught fan, as the balance was dealt with by the stock effect of the precipitator itself. Power consumption per precipitator, including the rectifier motors, but excluding the 2-h.p. motor for the rapping mechanism, was 13.7 kw.

—World Power

EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada
2050 Mansfield Street, Montreal

Situation Vacant

List No. 662

SENIOR INSPECTOR OF DREDGES

25358.—A Senior Inspector of Dredges for the Engineering Branch, Department of Public Work, Ottawa, at a salary of $2,520 per annum. By legislation this salary is subject to a deduction of 5 per cent during the fiscal year beginning April 1st, 1936. Although a temporary appointment only may be made at this time, this examination will qualify for permanent employment. For such employment the initial salary of $2,520 per annum may be increased upon recommendation for meritorious service and increased usefulness at the rate of $120. per annum, until a maximum of $3,000 has been reached.

Duties.—Under direction of the Mechanical Superintendent of Dredges to inspect from time to time units of the dredging fleet of the Department, to be responsible for the maintenance, repairs and operation of same, to determine the necessary repairs to same and the best method of making them; to prepare specifications of repairs and estimate cost of same; to take measurements of parts to be renewed and to make shop working drawings of same; to assist on drawing table in the preparation of drawings of new constructions; to inspect repairs and new constructions, to direct, advise and instruct officers and crews of the fleet in the performance of their duties and to perform other related work as required.

Qualifications required.—High school graduation and preferably graduation in mechanical or electrical engineering from a university of recognized standing; at least five years of practical experience in the construction, repair or design of dredges and/or floating mechanical equipment, at least two years of which shall have been in a position of supervisory or professional responsibility; ability to make inspections and prepare reports as to the condition of dredges and floating equipment and to prepare recommendations, estimates of cost and sketch plans covering required repairs or alterations; good physical condition, tact, firmness, ability to manage men; to be not over 35 years of age; preferably ability to speak both English and French.

Application forms properly filled in must be filed with the Civil Service Commission, Ottawa, **not later than August 20th, 1936.** Application forms may be obtained from the offices of the Employment Service of Canada, from the postmasters at any City Post Office, The Engineering Institute of Canada, Montreal, or the Secretary of the Civil Service Commission, Ottawa.

Situations Wanted

SALES ENGINEER, E.E.I.C.; B.SC. C.E., 1930 (Univ. N.B.), P.E.N.B. Age 28. Experience includes building inspection, structural detailing, road construction, and chemical operation. Interested in sales work on the sales staff of some manufacturing or wholesale concern. Apply to Box No. 225-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

ENGINEER AND ACCOUNTANT, JR.E.I.C., (Capt. Can. Engrs., reserve). Age 35, Canadian. Experienced in mechanical and civil engineering, Diploma; general office, draughting and instrument work; assistant engineer erection Royal York hotel; assistant resident engineer T. & N.O. Ry. const. Desires position in Toronto where combination of technical and business experience will be of value, as have been director and accountant last three years. Apply to Box No. 377-W.

ENGINEER, A.M.E.I.C. Age 30. Single. Employed. Civil and mining experience, capable of designing and superintending construction of timber, concrete and steel structures, rock crushing and ore plants. Would consider position with mining or engineering company designing and building mills. Apply to Box No. 431-W.

CIVIL ENGINEER, B.SC. '25, A.M.E.I.C., P.E.Q., single, experienced in pulp and paper mill construction and hydro-electric developments; also experienced in highway construction and topographical surveying. Available at once, location immaterial. Apply to Box No. 473-W.

Situations Wanted

MECHANICAL ENGINEER, B.SC. Age 31. Married. Last ten years includes:—Mechanical structural and reinforced concrete design in pulp and paper mills, industrial plants, hydro-electric, mine, sewers and sewage disposal plant construction. My experience also includes shop production, steam plant combustion, fuel analysing, inspecting, supervising and instrument work on industrial construction. Permanent position preferred. Apply to Box No. 521-W.

CONSTRUCTION ENGINEER, age 26, unmarried, graduate C.E. Experience includes hydro-electric, railroad, highway, and industrial plant construction, both field and office, including cost accounting, estimating, stores, layout, general engineering and supervision, as well as practical work in mechanical trades. Apply to Box No. 567-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aero-photographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

Employment Service Bureau

This bureau is maintained by The Engineering Institute of Canada for the benefit of members and organizations employing technically trained men.

An enquiry addressed to 2050 Mansfield Street, Montreal, will bring full information concerning the services offered. Details can also be obtained from Branch secretaries who are located in the larger centres throughout Canada.

Brief announcements of men available and positions vacant will be published without charge in The Engineering Journal and the Bulletin. Replies addressed in care of the required box number will be forwarded to the advertiser without delay.

An additional service also offered those who are unemployed or wish to change their positions, is the opportunity of placing their names and records on file at 2050 Mansfield Street for consideration by employers wishing to employ engineers. This is of great assistance as many employers will not advertise or wish to locate a suitable man on short notice. If desired the information contained in these records can be kept confidential.

Forms for registration purposes may be obtained from The Institute Headquarters or Branch secretaries.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

ELECTRICAL ENGINEER, B.SC., 1926. One year maintenance, one year operating, large hydro-electric plant. Five years hydro-electric construction, as wireman and foreman, on relay, metal, and remote control installations. Also conduit and switches. Three years maintenance electrician, in pulp and paper mill. Also small power system. Desires position of responsibility. Sober, reliable and not afraid of work. Available at once. Excellent references. Apply to Box No. 636-W.

ELECTRICAL ENGINEER, B.SC. '28; M.Eng. '35. Two years student apprenticeship at Can. Westinghouse Co., including test and electrical machine design. Also about two years experience in operating dept. of large electrical power organization. Available on short notice. Apply to Box No. 660-W.

ELECTRICAL AND RADIO ENGINEER, B.SC. '30. Variously engaged on receiver development work, testing, and transformer development, under direction. More recent experience includes transmitter test room procedure and short wave beam transmission engineering. For further information apply to Box No. 680-W.

Situations Wanted

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.SC. Elec. '29, B.SC. Civil '33. JR.E.I.C. Age 29. Experience includes four months with Can. Gen. Elec. Co., approximately three years in engineering office of large electrical manufacturing company in Montreal, the last six months of which was spent as commercial engineer. For the last year and a half employed in electrical repair shop. Best of references. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.SC., '27, JR.E.I.C. Four years maintenance of high speed Diesel engine units, 200 to 1,300 h.p. Also maintenance of d.c. and a.c. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.SC., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

CIVIL ENGINEER, B.SC. (Alta. '31), E.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.SC. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

MECHANICAL ENGINEER, E.E.I.C., B.A.SC., Univ of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER, M.SC., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering. Read, write and talk French. Married. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

RADIO AND ELECTRICAL ENGINEER, B.Sc., '31, JR.E.I.C. Single. Age 29. One year and a half actual field experience in power and lighting equipment. Extensive work in telephone and radio layouts in switchboard and installation depts. Particularly interested and experienced in sales and traffic work in telephone and radio company. At present supervisor over sales and service of radio and electrical company. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, B.SC. '29, A.M.E.I.C. Married. One year building construction. One year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

MANUFACTURERS' REPRESENTATIVE, at present doing business with leading industrial organizations in Canada, wishes to represent manufacturers of mechanical equipment. Such work as would involve technical data, and the preparation of plans where necessary, would be handled by an engineer whose experience with outstanding firms and projects, would be valuable to those seeking representation. Apply to Box No. 764-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

Situations Wanted

PLANT ENGINEER or SUPERINTENDENT, capable of supervising all phases of industrial plant operation, graduate electrical, eleven years diversified industrial experience including test course, four years on large Quebec industrial development, on construction and operation, also six years with prominent consulting firm supervising electrical and mechanical engineering projects. Age 31, single. Apply to Box No. 795-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys. assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.A.SC., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, B.SC. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies Position desired as engineer or superintendent. Available at once Apply to Box No. 841-W.

STRUCTURAL ENGINEER, B.A.SC., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W

SALES ENGINEER, A.M.E.I.C., graduate engineer, age 34, practical experience in the manufacture of power plant equipment, thoroughly conversant with Canadian power plant practice and equipment for the metal working industries. Available on short notice. Apply to Box No. 860-W.

CHEMICAL ENGINEER, B.SC. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

CIVIL ENGINEER, B.A.SC., JR.E.I.C., age 32, married. Two years in pulp mills draughting and designing additions, maintenance and plant layout. Three and a half years in the Toronto Building Department, checking and designing for steel, reinforced concrete and ordinary structures. One and a half years as transitman and draughtsman on road location and maintenance work. Available at once. Location immaterial. Apply to Box No. 899-W.

CIVIL ENGINEER, B.SC., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

ELECTRICAL ENGINEER, S.E.I.C., B.SC., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No. 1010-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices. reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

Situations Wanted

CIVIL ENGINEER, B.SC. (Queen's, '14), A.M.E.I.C., Dominion Land Surveyor, 5 months special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply to Box No. 1035-W.

ENGINEER, JR.E.I.C., E.E. '29, is very interested in applying electrical methods to cement testing and research work. Apply to Box No. 1062-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.SC. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

ELECTRICAL ENGINEER, B.SC.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

MECHANICAL ENGINEER, B.A.SC. (Univ. of B.C. '29); M.S. Age 27. Single. Four years experience in research work in applied mechanics and materials testing. Desires position involving analytical work in design, development or testing. Available on short notice. Apply to Box No. 1123-W.

PETROLEUM CHEMIST, B.SC. in Chem. Eng. Age 25. Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

CIVIL ENGINEER, B.A.SC., S.E.I.C., age 26, single. Experience includes one year in bridge construction, plain and reinforced concrete, pneumatic caissons and surveying. Available at once. Any location. Apply to Box No. 1204-W.

MECHANICAL ENGINEER, B.SC. (Queen's Univ. '28), age 36, married, desires position of trust and responsibility. Experience includes fitting and assembly of machine tools, production, draughting, and maintenance. Five years teaching draughting and mathematics. Available on reasonable notice. Location immaterial. Apply to Box No. 1210-W.

Situations Wanted

ENGINEER, with twenty years experience in industrial, pulp and paper mill, and general engineering and design. Age 41. Last five years chief engineer of paper mill making newsprint specialties and toilet tissues. Apply to Box No. 1246-W.

ELECTRICAL ENGINEER, B.SC. '34 (Univ. of N.B.), S.E.I.C. Age 21, single. Desires any kind of electrical work. Will consider any location. Apply to Box No 1262-W.

CIVIL ENGINEER, B.A.SC. (Toronto '33), S.E.I.C., age 25. Married. One year as instrumentman with provincial highways dept. Experience in concrete and retread construction, draughting, estimating and accounting. One year with department of National Defence on grading and reinforced concrete construction. Apply to Box No. 1265-W.

ELECTRICAL GRADUATE, S.E.I.C., B.SC. '32, M.SC. '34. Experience includes four years as part time operator and announcer for a radio broadcast station. At present employed in radio repair dept. of a large wholesale firm. Apply to Box No. 1283-W.

ENGINEER AND DRAUGHTSMAN, JR.E.I.C., age 33, married. Diplomas from Mtl Tech. Inst. in R.C. and Structural Design. 11½ years experience in civil engineering, draughting and instrument work. This includes 7 years with M.L.H. & P. Cons. as field engineer on construction and maintenance of gas mains. Present location Montreal. Available at once. Apply to Box No. 1326-W.

GRADUATE ENGINEER, (McGill), in responsible charge of design, construction and operation of hydro-electric plants. Also power design and mechanical maintenance of industrial plants. Apply to Box No 1328-W.

CIVIL ENGINEER, M.E.I.C. Married. Age 38. Twenty years experience in organization, design and estimating, and cost accounting. Active service in France. Apply to Box No. 1367-W.

FIRE PROTECTION AND SAFETY ENGINEER, A.M.E.I.C., B.SC. '24 (Mech. Engrg.). Age 33. Bilingual Ten years experience with insurance underwriters inspection bureau covering phases of field work. Thoroughly familiar with insurance requirements. Position desired industrial or other concern maintaining self insurance or relative departments. Location Montreal or vicinity preferred. Apply to Box No. 1395-W

ENGINEER SUPERINTENDENT, A.M.E.I.C., R.P.E., Que. and Alta. Age 47. Married. Twenty years experience as engineer and superintendent in charge of hydro-electric, industrial, railroad, and irrigation construction. Specialized in rock excavation and suction dredging. Intimate knowledge of costs, estimating and organizing. Available immediately. Apply to Box No. 1411-W.

1935 GRADUATE IN CIVIL ENGINEERING, B.SC. (Queen's Univ.), S.E.I.C. Experience includes eleven months summer work as county engineer's assistant in charge of the surveying party, and two months as surveyor's assistant during construction of concrete formwork and installation of machinery. Keenly interested in graphical analysis, draughting, design, organization and report writing. Now available for any location. Apply to Box No. 1415-W.

CIVIL AND ELECTRICAL ENGINEER, Univ. of Man. '35 and '36. S.E.I.C. Experience in irrigation and mapping. Available at once. Location immaterial. Box No. 1418-W.

CIVIL ENGINEER, B.SC. 1910, A.M.E.I.C. Married. Twenty-six years experience on heavy construction work, both field and office; rails, roads, power house, hotels, bridges, etc. Location immaterial. Available at once. Apply to Box No. 1470-W.

In the U.S.S.R. a total plant and equipment value of new heavy industry enterprises, of over 9,000 million roubles, will be put into operation this year, raising the value of plants and equipment of all heavy industry from 36,000 million to 45,000 million roubles. According to the *British Russian Outlook*, a number of new large power stations will be put into operation. Eighteen new coal mines, with a capacity of 5,750,000 tons will be opened, and sixteen new oil cracking units, with a capacity of 3,220,000 tons of oil, built. New units will give the country 758,000 tons of pig iron, 345,000 tons of steel, 722,000 tons of rolled steel, and 104,000 tons of cast iron tubing . The first sections of the Ural Car Building plant for 28,000 heavy freight wagons, the Novo-Cherkassk Locomotive Building plant for 200 freight locomotives, and the Krasnoyarsk Car Building plant for 2,000 wagons are to begin operation. The automobile plants are to produce new types of car and the Gorky plant's capacity is to rise by 100,000 machines annually and that of the Stalin plant (Moscow) by 30,000.

—*The Engineer.*

According to figures furnished by Messrs. Imperial Airways Limited, their fleet of eight air liners of the Hannibal and Heracles class have, since first coming into service on the company's routes, spent about 52,000 hours in the air. This, we are informed, means that this fleet of four-engined aircraft have, collectively, now flown a total distance of approximately 5,000,000 miles, operating night and day, with the highest reliability and comfort, in all kinds of weather and in widely varying conditions of climate.

THE ENGINEERING JOURNAL

THE JOURNAL OF THE ENGINEERING INSTITUTE OF CANADA

Published monthly at 2050 Mansfield Street, Montreal, by The Engineering Institute of Canada, Incorporated in 1887 as The Canadian Society of Civil Engineers.

Entered at the Post Office, Montreal, as Second Class Matter.

"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."

September, 1936 **Volume XIX, No. 9**

CONTENTS

Price 50 cents a copy, $3.00 a year, in Canada, British Possessions, United States and Mexico. $4.50 a year in Foreign Countries.
To Members and Affiliates, 25 cents a copy, $2.00 a year.

Published Monthly at 2050 Mansfield St., Montreal

THE ENGINEERING INSTITUTE OF CANADA

Incorporated in 1887 as The Canadian Society of Civil Engineers

BRANCHES:

Halifax Branch, Halifax, N.S.
Cape Breton Branch, Sydney, Cape Breton.
Moncton, Branch, Moncton, N.B.
Saint John Branch, Saint John, N.B.
Saguenay Branch, Kenogami, Que.
Quebec Branch, Quebec, Que.
St. Maurice Valley Branch, Three Rivers, Que.
Montreal Branch, Montreal, Que.
Ottawa Branch, Ottawa, Ont.
Kingston Branch, Kingston, Ont.
Peterborough Branch, Peterborough, Ont.
Toronto Branch, Toronto, Ont.
Hamilton Branch, Hamilton, Ont.
Niagara Peninsula Branch, Niagara Falls, Ont.
London Branch, London, Ont.
Border Cities Branch, Windsor, Ont.
Sault Ste. Marie Branch, Sault Ste. Marie, Ont.
Lakehead Branch, Port Arthur, Ont.
Winnipeg Branch, Winnipeg, Man.
Saskatchewan Branch, Regina, Sask.
Lethbridge Branch, Lethbridge, Alta.
Edmonton Branch, Edmonton, Alta.
Calgary Branch, Calgary, Alta.
Vancouver Branch, Vancouver, B.C.
Victoria Branch, Victoria, B.C.

Members of Council 1936

PRESIDENT
E. A. CLEVELAND, Vancouver, B.C.

VICE-PRESIDENTS
*E. V. CATON, Winnipeg, Man
†R. L. DOBBIN, Peterborough, Ont.
†H. W. McKIEL, Sackville, N.B
†A. B. NORMANDIN, Quebec, Que.
*P. L. PRATLEY, Montreal, Que.

PAST-PRESIDENTS
F. A. GABY, Toronto, Ont.
O. O. LEFEBVRE Montreal, Que
F. P. SHEARWOOD, Montreal, Que.

COUNCILLORS
*C. G. R. ARMSTRONG, Windsor, Ont.
†Y. C. BARRINGTON, Sydney Mines, N.S.
*C. B. BROWN, Montreal, Que.
†G. S. BROWN, Lethbridge, Alta.
*G. H. BURBIDGE, Port Arthur, Ont.
†H. CIMON, Quebec, Que.
*A. COUSINEAU, Montreal, Que.
†A. B. CREALOCK, Toronto, Ont
†T. H. DICKSON, Moncton, N.B.
†A. FRIGON, Montreal, Que
†A. B. GATES, Peterborough, Ont.
*L. F. GOODWIN, Kingston, Ont.
*B. GRANDMONT, Three Rivers, Que.
†A. K. HAY, Ottawa Ont.
‡F. S. B. HEWARD, Montreal, Que.
*G. H. KIRBY, Riverbend, Que.
*H. S. JOHNSTON, Halifax, N.S.
†T. C. MAIN, Winnipeg, Man.
†E. P. MUNTZ, Hamilton, Ont.
†E. P. MURPHY, Port Colborne, Ont.
†H. J. McLEAN Calgary, Alta
‡F. NEWELL, Montreal, Que.
†E. A. RYAN, Montreal, Que.
†F. SMALLWOOD, Sault Ste Marie, Ont.
*R. E. SMYTHE, Toronto, Ont.
*E. W. STEDMAN, Ottawa, Ont.
†H. L. SWAN, Victoria, B.C.
*J. A. VANCE, Woodstock, Ont.
*G. A. VANDERVOORT, Saint John, N.B.
*H. R. WEBB, Edmonton, Alta.
*A. S. WOOTTON, Vancouver, B.C.
*S. YOUNG, Regina, Sask.

*For 1936 †For 1936-37 ‡For 1936-37-38

TREASURER
J. B. CHALLIES, Montreal, Que.

SECRETARY
R. J. DURLEY, Montreal, Que.

OFFICERS OF BRANCHES

HALIFAX
Chairman, C. S. BENNETT
Vice-Chair., C. SCRYMGEOUR
Sec.-Treas., R. R. MURRAY, 87 Cambridge St., Halifax, N.S.
Executive, J. R. KAYE, I. P. MACNAB, J. D. FRASER, J. F. F. MACKENZIE, W. H. NOONAN, J. W. McLEOD, J. B. HAYES
(Ex-Officio) H. FELLOWS, H. S. JOHNSTON

CAPE BRETON
Chairman, W. E. BOWN
Sec.-Treas., SYDNEY C. MIFFLEN, 60 Whitney Ave., Sydney, N.S.
Executive, M. R. CHAPPELL, W. S. WILSON, C. M. ANSON, W. E. CLARKE
(Ex-Officio) Y. C. BARRINGTON

SAINT JOHN
Chairman, J. R. FREEMAN
Vice-Chair., G. H. THURBER
Sec.-Treas., F. A. PATRIQUEN, P.O. Box 24, Saint John, N.B.
Executive, T. C. MACNABB, T. MOFFAT, S. HOGG
(Ex-Officio) V. S. CHESNUT, G. A. VANDERVOORT

MONCTON
Chairman, G. L. DICKSON
Vice-Chair., E. B. MARTIN
Sec.-Treas., V. C. BLACKETT, Engrg. Dept., C.N.R., Moncton, N.B.
Executive, F. O. CONDON, C. S. G. ROGERS, R. H. EMMERSON, F. L. WEST, A. S. GUNN, G. C. TORRENS
(Ex-Officio) T. H. DICKSON, H. B. TITUS, H. W. McKIEL

SAGUENAY
Chairman, S. J. FISHER
Vice-Chair., F. L. LAWTON
Sec.-Treas., G. H. KIRBY, Price Bros. & Co. Ltd., Riverbend, Que.
Executive, G. F. LAYNE, A. B. SINCLAIR, G. E. LAMOTHE
(Ex-Officio) J. SHANLY, L. R. BEATH

QUEBEC
Hon. Chair., A. R. DECARY
Chairman, ALEX. LARIVIERE
Vice-Chair., J. T. F. KING
Sec.-Treas., J. JOYAL, Quebec Public Service Comm., Court House, Quebec, Que.
Executive, R. WOOD, L. P. METHE, M. BOURGET, A. O. DUFRESNE, J. G. O'DONNELL, A. ROBERGE
(Ex-Officio) A. B. NORMANDIN, HECTOR CIMON

ST. MAURICE VALLEY
Chairman, B. GRANDMONT
Vice-Chair., J. E. FLEURY
Sec.-Treas., J. A. HAMEL, 642 Notre Dame St., Three Rivers, Que.
Executive, F. W. BRADSHAW, C. L. ARCAND, H. J. WARD

MONTREAL
Chairman, J. B. D'AETH
Vice-Chair., H. MASSUE
Sec.-Treas., C. K. McLEOD, 1440 St. Catherine St. W., Montreal, Que.
Executive, R. H. FINDLAY, C. C. LINDSAY, B. R. PERRY, T. C. THOMPSON, J. A. LALONDE, J. A. E. GOHIER
(Ex-Officio) F. S. B. HEWARD, A. COUSINEAU, C. B. BROWN, P. L. PRATLEY, O. O. LEFEBVRE, E. A. RYAN, F. NEWELL, A. FRIGON, F. P. SHEARWOOD

OTTAWA
Chairman, E. VIENS
Sec.-Treas., F. C. C. LYNCH, Dept. of Mines, Victoria Memorial Museum, Ottawa, Ont.
Executive, E. M. DENNIS, T. A. McELHANNEY, N. B. MACROSTIE, G. R. TURNER, B. F. HAANEL
(Ex-Officio) E. W. STEDMAN, R. W. BOYLE, A. K. HAY

PETERBOROUGH
Chairman, H. R. SILLS
Sec.-Treas., W. T. FANJOY, 223 Crescent St., Peterborough, Ont.
Executive, V. R. CURRIE, A. L. KILLALY, E. J. DAVIES, W. M. CRUTHERS
(Ex-Officio) A. L. DICKIESON, A. B. GATES, R. L. DOBBIN

KINGSTON
Chairman, R. A. LOW
Vice-Chair., Lt.-Col. N. C. SHERMAN
Sec.-Treas., Major L. F. GRANT, Royal Military College, Kingston, Ont.
Executive, G. G. CARR-HARRIS, S. STEPHENSON, J. E. GOODMAN
(Ex-Officio) W. CASEY, L. F. GOODWIN

TORONTO
Chairman, O. HOLDEN
Vice-Chair., A. U. SANDERSON
Sec.-Treas., W. S. WILSON, Mining Bldg., University of Toronto, Toronto, Ont.
Executive, W. P. DOBSON, N. MACNICOL, W. E. P. DUNCAN, A. M. REID, D. D. WHITSON, C. E. SISSON
(Ex-Officio) W. E. BONN, A. B. CREALOCK, R. E. SMYTHE, F. A. GABY

HAMILTON
Chairman, W. HOLLINGWORTH
Vice-Chair., E. G. MACKAY
Sec.-Treas., A. LOVE, 40 Paisley Ave. S., Hamilton, Ont.
Executive, W. J. W. REID, A. R. HANNAFORD, V. S. THOMPSON, D. W. CALLANDER
(Ex-Officio) E. P. MUNTZ

LONDON
Chairman, JAS. FERGUSON
Vice-Chair., A. O. WOLFF
Sec.-Treas., D. S. SCRYMGEOUR, London Structural Steel Co. Ltd., London, Ont.
Executive, E. V. BUCHANAN, W. C. MILLER, J. R. ROSTRON, H. A. McKAY, W. M. VEITCH
(Ex-Officio) S. W. ARCHIBALD, S. G. JOHRE, J. A. VANCE

NIAGARA PENINSULA
Chairman, G. H. WOOD
Vice-Chair., L. C. McMURTRY
Sec.-Treas., P. A. DEWEY, 1224 Ontario Ave., Niagara Falls, Ont.
Executive, S. HAIRSINE, W. D. BRACKEN, M. H. JONES, C. S. BOYD, R. A. BRADLEY, C. G. MOON, A. W. F. McQUEEN
(Ex-Officio) P. E. BUSS, E. P. MURPHY

BORDER CITIES
Chairman, T. H. JENKINS
Vice-Chair., C. F. DAVISON,
Sec.-Treas., BOYD CANDLISH, 170 Rankin Blvd., Sandwich, Ont.
Executive, E. M. KREBSER, D. T. ALEXANDER, C. G. WALTON
(Ex-Officio) C. G. R. ARMSTRONG, H. J. COULTER

SAULT STE. MARIE
Chairman, J. L. LANG
Vice-Chair., W. SEYMOUR
Sec.-Treas., N. C. COWIE, 15 Hearst St., Sault Ste. Marie, Ont.
Executive, E. M. MACQUARRIE, T. FOULKES, C. W. HOLMAN, H. W. SUTCLIFFE
(Ex-Officio) F. SMALLWOOD

LAKEHEAD
Chairman, F. C. GRAHAM
Vice-Chair., G. R. DUNCAN
Sec.-Treas., G. R. McLENNAN, 80 North High St., Port Arthur, Ont.
Executive, H. G. O'LEARY, J. M. FLEMING, K. A. DUNPHY, E. A. KELLY, E. L. GOODALL, W. J. BISHOP
(Ex-Officio) G. H. BURBIDGE, R. J. ASKIN

WINNIPEG
Chairman, G. E. COLE
Vice-Chair., A. E. MACDONALD
Sec.-Treas., J. F. CUNNINGHAM, 918 Somerset Ave., Fort Garry, Man.
Executive, F. W. ALEXANDER, H. L. BRIGGS, W. D. HURST, R. W. McKINNON, W. F. RIDDELL
(Ex-Officio) E. V. CATON, F. V. SEIBERT, T. C. MAIN

SASKATCHEWAN
Chairman, W. E. LOVELL
Vice-Chair., STEWART YOUNG
Sec.-Treas., J. J. WHITE, City Hall, Regina, Sask.
Executive, A. R. GREIG, J. W. D. FARRELL, J. McD. PATTON, H. S. CARPENTER, H. J. BYRD, S. R. MUIRHEAD
(Ex-Officio) A. P. LINTON

LETHBRIDGE
Chairman, P. M. SAUDER
Vice-Chair., R. F. P. BOWMAN
Sec.-Treas., E. A. LAWRENCE, 207-7th St. S., Lethbridge, Alta
Executive, J. M. CAMPBELL, J. B. DEHART, W. MELDRUM
(Ex-Officio) W. L. McKENZIE, G. S. BROWN, C. S. CLENDENING

EDMONTON
Chairman, E. STANSFIELD
Vice-Chair., A. RITCHIE
Sec.-Treas., M. L. GALE, 9914-111 St., Edmonton Alta.
Executive, J. D. BAKER, W. E. CORNISH, C. E. GARNETT, A. J. GAYFER, E. NELSON
(Ex-Officio) F. K. BEACH, H. R. WEBB

CALGARY
Chairman, JOHN DOW
Vice-Chair., H. W. TOOKER
Sec.-Treas., JAS. McMILLAN, 506 Insurance Exchange Bldg., Calgary, Alta.
Executive, J. J. HANNA, W. T. McFARLANE, H. J. McEWEN
(Ex-Officio) J. HADDIN, F. M. STEEL, H. J. McLEAN

VANCOUVER
Chairman, JAS. ROBERTSON
Vice-Chair., H. N. MACPHERSON
Sec.-Treas., T. V. BERRY, 3007-36th Ave. W., Vancouver, B.C.
Executive, E. C. THRUPP, P. SANDWELL, G. L. BOOKER, J. P. MACKENZIE, P. H. BUCHAN, C. P. HAMILTON, F. O. MILLS
(Ex-Officio) G. M. GILBERT, E. A. CLEVELAND, A. S. WOOTTON

VICTORIA
Chairman, I. C. BARLTROP
Vice-Chair., J. C. MACDONALD
Sec.-Treas., KENNETH REID, 1336 Carnsew St., Victoria, B.C.
Executive, G. M. DUNCAN, G. M. IRWIN, G. M. TRIPP, C. D. SCHULTZ
(Ex-Officio) D. MACBRIDE, H. L. SWAN

THE

ENGINEERING JOURNAL

THE INSTITUTE as a body is not responsible either for the statements made
or for the opinions expressed in the following pages.

VOLUME XIX MONTREAL, SEPTEMBER, 1936 NUMBER 9

A Study of the Physical and Operating Conditions of the Pacific Great Eastern Railway

D. O. Lewis, M.E.I.C.,
Consulting Engineer, Vancouver, B.C.

Paper presented before the Vancouver Branch of The Engineering Institute of Canada, April 27th, 1936.

SUMMARY.—The author gives the result of a study of the P.G.E. Railway as regards passenger and freight traffic, operating rates, traffic density and concludes that the road has been efficiently and economically operated, its rates are reasonable, and its equipment fulfils present traffic requirements.

In 1934 the writer investigated the physical and operating conditions of the Pacific Great Eastern Railway. The investigation of the physical conditions included an estimate of the expenditures necessary for bridge replacement, general betterment and maintenance. The study of the operating conditions covered the economy of the system of operation, and a consideration of the possibilities of improvement.

As to the physical conditions, it may be stated that since 1927 the replacement of timber bridges with steel and concrete, the replacement of timber retaining cribs with concrete, and the train filling of temporary trestles has been vigorously prosecuted so that by the end of the year 1938 all temporary structures will have been replaced by filling or permanent structures. Considering the sparsity of traffic, the physical condition of the railway has been kept up to a high standard.

An enquiry into the operating conditions resolved itself into replies to two questions:—

Is the P.G.E. Railway efficiently and economically operated?

Can the operating conditions of the P.G.E. Railway be improved?

The first question was solved by considering this railway as a machine, the efficiency of the operations of which could be measured by comparing the "input" or work put into the machine, with the "output" or work performed by that machine. A railway is a transportation machine, the operation of which may be said to consist of buying or developing train mileage or "input," and selling passenger and ton mileage or "output," and the statistical averages train miles and passenger and ton miles, taken together provide the most important efficiency indices, when making yearly comparisons of the operations of a railway. Moreover, if the class of commodities carried, the capacity of cars used, and the number, tractive power and speed of the locomotives operated, are similarly proportioned throughout the yearly aggregations from which the averages are produced, then these averages become positive indications of efficiency of operation.

The mileage of the P.G.E. Railway, as in 1933, was not put into operation until October, 1921, and the operating results for 1922, 1923 and 1924 were abnormal and unfair statistically for purposes of comparison with later years. One of the cost indices used by J. G. Sullivan, M.E.I.C., in his report of June, 1922, was the train mile cost of 1921, which was $8.67. In 1923 the train mile cost was $6.70 and in 1925 $5.03, as compared with $4.04 in 1927 and $3.38 in 1933. In 1923, the average freight haul was 38 miles and in 1925, 52.5 miles, as compared with 111 miles in 1927 and 118 miles in 1933.

This railway first entered upon operating conditions fairly comparable with 1933 in the year 1925, but up to and including 1926 the fiscal years were as at June 30th and the statistical years as at December 31st. It was, therefore, impossible to deduct the operations of a detached portion of the line in North Vancouver (discontinued in 1929), so as to arrive at a comparable cost basis with 1933. In 1927, however, the accounting system was changed, so that the end of the fiscal year coincided with the statistical year as at December 31st. Therefore, the costs and statistics for 1927 could be brought down to a parity for purposes of comparison with the year 1933.

The author, therefore, decided to compare the operating statistics of 1925 with the operating statistics of 1933, and the operating revenues, costs and statistics of 1927 with 1933; then to compare the P.G.E. Railway operations with those of other Canadian railways, for the year 1933. The results of these comparisons would indicate whether P.G.E. Railway operations were efficient and economical.

All the data used as to 1925 and 1927 were taken from P.G.E. Railway records, and all data for the year 1933 from "Statistics of Steam Railways of Canada," a yearly publication of the Dominion Bureau of Statistics.

In passenger traffic, 1933, as compared with 1925, referring to Table I, it was found that the number of passengers carried one mile per mile of road (passenger density) had increased 36 per cent, the number of passengers per train increased 90 per cent, with a decreased passenger train mileage of 28 per cent, and a decrease in passenger car mileage of 10 per cent. In passenger traffic, 1933, as compared with 1927, the passenger density had increased 16 per cent, the number of passengers per train increased 35 per cent, with a decreased passenger train mileage of 14 per cent, and a decrease in passenger car mileage of 9½ per cent.

Table I

A comparison of passenger and freight traffic statistics, Pacific Great Eastern Railway, years 1925, 1927, 1933 and 1934.

	1925	1927	1933	1934
Number of passengers carried one mile per mile of road	4,765	5,598	6,491	7,532
Average distance carried in miles	67	58	68	64
Average number of passengers per passenger train mile	42.0	59.2	79.8	68.00
Average number of cars per passenger train mile	7.06	8.06	10.71	10.58
Revenue passenger train miles	39,231	32,917	28,214	38,439
Average receipts per passenger train mile		$ 0.04	$ 0.039	$ 0.039
Average revenue per passenger train mile		$ 3.96	$ 5.26	$ 4.66
Number of freight tons carried (revenue)	82,986	42,068	60,396	62,779
Number of tons carried one mile (revenue)	4,362,308	4,672,588	7,127,054	7,561,378
Number of tons carried one mile (all freight)	5,318,476	6,446,239	9,207,340	10,066,988
Number of tons carried one mile per mile of road (revenue)	12,532	13,423	20,539	21,791
Number of tons carried one mile per mile of road (all freight)	15,279	18,518	26,534	29,011
Average distance haul of one ton in miles	52.56	111.07	118.00	120.44
Freight train miles (revenue)	66,478	70,496	80,037	81,312
Average tons per train mile (revenue)	65.62	66.28	89.05	92.99
Average tons per train mile (all freight)	80.00	91.44	115.04	123.81
Average tons per loaded car (all freight)	15.08	16.05	18.82	19.50
Average number of cars per train mile	9.37	9.09	10.22	10.51
Total all service train miles	143,434	152,156	142,170	172,871
Average receipts per revenue ton mile		$ 0.053	$ 0.056	$ 0.55
Average revenue per freight train mile		$ 3.56	$ 4.44	$ 5.12
Operating revenue per total train mile		$ 2.84	$ 3.92	$ 3.81
Operating expenses per total train mile		$ 4.04	$ 3.38	$ 3.08
Total operating revenues		$433,272.19	$557,980.52	$658,962.47
Total operating expenses		$615,268.53	$480,998.42	$533,429.64
Operating ratios	165 per cent	142 per cent	86 per cent	81 per cent

In freight traffic, 1933, as compared with 1925, the revenue ton mileage increased 63 per cent, the revenue train load increased 36 per cent, with an increase in revenue freight train mileage of 20 per cent. The all freight ton mileage, including non-revenue ton mileage, increased 73 per cent, the all freight train load increased 44 per cent, with a decrease in total freight train mileage of one per cent, and an increase in the average haul of 124 per cent. In freight traffic, 1933, as compared with 1927, the revenue ton mileage increased 52½ per cent, the revenue train load increased 34 per cent, with an increase in revenue freight train miles of 13½ per cent. The all freight ton mileage, including non-revenue ton mileage, increased 43 per cent, with a decrease in all freight train mileage of 6 per cent, and an increase in average haul of 6 per cent.

Table II

A comparison of Pacific Great Eastern revenue tonnage and ton mileage, years 1925 and 1933.

	1925		1933	
	Tons	Ton Mileage	Tons	Ton Mileage
Agricultural products	6,598.94	346,887	3,762.80	444,028
Animal products	4,778.20	251,176	5,401.27	637,375
Mine products	1,704.98	89,626	2,740.18	323,354
Forest products	64,005.33	3,364,576	29,927.93	3,531,634
Manufactures, etc	5,898.03	310,043	18,564.22	2,190,663
Totals	82,985.48	4,362,308	60,396.40	7,127,054

The revenue tonnage handled in 1933 was 27 per cent less than the revenue tonnage of 1925, but the lesser tonnage of 1933, on account of the longer haul, produced 63 per cent more ton mileage than in 1925. This is illustrated in Table II. A change had taken place in traffic, a short haul logging traffic had ceased and whereas in 1925 forest products tonnage constituted 77 per cent of the total revenue tonnage moved, in 1933 forest products tonnage amounted to only 49 per cent. In 1925 manufactures and miscellaneous tonnage constituted only 8 per cent of the total revenue tonnage, but in 1933 this subdivision of tonnage had risen to 31 per cent of the total revenue tonnage moved, indicating a large increase in less than carload (L.C.L.) movements and increased revenue. The 1933 and 1927 comparison showed similar characteristics in a lesser degree.

This increased traffic movement was handled with a reduced staff of employees. The average number of employees in 1933 was 29 per cent less than the staff employed in 1925, and 13½ per cent less than the staff employed in 1927.

As compared with 1925, the 1933 all service locomotive mileage had increased only 4 per cent, and as compared with 1927, the all service locomotive mileage had decreased one half of one per cent. The consumption of fuel in 1933 had increased, as compared with 1925, 11 per cent, but in the 1927 comparison, the increase was only 2¼ per cent.

Table III

A comparison of all service fuel consumption per 100 locomotive miles, Pacific Great Eastern Railway, years 1925, 1927 and 1933.

	1925	1927	1933
All service locomotive miles	155,644	162,794	161,699
Total fuel tonnage consumed	7,665.47	8,711.73	8,842.33
Fuel tons per 100 loco. miles	4.93	5.35	5.47

Average all service fuel consumption per 100 locomotive miles for the year 1933 on all Canadian railways was 6.07 tons.

So far these comparisons have not dealt with costs, and have only dealt with the actual work put into and performed by this railway machine.

Dealing with costs, Table I indicates that the total train mile cost in 1933 had decreased 16 per cent, as compared with 1927, and the total expenses of the railway decreased 22 per cent. All the sub-items of total expenses indicated large decreases in cost. Maintenance of way expenses decreased 28 per cent, maintenance of equipment expenses decreased 27½ per cent, traffic expenses decreased 26 per cent, transportation expenses decreased 10 per cent and general expenses decreased 25 per cent.

In revenues, 1927 and 1933 comparisons, while the average receipts per passenger per mile decreased 2 per cent, the revenue per passenger train mile increased 32 per cent, indicating that while passenger rates had been reduced, the number of passengers per train increased 35 per cent, resulting in increased revenues per passenger train mile of 32 per cent. In freight traffic, 1927 and 1933 comparisons, the average receipts per revenue ton mile increased 5½ per cent, and the average revenue per revenue freight train mile increased 24½ per cent, indicating that while rates had been reduced, and a change in traffic had occurred, that on account of the increased tonnage per loaded car of 17 per cent, an increase in cars per train of 12½ per cent, an increase in haul of 6 per cent, and the increase in L.C.L. freight carried, there had resulted an increase in revenue per freight train mile of 24½ per cent. The operating revenues had increased from $433,272.19 in 1927 to $557,980.52 in 1933, an increase of 29 per cent. The operating expenses had decreased from $615,268.53 in 1927, to $480,998.42 in 1933, a decrease of 22 per cent. The operating ratio (ratio of expenses to earnings) had decreased from 165 per cent in 1925 and 142 per cent in 1927, to 86 per cent in 1933. That is, it had cost $165.00 to earn $100.00 in 1925, $142.00 to earn $100.00 in 1927 and $86.00 to earn $100.00 in 1933.

The statistical averages used in the preceding comparisons clearly indicate the comparative conditions of traffic on the P.G.E. Railway for the years 1925, 1927 and 1933, but the use of these statistics as bases of comparison in studying the operating efficiency of different railway systems is apt to lead to erroneous conclusions, unless all the factors influencing operations on each railway are known, and can be given full consideration. The kind and capacity of cars used, the classes of commodities carried, the character and density of traffic, the tractive power and speed of the locomotives operated, and the physical characteristics of the railways compared, are all factors affecting the results of any comparisons made.

Taking into consideration the factors enumerated, it is obvious that no Canadian railways in 1933, were on a parity and statistically comparable with the P.G.E. Railway.

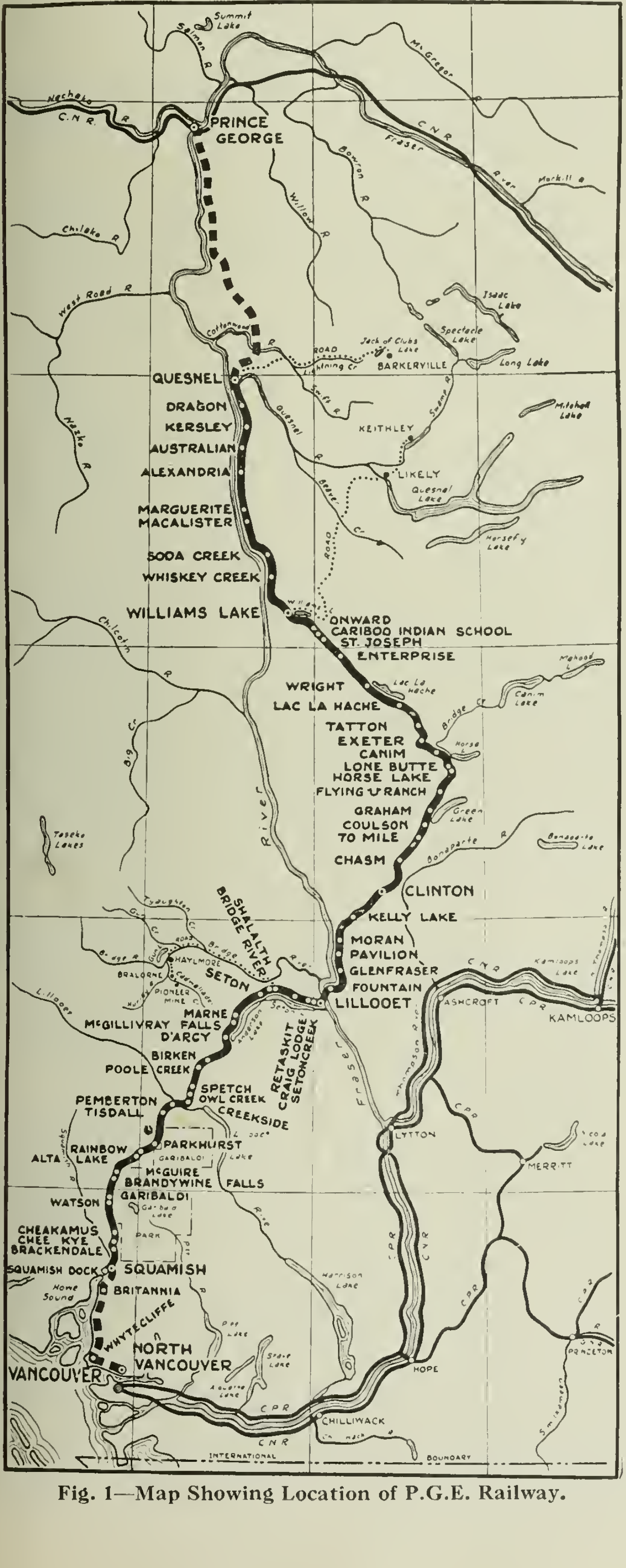


Fig. 1—Map Showing Location of P.G.E. Railway.

No Canadian railway had as high a percentage of its total mileage in maximum gradients, and no Canadian railway earning its operating expenses, had such a low volume of traffic in 1933. Of the thirty-six railways operated in Canada in 1933, only eleven had route mileages over 100 miles, and only eight, including the P.G.E. Railway, had route mileages over 200 miles.

Table IV indicates that in 1933, the P.G.E. Railway train mile cost was:—

33½ per cent lower than the train mile cost of the Algoma Central,
4 " " " " " " " " " " Canadian National,
46 " " higher " " " " " " " " Canada Southern,
25 " " " " " " " " " " Canadian Pacific,
18½ " " " " " " " " " " Northern Alberta,
9 " " " " " " " " " " Temiskaming & N.O.,
25 " " " " " " " " " " Wabash in Canada.

Considering the handicaps of the P.G.E. noted above, the train mile cost compares favourably with all the railways shown except the Canada Southern. The Canada Southern, however, is not statistically comparable with the P.G.E. Railway, on account of the disparity in the traffic and the physical characteristics of the two railways. The Canada Southern, a part of the Michigan Central Railway, is double tracked and operated through the most productive part of Canada. It is noted for its easy gradients and curvature, and its large volume of traffic, the latter being three times greater than that of the Canadian Pacific Railway (see Table IV). This railway is a fitting illustration of the economic law of increasing business lowering production costs.

Table IV

A comparison of route mileage, freight traffic density, train mile cost, and operating ratio, Pacific Great Eastern Railway and seven other Canadian railways, year 1933.

Railways	Route Miles	Traffic Density	Train Mile Cost	Operating Ratio
Pacific Great Eastern Railway.	347.0	20,539	$3.38	86 per cent
Algoma Central Railway......	383.7	191,307	5.08	97 " "
Canada Southern Railway.....	381.0	1,647,408	2.31	58 " "
Canadian National Railway....	21,941.2	454,655	3.53	97 " "
Canadian Pacific Railway......	17,030.1	549,210	2.70	78 " "
Northern Alberta Railway.....	927.6	108,653	2.85	80 " "
Temiskaming & N.O. Railway..	531.7	272,038	3.18	78 " "
Wabash in Canada............	245.4	1,426,963	2.70	78 " "

The largest item in the expenses of railway operation is the cost of fuel for locomotives. The tonnage of fuel consumption for individual railways is not given in "Statistics of Steam Railways of Canada," costs only are shown, and costs are useless for purposes of comparison, as prices of fuel vary in different parts of Canada. But the tonnage, as well as costs of fuel consumption for all railways, are given. The average all-service fuel consumption for all Canadian railways in 1933 was 6.37 tons per 100 locomotive miles, and the all-service fuel consumption of the P.G.E. Railway for the same year was 5.47 tons per 100 locomotive miles, or 16½ per cent lower than the average consumption of fuel for all Canadian railways as is shown in Table III.

Table IV indicates that the operating ratio of the P.G.E. Railway in 1933 was:—

11 per cent lower than the operating ratio of the Algoma Central,
11 " " " " " " " " " Canadian National,
48 " " higher " " " " " " Canada Southern,
10 " " " " " " " " " Canadian Pacific,
7 " " " " " " " " " Northern Alberta,
10 " " " " " " " " " Temiskaming & N.O.,
10 " " " " " " " " " Wabash in Canada.

While the density of traffic (ton miles per mile of road) of the P.G.E. Railway showed an increase in 1933 as compared with 1925, the volume of traffic was insignificant when compared with the other Canadian railways shown in Table IV. On account of this low volume of traffic on the P.G.E. Railway, the operating conditions are unusual, difficult to handle economically and differ in a marked degree from the conditions prevailing on the other Canadian railways. There is not sufficient traffic between Lillooet (Mile 120) and the northern end of the line at Quesnel, to permit of the operation of freight trains, which are run only when necessity compels, over the first 120 miles between Squamish and Lillooet, but the frequency of service required for the public convenience renders impossible the heavier train loading which otherwise would occur.

Fig. 2—Cheakamus Canyon. Wooden Structures now replaced by Steel and Concrete.

Mixed trains handle a portion of the freight traffic between Squamish and Lillooet, and all freight traffic between Lillooet and Quesnel. Way freight between Squamish and Lillooet is handled by freight trains, and way freight between Lillooet and Quesnel by mixed trains. If freight trains arriving at Lillooet from Squamish have a load which is over the rating of the mixed train locomotive, this particular load is taken through by freight engine to Kelly Lake (Mile 155), the summit of the maximum gradient of 2.2 feet per 100 feet. These methods of handling traffic, although the most economical under existing traffic conditions, affect the significance of the statistical indices used in operating comparisons with other railways, where such conditions do not prevail and, of course, increase the cost of service.

Ton mile averages are not segregated as between freight and mixed train traffic in "Steam Railways of Canada" and the traffic conditions of partially loaded freight trains and fully loaded mixed trains are not indicated, but the car mile average expresses the situation clearly. The average number of loaded and empty freight cars per revenue mixed train P.G.E. Railway 1933, was 11.27 or slightly higher than the Canada Southern, Canadian National and Canadian Pacific railways, indicating that P.G.E. Railway mixed train service was normal. In freight trains, however, the P.G.E. Railway car rating average was only 21½ per cent that of the Canadian Pacific and only 13 per cent that of the Canada Southern, reflecting clearly the low volume of P.G.E. Railway freight traffic—65 per cent of the freight car mileage of the P.G.E. Railway in 1933 was developed on mixed trains, on the Canadian National and Canadian Pacific this proportion was only 4½ per cent, and the Wabash had no mixed train service. The car loading of the P.G.E. Railway was on a parity with the Canada Southern and Wabash, but only 60 per cent that of the Canadian Pacific. This comparison directs attention to the preponderance of tonnage movements of manufactures and miscellaneous goods on the P.G.E. Railway, Canada Southern, and Wabash, and the high percentage of heavy commodity loads on the Canadian Pacific. In 1933 the tonnage of grain constituted 24½ per cent of the total tonnage moved on the Canadian Pacific. The grain movement on the Canada Southern was only 2 per cent, on the Wabash 4 per cent, and practically no movement on the P.G.E. Railway; the tonnage of manufactures and miscellaneous goods on the Canadian Pacific was 21 per cent of the total tonnage; on the Canada Southern 51 per cent; the Wabash 42 per cent, and on the P.G.E. Railway 31 per cent.

Another factor in P.G.E. Railway traffic militating against economic operation is the high percentage of non-revenue traffic, while in 1933 the non-revenue traffic of the seven other Canadian railways compared, as expressed in train and car mileages, amounted to less than one per cent of the total traffic, the non-revenue traffic of the P.G.E. Railway was 30½ per cent. The P.G.E. Railway non-revenue traffic appears large on account of the small revenue tonnage.

The foregoing comparisons indicate that as compared with 1925 and 1927 the year 1933 showed a large increase in both passenger and freight traffic with no corresponding increase in train mileage, or other service performed by the railway. In fact there was a reduction in the operating service, and except in one instance, an actual decrease in train and locomotive mileage. These comparisons also indicate that compared with the seven principal railways of Canada, and taking into consideration the sparsity of traffic, the conditions under which traffic was moved, and the physical characteristics of the P.G.E. Railway, the unit costs of operation of the P.G.E. Railway were remarkably low.

During a period extending over several weeks in 1934, the writer was in intimate contact with the personnel and work of all the operating departments of the P.G.E. Railway and noted a planned co-operation between these various units in transacting the business of the railway.

From the evidence of the foregoing data and from personal observation, the writer concluded that the Pacific Great Eastern Railway was efficiently and economically operated.

Can the Operating Conditions of the P.G.E. Railway be Improved?

In Canada and the United States the operating expenses of railways are classified under five headings, and the averages of these five subdivisions of operating costs for all Canadian railways for the fifteen years prior to and including 1933, expressed as percentages of total operating expenses are: maintenance of way and structures 20.8 per cent, maintenance of equipment 22.5 per cent, traffic 4 per cent, transportation 49.3 per cent, and general 3.4 per cent. While the total operating expenses of an individual railway may vary from year to year, according to fluctuations in the volume of traffic, the varying amounts of repairs and renewals, and the difference in costs of material and labour, the proportion of each of these five subdivisions of operating cost to total expenses is generally uniform. Neither these sub-items of expenses nor the total operating expenses of any railway vary in exact proportion with traffic increase or decrease. Some expenses of a railway are not connected in any way with traffic movement; other expenses are directly connected with the movement of passengers and tonnage.

Under the heading of maintenance of way expenses it may be stated that regardless of traffic the track and structures of a railway must be kept up to a standard, ensuring the safe operation of trains. The elements of nature cause ties to decay, wash-outs of embankments, cuttings, bridge foundations and culverts. Wear on account of traffic does not appreciably affect station and other buildings, and accounts only in part for the deterioration of bridge structures. Repairs and renewals of fences, road crossings, signs, cattle-guards, and telegraph lines are not affected by traffic.

In like manner, it may be said of maintenance of equipment expenses, that cars are worn out almost as much by carrying a half as a full load, locomotives deteriorate little more from hauling heavy loads than light loads, and both cars and locomotives are often replaced as much on account of them being obsolete as from wear and tear.

Traffic expenses are only slightly affected by changes in traffic.

Transportation expenses for superintendence, station service and supplies, watchmen, flagmen and switchmen are not affected appreciably by changes in volume of traffic. The wages of locomotive engineers and roundhouse forces, costs of fuel and water, train supplies and service are affected by traffic, although the expense for a fully loaded train is not much greater than for a partially loaded train.

General expenses are only slightly affected by traffic.

Some economists in analysing the operating expenses of railways have advocated a method whereby the expenses not affected by traffic are called constant costs, and those affected by traffic are called variable costs. But the expenses which do not vary with traffic are not constant costs, for the deterioration and destruction caused by the elements of nature are not constant year by year. Destructive flood conditions, which cause damage to bridge structures and waterways, and abnormal snowfall and ice conditions causing great expense for renewals and repairs, may occur only one year in ten. Even the expenses for painting steel and wooden structures do not occur yearly, and are chargeable to the year in which such expenditures are made, therefore even the expenses not affected by traffic are intermittent, and vary from year to year.

The distribution of these costs for a series of years has been apportioned by actual accounting as:—

	Costs not affected by traffic	Costs affected by traffic
Maintenance of way	13.5 per cent	7.3 per cent
Maintenance of equipment	11.3 " "	11.2 " "
Traffic	4.0 " "	
Transportation	17.3 " "	32.0 " "
General	3.4 " "	
Total operating	49.5 " "	50.5 " "

Editor's Note:

Traffic—Includes all expenses of securing business.
Transportation—Cost of handling the business when secured.
General—Administrative, legal and overhead expenses.

That is, practically 50 per cent of the operating expenses are not affected by traffic volume, and 50 per cent of the expenses are directly affected.

Table V gives these subdivision costs expressed as percentages of total operating expenses on eight Canadian railways for 1933. It will be noted that the Canadian National, Canadian Pacific and Temiskaming subdivision percentages do not vary much from the general averages previously shown and it may be assumed that when there is a large variation in these proportional sub-items of expenses, it is due to some abnormal traffic condition. The P.G.E. Railway maintenance of way costs are proportionally very high and those of the Canada Southern very low. These exceptional traffic conditions are illustrated in Table IV, where it will be noted that the traffic density of the P.G.E. Railway is only 1.2 per cent that of the Canada Southern, 1.4 per cent that of the Wabash, and 3.7 per cent that of the Canadian Pacific. On account, also, of this sparsity of traffic, the maintenance of equipment and transportation costs of the P.G.E. Railway are proportionally low, and on account of high traffic density these sub-items of expenses on the Canada Southern are proportionally high. The high proportional cost of P.G.E. Railway maintenance of way is, therefore, not an indication of over expenditure, but of low volume of traffic. A large increase in volume of traffic on the P.G.E. Railway would lower the proportional cost of maintenance of way to the average of the other Canadian railways. There is, therefore, a tendency to decreasing proportional cost with increasing traffic until the capacity of the machine is reached. Beyond that point increasing traffic may require the additional expense of a larger plant, by double tracking in the case of a single track railway. The Canada Southern and Wabash are both double track railways, and capable of handling a far larger volume of traffic than that reached in 1933. In fact during the peak year of 1928 the traffic density of both these railways was double that of 1933.

Table V

Comparison of the percentage of each subdivision of total operating expenses on eight Canadian railways and all railways in Canada for the year 1933:

Railway	Maintenance of Way Per cent	Maintenance of Equipment Per cent	Traffic Per cent	Transportation Per cent	General Per cent	Total Expenses Per cent
P.G.E. Railway	44.7	12.8	1.5	37.8	3.2	100
Algoma Central	25.1	19.0	1.5	46.1	8.3	100
Canada Southern	10.1	34.8	4.5	43.2	7.4	100
Canadian National	21.9	21.1	3.5	48.5	5.0	100
Canadian Pacific	19.7	19.4	7.5	50.0	3.4	100
Northern Alberta	36.1	11.4	1.4	47.2	3.9	100
Temiskaming & N.O.	21.4	21.5	1.0	48.9	7.2	100
Wabash in Canada	12.7	17.5	6.4	56.8	6.6	100
All railways in Canada	20.6	20.6	5.0	49.1	4.7	100
All railways in Canada for 15 years prior to, and including 1933	20.8	22.5	4.0	49.3	3.4	100

Fig. 3—North End of Anderson Lake.

The maintenance of way costs of the P.G.E. Railway cannot be lowered without interfering with the safe operation of trains, and maintenance of equipment, traffic, transportation and general expenses are down to the minimum. The operating expenses of the P.G.E. Railway, therefore, under present conditions of traffic, cannot be reduced, as rigid economy is now exercised in all departments of the railway.

The equipment and motive power of the P.G.E. Railway appear to fulfill the present traffic requirements, although the two prairie type locomotives are too light for any but light work train service.

Fig. 4—Crossing the Fraser River North of Lillooet. Steel Truss and Concrete Bridge, Length 821 feet, Height 265 feet.

When freight traffic increases sufficiently to warrant running freight trains between Lillooet and Quesnel, an economy can be effected by substituting Diesel-electric power in an exclusive fast passenger and express service for the present steam powered mixed trains. This would permit of a normal freight service over the entire mileage, which would result in economy, and a fast passenger and express service which would attract tourist travel and additional business.

The first cost of Diesel power is four times that of steam, but the maintenance and operating costs are only one half the cost of steam maintenance and operation. The economic supremacy of the Diesel is, therefore, controlled by the hours of use in service, for as idle time on duty increases, the advantage of the saving in maintenance and operating costs decreases. Up to the present, the Diesel has not afforded in practice the continuous efficiency of the modern steam engine, and consequently has been inadequate for constant heavy fast freight service. But for fast light passenger service, when there is a reserve of tractive power sufficient to allow of loss of efficiency, the Diesel has been found both satisfactory and economical. Also for heavy, intermittent switching service, the Diesel has effected a large saving over steam, as there is greater availability, and no loss from fuel consumption when idling.

The P.G.E. Railway operates its own tug, and car transfer service between Vancouver and Squamish. With an increase of business, and when a through passenger and express service between Squamish and Quesnel is inaugurated, the establishment of a quick passenger boat service between Vancouver and Squamish should be considered.

An examination of the freight tariffs of the P.G.E. Railway indicates that rates are not unreasonable as compared with other railways in British Columbia for similar services and distances from Vancouver.

Southbound Rates

The commodity rates on products of agriculture southbound are lower than those of the Canadian Pacific for similar distances to Vancouver. Livestock carload rates are from one to three cents per hundred pounds higher than those of the Canadian Pacific for similar distances to Vancouver. Rates on mine products are low and not as high as the traffic can bear. Lumber shipments to the Prairies, Eastern Canada and the United States are covered by arbitraries of from 2½ cents to 5½ cents per hundred pounds over Coast rates.

Northbound Rates

Class rates are from 25 per cent to 35 per cent higher than those of the Canadian Pacific for similar distances out of Vancouver. Rates on petroleum products are 25 per cent higher than Canadian Pacific rates for similar distances out of Vancouver. Rates on mining machinery are lower than those of the Canadian Pacific. Settlers, therefore, along the P.G.E. Railway are in as good a position as those on the Canadian Pacific. They can meet the market prices in Vancouver and are under no handicap.

Regarding the 25 per cent to 35 per cent increase in class rates northbound, as compared with Canadian Pacific rates, this should make no practical difference to the

Fig. 5—Town of Quesnel at Junction of Quesnel and Fraser Rivers.

consumer on the P.G.E. Railway. It would mean that a pound tin of salmon would have an added cost of one quarter of a cent at Lillooet, one half a cent at Williams Lake and one half a cent at Quesnel, on an L.C.L. third class rate. On the fifth class carload rate, minimum 24,000 pounds, the added cost on a one pound tin of salmon would be one tenth of a cent at Lillooet, one quarter of a cent at Williams Lake, and one third of a cent at Quesnel.

The rates of the Pacific Great Eastern Railway should not be lowered; in some cases they may be raised with benefit to the railway, and at little detriment to the shippers and consumers.

The P.G.E. Railway, in common with all Canadian railways, suffers loss on account of unregulated truck and stage competition. Without considering the capital involved in the transportation systems of Canada (a debt as at December 31st, 1934, of about $4,500,000,000) no other form of transportation, at the present time, can take the place of the railway. All low value, bulky commodities moving in large volume, such as coal, gravel, stone, sand, fertilizers and grain, must be carried by the railways, even gasoline, without which trucks and stages could not operate, must be distributed throughout the country by railways. Hitherto the railways have carried these low grade commodities at the bare cost, and in some instances, below the cost of transportation, the high value commodities bearing a proportionally higher rate. If, however, the trucks are carrying a large proportion of the high value L.C.L. traffic, then the railways must reimburse themselves by charging higher rates on high value commodities if the low value commodities are to move. This truck competition is a national question, a matter of public policy, and the public is not informed. Space will not permit further reference in this paper to this important problem.

There has been much idle talk about abandoning the P.G.E. Railway and converting it into a highway. In the first place, a very large sum of money would be required to widen the structures and roadbed of this railway sufficiently to accommodate highway traffic; secondly, the important mining industries and communities tributary to this railway could not be adequately served by a highway.

It is true that if a railway or any other industrial concern cannot now, or in the future, earn sufficient to pay the expenses of operation, it ceases to become economically desirable, and the amount spent might be more profitably invested in some other industry. But capital invested in a railway bears no relation to capital invested in other industries, for capital sunk in a railway, if that enterprise is abandoned, may be considered lost, as there is practically no salvage except the equipment and rails. The money invested in roadbed and structures remains there for all time, and abandoning a railway does not relieve the railway corporation of its interest and capital obligations unless it becomes bankrupt by due process of law.

Since 1933 the P.G.E. Railway operations show steady improvement. As compared with 1933, in the year 1934 the revenue ton mileage increased 6 per cent, with an increase in freight train load of 4½ per cent, an increase in freight train mileage of 1½ per cent. The average haul increased 2 per cent, the tonnage per loaded car increased 3½ per cent, with an increase of cars per train of 2.8 per cent. The train mile cost was lowered 9 per cent from $3.38 to $3.08 and the operating ratio decreased from 86 per cent to 81 per cent. Compared with other Canadian railways in 1934, the train mile cost was less than the Algoma Central, the Canadian National and the Temiskaming, and only 8 per cent higher than the Canadian Pacific. The operating ratio was lower than the Algoma Central or the Canadian National and only 5 per cent higher than the Canadian Pacific.

The Pacific Great Eastern Railway has a debt as at December 31st, 1934, of about $227,000.00 per mile of road, a result of the pyramiding of interest for the last twenty-three years. There is no possibility of earning interest on such a high capitalization, even if the P.G.E. Railway had the highest traffic density and earning capacity of any railway in Canada. But the P.G.E. Railway, with an increase of business, can earn in time, in addition to its operating expenses, interest on the actual cost of construction and equipment. Revenues have increased and operating expenses have been so reduced that there was a surplus over all expenses in 1933 of something over $85,000.00 and in 1934 a surplus over $125,000.00.

Fig. 6—Stewart Ranch North of Pavilion Mountain.

The mining industry, which is practically in its infancy, may bring, in the future, a great increase in revenue to the P.G.E. Railway, as it has done to the Temiskaming and Northern Ontario Railway, and with an increase in population and a gradual return to normal conditions, the prospect of additional business on the P.G.E. Railway is sufficient to justify optimism.

In the opinion of the author, no improvement can be made in the operating system of the P.G.E. Railway, under existing conditions of traffic. The greatest need of this railway is not retrenchment, but tonnage, which can only be obtained through increasing population and business along the present line, and by reaching out and exploiting new fields for settlement and tonnage.

APPENDIX I

A Brief History of the Pacific Great Eastern Railway

In 1911, in the lower coast region of British Columbia, popular opinion was in favour of a Vancouver connection for the Grand Trunk Pacific Railway, and the Pacific Great Eastern Railway was incorporated under the laws of the Province of British Columbia, February 27th, 1912, and amending acts to construct this railway connection. The Howe Sound and Northern Railway, of which seven miles had been constructed from Squamish north, was acquired by purchase, and the P.G.E. Railway was empowered by its charter to construct and operate a railway from Vancouver to North Vancouver; thence along Howe Sound and northeasterly to Lillooet, on the Fraser river; thence northerly to a junction with the Grand Trunk Pacific Railway at Prince George, a total distance of 430 miles. A traffic agreement was made with the Grand Trunk Pacific Railway, and the construction of the railway was proceeded with.

War broke out in 1914, causing conditions which brought about the collapse of the Grand Trunk Pacific, Grand Trunk and Canadian Northern Railways. These railways were taken over by the Dominion Government, and became parts of the Canadian National Railway System, obviating the necessity of the construction of a Vancouver terminus for the Grand Trunk Pacific Railway.

In the meantime, however, settlers had moved into the territory served by the P.G.E. Railway, and whole communities were dependent upon the railway for their connection with the outside world. The Government of British Columbia, then, as a matter of public policy, decided to carry on, and on April 23rd, 1918, took possession of the P.G.E. Railway undertaking.

On September 18th, 1918, a contract was let to construct the extension of the railway from the then end of track at Clinton, Mile 166, and on October 22nd, 1921, the operating department took over the entire mileage as at present operated to Quesnel, Mile 347.

APPENDIX II

Statistical Unit Averages Used in the Study of Pacific Great Eastern Railway Operations

1. Passenger miles
2. Ton miles
3. Passenger train miles
4. Freight train miles
5. Passenger locomotive miles
6. Freight locomotive miles
7. Passenger car miles
8. Freight car miles
9. Train load
10. Car load
11. Passenger traffic density
12. Freight traffic density

1. *Passenger miles:*
The product of the number of revenue passengers carried multiplied by the average distance hauled. A passenger mile represents one passenger carried one mile.

2. *Ton miles:*
The product of the number of revenue tons carried multiplied by the average length of haul. A ton mile represents one ton hauled one mile.

3. *Passenger train miles:*
The product of the number of passenger trains hauled multiplied by the average distance hauled. A passenger train mile represents one passenger train of one or more cars hauled by one or more locomotives a distance of one mile.

4. *Freight train miles:*
The product of the number of freight trains hauled multiplied by the average distance hauled. A freight train mile represents one freight train of one or more cars hauled by one or more locomotives a distance of one mile.

5. *Passenger locomotive miles:*
Represent the mileage run by locomotives between terminals or stations with passenger, mail and express trains.

6. *Freight locomotive miles:*
Represent mileage run by locomotives between terminals or stations with freight trains.

7. *Passenger car miles:*
The product of the number of passenger and sleeper cars (exclusive of mail and express cars) hauled, multiplied by the average distance hauled. A passenger car mile represents one passenger car hauled one mile.

8. *Freight car miles:*
The product of the number of freight cars (exclusive of cabooses) hauled, multiplied by the average distance hauled. A freight car mile represents one freight car of any description (exclusive of cabooses) hauled one mile.

9. *The train load:*
The quotient of the ton mileage divided by the train mileage, and represents the average tonnage of freight per train mile.

10. *The car load:*
The quotient of the ton mileage divided by the loaded freight car mileage, and represents the average tonnage of freight per loaded freight car mile.

11. *Passenger traffic density:*
The quotient of the passenger mileage divided by the route mileage of railway operated, and represents the number of passengers carried one mile per mile of railway. This index affords a comparable basis of measuring passenger traffic irrespective of the route mileages of the railways compared.

12. *Freight traffic density:*
The quotient of the ton mileage divided by the route mileage of railway operated, and represents the number of tons hauled one mile per mile of railway.
This index affords a comparable basis of measuring freight traffic irrespective of the route mileages of the railways compared.

Mechanical Difficulties in the Formation of Newsprint at High Speeds

L. C. Anderson,
Manager of Manufacturing, Ontario Paper Company Limited, Thorold, Ont.

Paper presented before a joint meeting of the Niagara Peninsula Branch of The Engineering Institute of Canada and the Ontario Branch of the American Society of Mechanical Engineers, at Thorold, Ont., on May 21st, 1936.

SUMMARY.—Notes on difficulties in making newsprint which are caused by increases in size and speed of a machine and affect the cost and quality of the product.

The problem in newsprint manufacture is similar to that in most other industries at the present time. By this is meant that the customer demands a better product at a lower cost. Lower cost can be obtained by increases in production rates, but usually a lower quality results. The other half of the problem still remains, namely to maintain or improve quality while increasing the rates of production.

Prior to 1827 in the United States and to 1803 in England, all paper was made slowly and laboriously by hand. Credit for inventing the first paper-making machine goes to Louis Robert in France. Improvements upon his device were financed in England by the Fourdrinier brothers. In fact, they bankrupted themselves in undertaking to develop equipment which thereafter became standard throughout the world. All newsprint — and many other kinds of paper—is today made upon so-called Fourdrinier machines.

The first paper-making machine was simply a moving wire screen by which the pulp was carried to a single press with the drying still done as it was when paper was handmade. Then came the idea of running the sheet over hollow, rotating, iron cylinders heated with baskets of burning charcoal suspended inside. Later developments came with the use of steam for heating and suction for water removal, and so on up to present day equipment.

When in 1848 a ton of newsprint paper was made in a day on one machine it was thought that great progress had been made—and it was great progress from 1697 when a day's work for three men was 4½ reams of newspaper 20 by 30 inches in size, equal to approximately 300 pounds production, or 100 pounds production per man day. The present production per man day is approximately 2,000 pounds in a newsprint mill.

General Outline of Newsprint Manufacture

Groundwood Mill

The heart of a news mill can be truthfully said to be in the groundwood pulp mill, where over 80 per cent of the furnish to the paper machine is produced. A common saying is that newsprint is made on the pulpstone. For high grade newsprint the pulp must have certain very definite characteristics. There must be sufficient long fibres, not too thick in cross section and there must be sufficient short fine fibres to assist in the felting and filling up of the sheet to make it level and smooth. All these features are produced by a combination of pressure on the wood rubbing against the stone, a control of the amount of water that is added to the stock on the stone and by the method of burring the sandstone itself. Even speed of rotation comes into the picture, as it has been proved that the rate of movement of the stone surface past the wood has some effect on the resulting fibre balance.

Sulphite Mill

If the heart of the newsprint process is in the groundwood mill, then it may be equally well said that the sinews and backbone are represented by the sulphite mill. Chemical pulp is a much purer form of cellulose and the fibres have greater flexibility and length; and it is these fibres, blended into the high percentage of groundwood, that add to the strength of the sheet, particularly while it is being formed, and increase the rate of drainage of the water from the sheet. This rate of drainage is spoken of as "freeness." The pulp is called "free" when water drains readily from the water fibre suspension and it is termed "slow" when the felting of the fibres restricts the flow of water from the pulp.

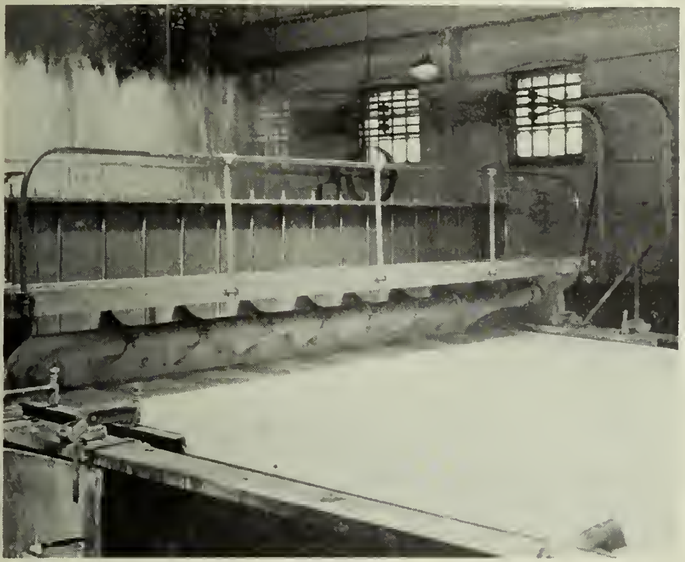


Fig. 1—Headbox, Fourdrinier and Slice.

Screening and Mixing

When the pulps from the two processes have been produced in the groundwood and sulphite mill they are diluted with water and passed through various screening machines to remove the over-size fibres which cannot be used in the process. Considerable water is then removed from the accepted pulp and it is stored in large tanks before being blended in the proper proportion to form the furnish of the paper machine. At this stage of the process colour, alum and non-fibrous fillers are sometimes added.

Paper Machines

The modern paper machine has an overall length of 300 feet from the head screens to the winder. It weighs approximately 2,000 tons and has a wire width of 20 to 25 feet. The speed of operation ranges from 1,000 feet per minute upwards to over 1,300 feet and machines are being designed to-day to operate at 1,500 feet. Such machines will have a producing capacity of over 200 tons per machine day of twenty-four hours.

Let us for a moment consider what happens when the diluted furnish flows from the head box through the slice on to the moving Fourdrinier wire. The furnish in the head box has been diluted so that there are 100 parts of water by weight, to one part of fibre. The sheet formed on the Fourdrinier wire arrives at the reel in 35 seconds from the time the furnish flows through the slice. At this point it contains approximately 80 per cent moisture. In the interval water has been removed by gravity, suction, pressure and evaporation and finally the sheet has been ironed to a glossy smooth surface. For each ton of paper made the quantities of water removed by the various processes are approximately as follows:—

(1) By gravity	140	tons
(2) By vacuum in flat boxes and couch	30	"
(3) By pressure and vacuum in presses	3.1	"
(4) By evaporation	2.5	"
Total	175.6	tons

Naturally the easiest and cheapest way of removing water is by gravity and each step in the process from this point is more costly. To remove water by drying or evaporation is about five times as costly as by pressing or sucking the water from the sheet. Of course there are physical limits to each one of these various steps.

Some Problems and Difficulties

On Wide Machines

As machines became wider, that is 20 to 25 feet wide, it was naturally expected that parts would have to be made heavier. This problem brought several difficulties in its wake. For instance the size of the table rolls meant that less rolls could be installed in a machine in the same wire length. This meant that the rate of water removal was decreased as most of the water actually is drawn away from the under side of the wire by capillary attraction. This in turn demanded that the wire length be increased. Thus the improvement of one feature immediately brought with it several other problems which in turn had to be solved.

On the wide machines it is more difficult to even up the sheet and get good formation due to the stock in the head box being screened through several screens and being discharged through several points across the width of the wire, therefore causing difficulty in getting even dispersion of fibre and water, as after the discharge from the screens it tends to flow in straight lines rather than spreading out and becoming evenly distributed. Considerable thought and engineering skill is being devoted to better means of screening the stock at the head screens and distributing it evenly to the slice.

The consistency of stock and water must be kept low as it passes through the head box and slice. If the pro-

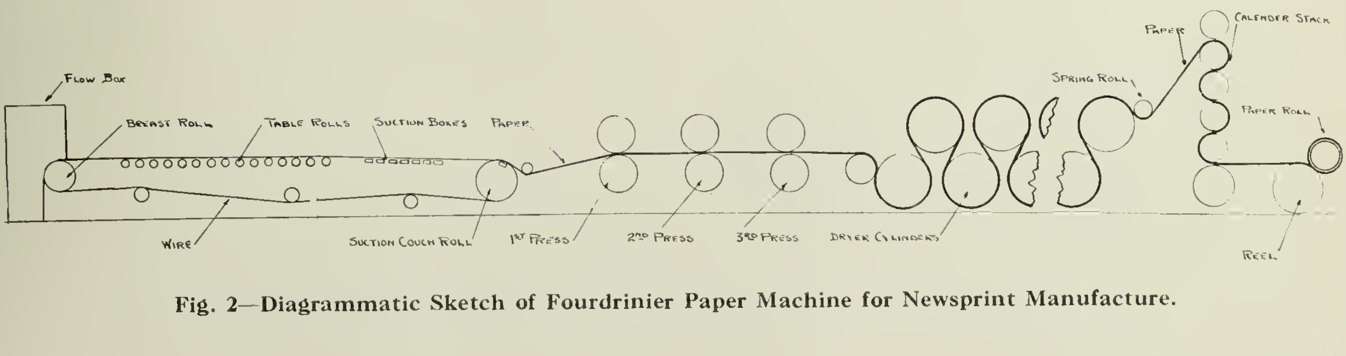


Fig. 2—Diagrammatic Sketch of Fourdrinier Paper Machine for Newsprint Manufacture.

portion is not maintained properly the fibres tend to stick together and form "flocks." Actually, this is what you want to happen right after the stock flows on to the wire. If it happens in the head box, uneven blotchy formations result which cannot be corrected on the wire. Here again two opposing forces are at work. If the stock is kept agitated in the head box flocking will not occur. However, the agitation creates eddies which cause the stock to flow at various angles from the direction that the wire is moving.

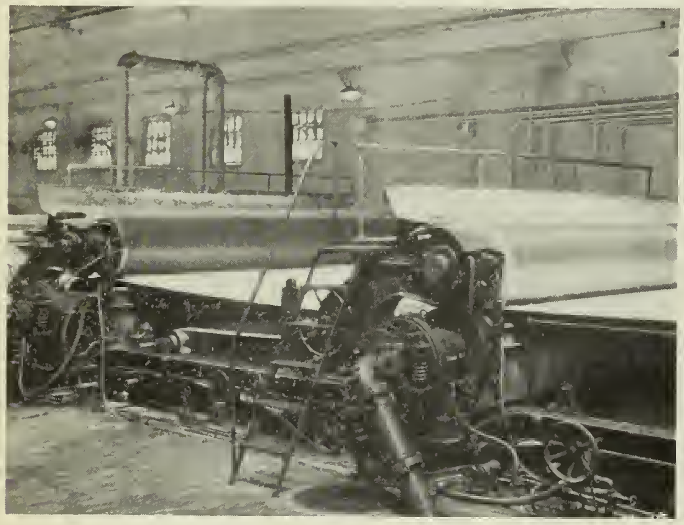


Fig. 3—First and Second Presses and Suction Rolls.

This causes rippling and other formation difficulties. Much thought is continually being given to this very problem by paper makers. They wish the stock to flow evenly through the slice without agitation in the head box and at the same time they wish as little flocking to occur in the head box as it is physically possible to maintain.

On wide machines the removal of vapour is becoming quite a problem. On narrow machines this had not developed as natural eddy currents of air around the machine tended to sweep the vapour from between the dryer rolls. Now we find that if these pockets of vapour are not continually being swept away, damp streaks appear in the sheet and uneven drying results. The present method used to overcome this is a cross-ventilation between the dryer rolls.

On Fast Machines

Fast machines require an increased head in the flow box. This has required increased stiffness of the slice to keep it from bulging and therefore varying the quantity of stock at different points across its width. Higher velocity approaching the slice proper has also caused cavitation and eddy currents. These of course are a deterrent to good formation and changes in design have had to be made.

The so-called forming area on a Fourdrinier machine is the distance on the wire between the slice and some point farther down the wire near the suction boxes where so much water has been removed that the fibres do not float freely, and therefore become fixed. On fast machines it has a length of 20 to 22 feet and on more recent machines this has been increased to over 25 feet. When it is considered that with a machine going 1,200 feet per minute, a 20-foot forming length results in a time interval of one second during which the formation of the sheet has to be completed. A great many things happen during that second.

On wide machines the table rolls had to be increased in diameter to maintain rigidity. On fast machines the diameter has also to be fairly large and all the table rolls tested for dynamic balance to determine whether there are critical speeds in the operating range, at which points whipping of the roll will occur. Usually for reasons given above, the diameter is kept as low as possible and as a result these critical speeds develop very often just above the normal operating speed.

Usually there are seven suction boxes on a paper machine but naturally the amount of work done by each one of these varies considerably. During the past few years, considerable improvement in the design of the water channel and outlets of the box have been made. Also there have been marked improvements in the covers for the boxes themselves which are in contact with the wire. Naturally friction develops at this point and wearing of the wire reduces its life. These things have been studied and great improvements made.

In the wider machines naturally a couch larger in diameter is required and here width and speed did not oppose each other. The larger couch roll allowed for a wider vacuum box to be installed and thereby the time that the sheet is under vacuum at the couch has been fairly well maintained. Naturally there have been attempts to increase the vacuum at these various points so as to increase the rate of the water removal. This has brought about larger vacuum pumps with more power.

Summer and winter temperatures have quite an effect in the formation of a sheet of paper. The whole tendency of technical help in paper mills to-day is to try to reduce this difference in temperature so that better control of viscosity can be maintained. The change in viscosity of water due to temperature is quite marked and therefore the rate at which water can be removed in winter is much lower than in summer. With high speeds the whole tendency is to maintain the process water at higher and more uniform temperatures. This of course takes large quantities of

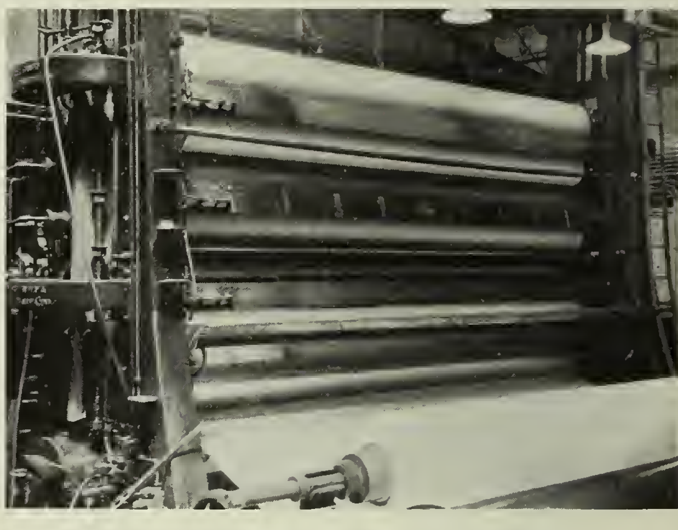


Fig. 4—Calender Stack at Dry End of Machine.

heat and the real problem is to obtain this heat for little or no cost, i.e., to reclaim it from present sources of waste heat.

Manufacturing Costs

Groundwood pulp is the cheapest furnish in the paper mill and the whole tendency recently is to increase the proportion of this in relation to sulphite, whenever possible. This brings in other problems such as reduction in freeness of the furnish, which tends to decrease the amount of water which can be removed in the forming area. To offset this, studies are being made in the groundwood mills to improve the quality of the fibre by increasing its drainage rate while maintaining its filler characteristics. There is plenty of room here for all to make a name for themselves.

As pointed out previously, water can be removed by presses for approximately one-fifth the cost of evaporating it in the dryers. Naturally then much attention is being paid to the pressing operation. Higher vacuums are continually being tried out and at the same time higher loading of the presses is being attempted. Naturally there are economic limits to both pressing and vacuum. In the latter case felt life is decreased and in the former the power required at high vacuum goes up very rapidly.

Fig. 5—General View of Drying Rolls.

The wire life ten years ago used to run between twelve and sixteen days, now mills are obtaining thirty to forty days and a few claim that they are averaging better than fifty days' life for a wire. Several things have occurred to cause this condition. Suction box covers have already been mentioned; others are less grit in the water, greater care in handling the wires themselves and improvements by the wire manufacturer in his materials of construction and method of seaming the wire.

In Canadian mills the steam consumption varies from 8,500 to 10,000 pounds of steam per ton. Of this amount, drying steam averages well over 6,000 pounds, the balance is used in the heating of the mills themselves, in the sulphite cooking operation, and other miscellaneous uses. Of the steam consumed, very little is recovered. Attempts have been made in the sulphite mill to reclaim heat by releasing gases and steam back into the acid storage system. On the paper machines attempts are made to reclaim some of the sensible heat and a small amount of the latent heat in the vapour being drawn off from the paper machines, but at the outside not over 10 per cent of the total available heat is being recovered. There are great rewards for those who can make material savings in steam consumption as it is one of the major costs in the production of paper.

Quality

In the introduction to this subject the reduction in price and improvement in quality was referred to. Quality in the mill is a very vital factor. Press rooms all over the country, and that of the "Chicago Tribune" in particular, are being forced to increase their rates of production and naturally reduce costs. Presses are operating these days at over fifty thousand copies per hour. This means that the paper is passing through the printing press faster than it is made on the paper machines and therefore the ink transferred to the sheet must be dried almost instantaneously. In newsprint this ink dries by absorption into the sheet and studies are being continually made to improve the absorption qualities of the sheet while maintaining its high finish and smoothness. The strength of the sheet also becomes a factor. Coarse fibres must not be allowed to get into the sheet as these may be of such thickness that they are thicker than the sheet itself and cut the sheet so that any tension at such points will break the sheet in two. The sheet is probably ten times as strong as required for the tension put upon it, but it is the coarse fibres that get into the sheet which cause most of the failures in the printing presses.

There are two final qualities which the printer is continually demanding. These are brightness and opacity. Brightness to get contrast with the black ink or the coloured inks which are commonly used to-day, and opacity to prevent this same ink from being transferred through the sheet and showing dark areas in the printing of the reverse side. Considerable progress has been made in these problems during the past few years by the use of non-fibrous fillers, and great hopes are held out that further success along these lines will be obtained.

Evolution of the Modern Transmission Line

Theodore Varney,
Aluminium Limited, Montreal.

Paper presented before the Montreal Branch of The Engineering Institute of Canada, January 30th, 1936.

SUMMARY.—A brief historical resume of the development of the transmission line, and a discussion of certain factors affecting the design of transmission lines, including wind and ice loads and lightning protection; the elastic properties of conductors; the causes and prevention of conductor vibration, and the characteristics and behaviour of dampers.

The date assigned by the papers committee for this paper was especially fitting. The two hundredth anniversary of the birth of James Watt occurred on January 19th. The centennial of the discovery of electro-magnetic induction was celebrated four years ago. The fiftieth anniversary of the Munich Exposition, where the first long distance transmission line was used, occurred last year. Finally, the present year marks the fiftieth anniversary of the discovery of the electrolytic method of producing aluminium.

In September, 1882, during the exposition at the Crystal Palace in Munich, Marcel Deprez put into operation the first long distance transmission line worthy of the name. The generator was driven by a steam engine and was located at Miesbach, about thirty-five miles from Munich. The generator voltage was 1,343 d.c. and the line consisted of a single iron wire, about No. 5 B and S gauge, with the return through the ground. The insulators were apparently of porcelain and about the size of those used in telegraph lines.

The energy which finally struggled through to the receiving end of this line was reported to be 0.519 amperes and 850 volts, representing about ½ h.p.

The first polyphase transmission line of importance is generally conceded to have been built in 1891. It received power from an hydraulic plant at Lauffen and delivered it at the Frankfort Exposition of that year, a distance of seventy-five miles. The generator was constructed by C. E. L. Brown of Oerlikon and was a three-phase machine delivering 1,400 amperes per phase at 50 volts. The current was transformed up to 13,000 volts for the transmission. The line was built with copper wire supported upon pin type insulators on wood poles.

In 1892 the Stanley Company of Pittsfield, Mass., constructed a two-phase, three-wire line from Housatonic Falls to Housatonic, Conn., and Great Barrington, Mass. Also, in that year the Reverend Mr. Baldwin was instrumental in the building of a single-phase 10,000-volt line, twenty-eight miles long, at Ramona, Calif.

The first transmission lines using aluminium conductors were built in 1895 by the Bay Counties Electric Company and the Standard Electric Company of California, now part of the Pacific Gas and Electric Company system.

In 1900 the Snoqualmie Falls Power Company in Washington constructed 150 miles of transmission line at 30,000 volts, using aluminium conductors.

In 1901 the second transmission line from Niagara Falls to Buffalo to supply the Pan American Exposition was constructed with aluminium wires. This line consisted of wood poles spaced 112½ feet apart, carrying three 300,000 circular mil, 37-strand aluminium conductors. The circuits were three-phase, 22,000-volts. The original Niagara Falls-Buffalo line was built with copper wire and the poles were spaced 75 feet apart. Another line was subsequently built with 497,000 circular mil aluminium conductors with pole spacings of 140 feet.

In 1901 a 4,700-foot span was constructed across the Carquinez Straits, Oakland, Calif., using 19-strand, ⅞-inch steel conductors and an elaborate system of porcelain pin type insulators for the anchorages.

In 1902 a 50,000-volt wood pole line using aluminium conductors and pin type insulators was built from Shawinigan Falls to Montreal.

F. O. Blackwell* appears to be the first on record to advocate steel towers for transmission lines and gave the economic proportion of a tower base to height as 1 to 4. He described a line built in Mexico from Guanajuato to Necaxa, two circuits, pin type insulators, 440-foot spans and also described the Niagara Falls to Toronto steel tower, 60,000-volt line, which on account of sleet had spans 400 feet long. (See Fig. 1.)

One of the early important aluminium lines was described by Mershon†. This was the Rochester line of the Niagara, Lockport and Ontario Power Company. It was built on double wood poles and pin type insulators and operated at 60,000 volts. Certain portions of this line were constructed with steel towers which were first assembled on the ground and hoisted into position.

The year 1907 is especially marked by the introduction of the first suspension insulator. It was produced by E. M. Hewlett and was of the link or "fish-tail" type. (See Fig. 2.)

In 1909 the Great Western Power Company, California, began the construction of a 100,000-volt line using suspension type insulators, and the Central Colorado Power Company constructed a 100,000-volt line using suspension insulators in 1910. A 100,000-volt line was also constructed in 1909 by the Southern Power Company in South Carolina.

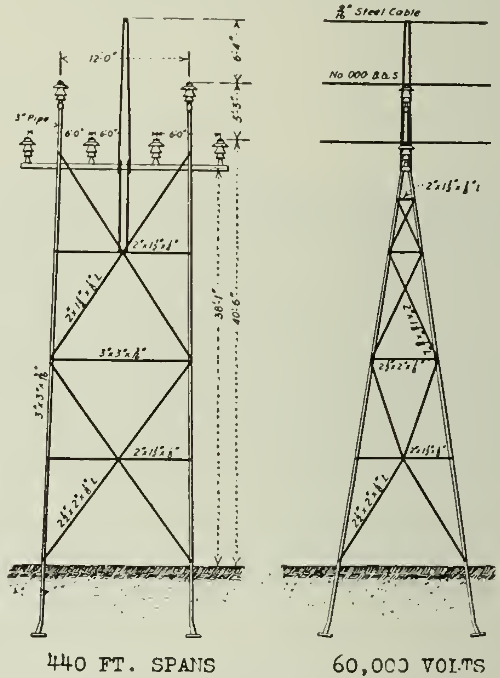


Fig. 1—Transmission Tower of Mexican Light and Power Company.

A. O. Austin of the Ohio Brass Company in 1911 described a cap and pin type suspension insulator which was used in that same year by the Great Falls Power Company, Montana, in a 130-mile, 100,000-volt line from Great Falls to Butte, using No. 0 B and S hemp core copper conductor.

*"Long Spans for Transmission Lines," by F. O. Blackwell, A.I.E.E. Trans. Vol. XXIII, 1904.

†"Transmission Plant of the Niagara, Lockport and Ontario Power Company," by R. D. Mershon, A.I.E.E. Trans. Vol. XXVI, 1907.

The insulator strings contained six 10-inch suspension units. The normal spans were 600 feet.

The first 150,000-volt lines were the Big Creek circuits of the Southern California Edison Company which were built in 1912. These lines used 605,000 circular mil steel reinforced aluminium conductors and were about 240 miles long. These lines were reinsulated and put into service on 220,000 volts at the time that company constructed its Laguna Bell 220,000-volt line about 1923. The latter line was built with 666,600 circular mil A.C.S.R. and the spans were increased to 1,200 feet. The original Big Creek line had spans about half that length. Subsequently in 1924 this company constructed another 240-mile, 220,000-volt line, using 1,033,500 circular mil A.C.S.R., known as the Vincent line.

More recently a number of 220,000-volt lines have been built in the United States and Canada, notable among which are the Ottawa river to Toronto lines of the Hydro-Electric Power Commission of Ontario and the Beauharnois line of that same company.

At the present time the Water Board of the City of Los Angeles is constructing a line from the Boulder dam development on the Colorado river to Los Angeles which is to operate at approximately 275,000 volts. The steel towers are larger and heavier than ever before built and the conductor is a newly developed hollow copper flexible tube.

There are in operation or under construction in North America to-day thirty-five, 220,000-volt transmission lines, of which twenty-eight have steel reinforced aluminium conductors and seven have copper. (See Appendix I.)

From its beginning a century ago, the annual world's electric power production has grown to the tremendous figure of 283 billion kilowatt hours for the year 1934. In that year the consumption in the principal countries was as follows:

Table I

United States	31.0 per cent of total
Germany	10.7 per cent of total
Japan	7.4 per cent of total
United Kingdom	7.2 per cent of total
Russia	7.0 per cent of total
Canada	6.7 per cent of total
France	5.3 per cent of total
Italy	4.1 per cent of total

Conductor Materials

Copper has the highest conductivity of all commercial base metals, hard drawn copper wire being taken at 97 per cent in the International Conductivity Scale. Next is aluminium with a conductivity of 61 per cent. Steel has a conductivity of only 12 to 15 per cent, and is not generally used for transmission line conductors. The ultimate strength of hard drawn copper is from 50,000 to 60,000 pounds per square inch, depending upon the diameter for the sizes commonly used for conductors, while the strength of aluminium wire varies from 22,000 to 29,000 pounds per square inch.

The most remarkable characteristic of aluminium is its lightness, having a specific gravity of 2.705 while that of copper is 8.89 or 3.3 times the weight of aluminium for equal cross section and 2.1 times for equal conductivity. The coefficient of expansion of aluminium is higher than that of copper.

In the early days when short spans were commonly used, conductors made entirely of aluminium were employed with usually satisfactory results, but in sleet regions and cold climates the all-aluminium conductors stretched and sometimes blew together, causing short circuits.

An interesting case of an oldtime all-aluminium line, still in service, is that of the Western Colorado Power Company. This line was installed across the Continental Divide in the Rocky Mountains at an elevation of 13,285 feet in 1905.

With the increasing demand for longer spans and higher strength, improvements became necessary for both copper and aluminium conductors. Alloys of both are available which have higher strength than the pure materials but their conductivities are lower. Weight for weight, aluminium has the highest conductivity and high grade steel has the greatest strength, so that a combination of these materials is logically the best.

About 1908 there was first brought out in the United States composite conductors of galvanized high grade steel

Fig. 2—First Suspension Insulator.

wire, around which were stranded aluminium wires. The steel has an ultimate strength of from 180,000 to 200,000 pounds per square inch and a yield point so high that at the ultimate elongation of the aluminium the stress in the steel is from 160,000 to 170,000 pounds per square inch. The rated ultimate strength of a complete A.C.S.R. conductor is taken as the sum of the ultimate strengths of the aluminium wires plus the stress in the steel at 1 per cent elongation. In this type of conductor the conductivity of the steel is neglected.

The use of this type of composite conductor grew rapidly and is now the standard type of aluminium conductor used in transmission lines. It is commonly known as A.C.S.R. (Aluminium Cable Steel Reinforced).

Steel cores could be used to increase the strength of stranded copper conductors as well as those of aluminium, but on account of the great weight of copper such conductors are not as efficient as A.C.S.R.

Wind and Ice Loads on Conductors

H. W. Buck read a paper at the Louisiana Purchase Exposition at St. Louis in 1904 describing extensive experiments to determine the pressure exerted by the wind on cylindrical conductors. The formula given by him is as follows:—

$F = .0025\,V^2$

= Pounds pressure per square foot of projected conductor surface

V = Actual wind velocity in miles per hour

As the wind blows across the conductor span it swings sideways and if the wind is steady and uniform throughout the span the conductor is deflected through a certain angle, depending upon the ratio of the wind pressure to the weight per foot of the conductor, thus representing the tangent of the angle of deflection.

For any given type of conductor the weight increases with the square of the diameter, whereas, the pressure increases directly with the diameter. Consequently, large conductors are not deflected as much as small ones.

Under sleet-forming conditions, ice adheres to all types of conductor and while the shape of the ice coating may be irregular it usually is approximately cylindrical in form and of the same thickness on all sizes. Thus, while ice coatings of several inches radial thickness have been recorded, the normal assumption for purposes of conductor sag calculations is ½ inch all around the conductor.

Sleet forms at 32 degrees F. but it is assumed that after forming the temperature may drop, thus subjecting

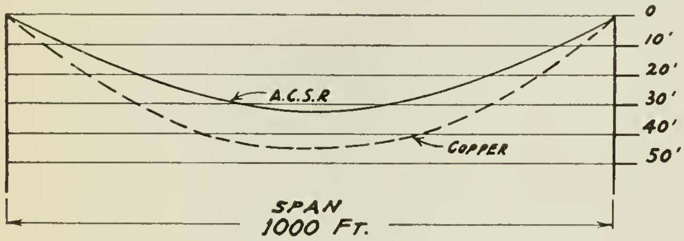


Fig. 3.

the conductor to an increased tension. At the same time, the wind may blow against the ice-coated conductor, subjecting it to a still higher tension.

It is of rather rare occurrence that a line is subject to these simultaneous conditions of ice coating, low temperature and high wind but after years of experience a generally accepted load condition has developed, viz., ½ inch ice all around the conductor combined with a temperature of zero F. and a wind of 8 pounds per square foot of projected area. Under some conditions and in some localities different values and combinations are assumed but the one mentioned is generally accepted for average conditions in sleet regions.

It is customary to assume for the loaded condition the maximum tension to which the conductor will be subjected. This is usually from 35 to 70 per cent of the ultimate strength of the conductor depending upon its character and the condition of span length and tower height. The figure most commonly used is 50 per cent although large conductors are sometimes strung with lower maximum tensions and small ones with higher.

The weight of a cubic foot of ice is 56 pounds and as that is less than the specific weight of conductor materials the ratios of wind pressure to weight of ice-covered conductors differ from those when they are bare.

An important point to be noted is that while the lighter conductors swing out to a larger angle than the heavy ones, the total horizontal displacement is approximately the same on account of the smaller sag.

As the wind dies down and the ice falls off the conductor swings back into a vertical position with a reduced sag. As the temperature rises the sag again increases. It is customary to assume 60 degrees F. for the average condition and a maximum of 120 degrees F. for hot weather.

The unloaded sags at 120 degrees F. for two electrically equivalent conductors of dissimilar materials are shown in Fig. 3. The maximum load in each case is taken as 35 per cent of the ultimate strength at ½ inch ice, 8 pounds wind, zero F.

Calculation of Sags and Tensions

It has been for some years common practice among engineers to assume a definite fixed modulus of elasticity for the conductor. However, even for a single solid wire of any hard drawn material, its elongation when first subjected to stress is greater than when subsequently loaded. That is, the first application of load produces a permanent set and when the load is removed the conductor is slightly longer than it was at first. The modulus of elasticity is not constant during the first application of load because the stress-strain curve under this condition is not straight. The curve of contraction is, however, a straight line and is identical with the curve of application of subsequent loads, provided the original maximum load is not exceeded.

This condition exists in greater degree with a stranded conductor because of the slipping of the strands at light loads.

For composite cables, such as A.C.S.R., data obtained by actual test upon a long piece of the conductor, in a testing machine, are used for sag-tension calculations.

Curve (2) in Fig. 4 is the result of the first application of stress to a complete 795,000 c.m. A.C.S.R. having 54 aluminium and 7 steel strands, which is the equivalent of 500,000 c.m. copper. The maximum stress reached in this case is 27,500 pounds per square inch at 0.480 per cent elongation, which is about 70 per cent of the ultimate strength of the conductor.

Curve (3) shows the contraction of the complete cable as the stress is removed. After contracting to 0.255 per cent longer than its original length, the stress leaves the aluminium part of the conductor and follows the contraction curve (5) of the steel portion back to zero load when the elongation or permanent set of the conductor is 0.055 per cent.

In order to determine the behaviour of the aluminium part of the conductor under load, a second piece exactly like the first is selected and the aluminium layers are removed. A test similar to the first is then made on the steel core alone.

If H_s represents the ratio of the cross section of the steel core to that of the complete cable and T_s represents the stress per square inch on the steel during these tests, the curves (4) and (5) plotted with values of T_sH_s, become directly comparable with curves (2) and (3) of the complete cable.

Subtracting curve (4) from curve (2) and curve (5) from curve (3) give curves (6) and (7) which show the performance of the aluminium part of the cable in terms of T_aH_a where T_a is the stress in pounds per square inch of

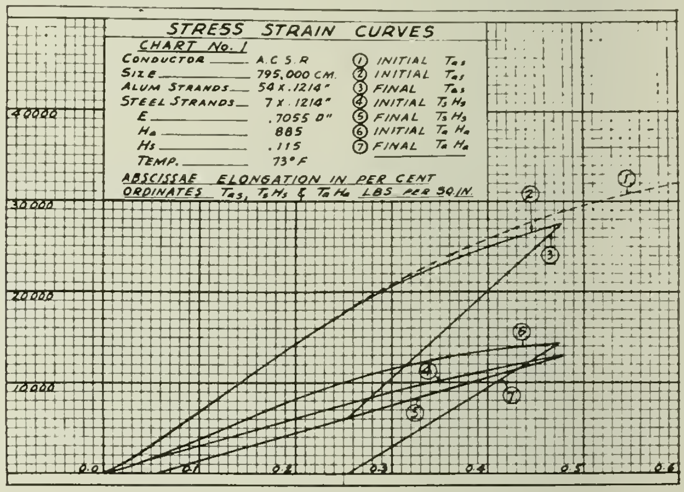


Fig. 4.

the aluminium section and H_a is the ratio of the aluminium cross section to that of the complete conductor.

Figure 4 shows the performance of the conductor at about the same temperature at which it was stranded (73 degrees F.).

Figure 5 shows the performance of the conductor at 32 degrees F. The separate steel and aluminium curves are each moved to the left a distance corresponding to its coefficient of expansion multiplied by the temperature change.

New curves, (8) and (9), for the composite cable are then made up by adding together the component steel and aluminium curves.

If a new cable is installed with sags and tensions calculated with moduli of elasticity taken from curves (2) or (8), at some intermediate temperature without ice and wind load, then if the conductor is subjected to the loaded condition assumed as the maximum, the conductor will have a sag the following summer corresponding to curves (3) and (9). That is, when installed the sag is made such that the conductor will still have the necessary ground clearance after it has been stretched by the maximum load.

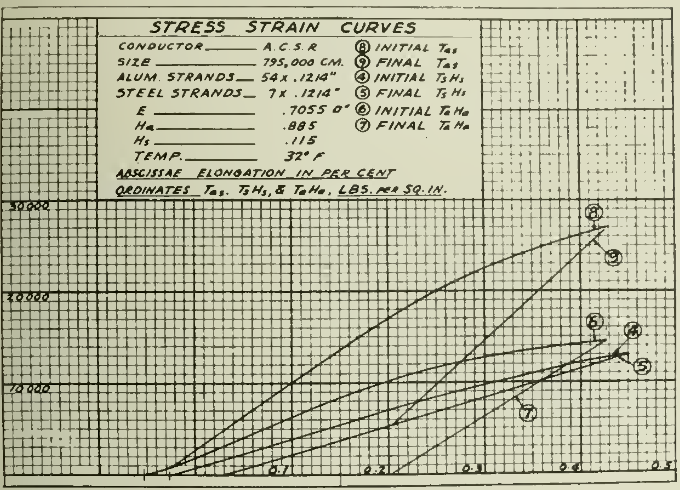


Fig. 5.

Having accurate data for the actual conductor elongation under stress and temperature change, it is possible by graphic methods to determine what the corresponding sags are for any length of span. While the method is simple, a detailed description of its application will be omitted here. It is sufficient to say that A.C.S.R. installed by this method has stayed in place for years.

Corona

With the increase in transmission line voltages it was observed that small wires experienced loss of electrical energy not accounted for by the resistance of the conductor.

After research by the late F. W. Peek and others this loss was found to be due to corona which occurs when the air in the vicinity of a conductor partially brakes down, permitting a certain amount of the electrical energy in the wire to escape.

Corona is effected by altitude, stormy weather, voltage and the diameter of the conductor. The practical remedy is to make the conductor large enough in diameter. A diameter of about 1 inch is necessary for 220,000 volts at ordinary altitudes. When the cross section of the conductor need not be great for conductivity purposes, a tubular construction is sometimes resorted to for protection against corona loss. A.C.S.R. has natural inherent characteristics which make it unnecessary to resort to tubular construction.

Accessories

Electrical conductors must be anchored lengthwise and they must be spliced. In order to develop the full strength of A.C.S.R. the steel core must be firmly held as well as the aluminium envelope. Compression devices which are applied in the field by means of an hydraulic compressor are best.

The field compressor weighs about 180 pounds and can develop a pressure of 100 tons. For the smaller sizes, bolted anchor clamps and twisting joints are suitable.

Bus Bars

An important and increasing use of aluminium for electrical conductor purposes is that of bus bars. Usually this type of conductor is required in power stations or those places where large amounts of energy are concentrated and where space requirements are severe.

Conductors of this type in general must be rugged and stiff enough to withstand magnetic and other forces tending to distort them. They must be capable of ready installation and adapted to frequent tap-off connections which will be permanent and reliable electrically and mechanically.

Aluminium bus bar installations may use flat bars or channel sections, put together in such a way as to provide a box-like cross section of great stiffness. For alternating current work this latter design is especially advantageous on account of the suppression of eddy currents by the separation between the channels. The outside of the channel affords an ideal means of attaching branch connections. For many situations tubular bus bars are advantageous. Particularly for high tension construction is this true.

Lightning

The greatest menace to the continuous operation of a transmission line today is lightning. The late F. W. Peek conducted an exhaustive series of experiments some years ago, culminating in his classic paper before the Franklin Institute* in which he developed the conclusion that the average charged storm cloud floats at an approximate average height above the level earth's surface of 1,000 feet.

He found that the average maximum potential gradient is of the order of 100,000 volts per foot. On this basis a potential may exist between the cloud and the earth of 100,000,000 volts. If the maximum height of the peak of a normal transmission line tower above ground be taken as 100 feet, the potential gradient from that level to the earth may be as high as 10,000,000 volts.

Extensive investigations as to the best method of safeguarding a transmission line against this tremendous static potential have been carried on during recent years by many experts, the results of which indicate that a certain considerable amount of money must be invested in each line for this purpose.

The simple thought suggests itself that by locating a series of slender metallic masts at proper intervals along the right-of-way of a transmission line, entirely separate from but extending a suitable distance above all parts of it, the overhead cloud might be drained and violent potential disturbances in the conductors prevented. Since these masts need support no wires, their expense could be reduced to a minimum and a corresponding saving made in the line towers by omitting all ground wires from them. Assuming the maximum line tower height at 100 feet, two lightning

Fig. 6.

towers per span, each 140 feet high, and located 149 feet from each line tower, would seem to be able to protect the transmission line from lightning damage.

This scheme is entirely theoretical and so far as the author is aware has never been tried in practice.

Conductor Vibration

From what has been said it is apparent that the modern transmission line requires its conductors to be strong and to be installed with sufficient tension to meet the economic

*"Lightning," by F. W. Peek Jr., Journal of The Franklin Institute, Feb. 1925.

requirements of long spans without excessive heights of towers.

About a dozen years ago this trend of design experienced a new and unexpected difficulty in the form of breakage of the conductor strands, not from direct stress in them, but due to a combined tension and bending stress resulting from resonant vibration in the conductors caused by wind action. These vibrations appeared as the familiar nodes and loops of a piano or violin string and were of

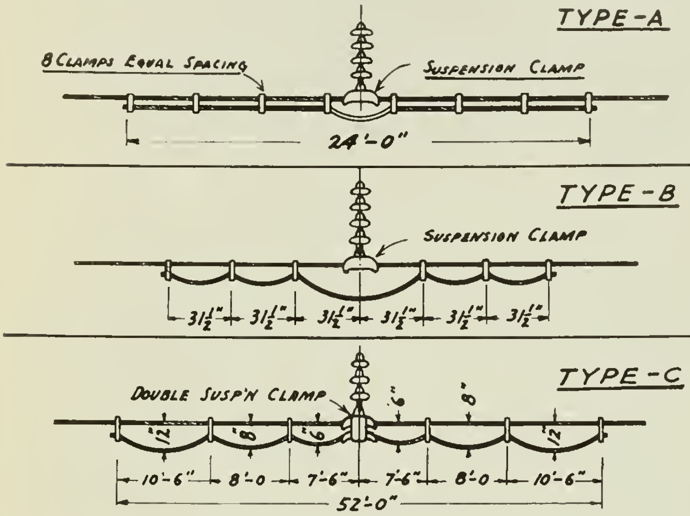


Fig. 7—Types of Festoon.

sufficient amplitude and length to be seen and recorded wherever they had been discovered.

In spite of the great variations in direction and velocity of the wind these nodes and loops can and do appear and remain for considerable periods of time, more especially at night and at dawn and dusk when turbulence due to the heat of the sun is least.

At a node point in the span no bending of the conductor occurs, while at the middle of a freely vibrating loop the radius is great enough to prevent breakage. No trouble has ever occurred at these points. At a support, however, or at a heavy joint where the vibration wave undergoes a partial reflection the bending is sharper and it is at such points that broken strands have been found.

Two practical and reliable remedies for this strand breakage have been found. One is to reinforce the conductor at the supports so as to increase the radius of the sharp bend to a safe limit; and the other is to kill the vibration throughout the span. (See Fig. 6.)

One effective means of accomplishing the first type of remedy is to apply an additional layer of spiral strands around the conductor at the supporting clamp. These strands or rods are each of considerable diameter and are tapered at both ends. They are applied by means of special wrenches and the taper allows the pitch of the twist to increase rapidly toward the ends so that chafing is reduced at these points. When tightly twisted so as to grip the conductor firmly close to the clamp, these armour rods have proved universally successful in preventing conductor strand breakage. At the present time upwards of one million sets of these rods are in service on transmission lines in North America and elsewhere.

This form of protection, while reducing vibration throughout the span 10 or 15 per cent, does not eliminate it. As this device, however, has now been in use nearly ten years its effectiveness is well established.

Another form of this general type of protection which has been used with success is to attach one or more pieces of stranded cable to the main conductor by means of clamps spaced at intervals on either side of the support. The supplementary cables extend for a sufficient distance from the support to reduce the amplitude of incoming waves to a safe limit. This type of damper is called a "festoon."

The steel conductors of the Carquinez straits crossing in California, originally installed in 1901, broke from vibration after being in service a number of years. Festoons were installed and it is understood that no further vibration trouble has occurred.

At various times during recent years several types of festoon have been installed in such widely scattered localities of the world as Australia, South America and Canada. They have successfully prevented vibration damage. (See Fig. 7.)

There exists in the minds of many transmission engineers the thought that complete elimination of vibration is the ultimate solution. Due, however, to the variable behaviour of the wind there is a great lack of unanimity of opinion as to the best method of accomplishing this result. Up to the present time no complete analysis of the problem has been published upon which can be based a definite and reliable method of design of a vibration suppressor.

Fundamentally the problem is one of aerodynamics and in spite of the vagaries of the wind sufficient data have been accumulated to permit of an approximate understanding of the phenomenon. Its principal features will be briefly discussed.

If a rigid obstruction is placed in a flowing fluid such as air or water the fluid passes the obstruction practically without turbulence provided the velocity of the fluid is extremely low. As the velocity increases eddies or spirals appear at the edges of the obstruction. The problem may be simplified somewhat if the obstruction is a cylinder with its axis perpendicular to the direction of flow. Karman and Rubach in Germany in 1912 developed mathematically and experimentally the fact that the eddies cannot form simultaneously on opposite sides of the cylinder but must appear alternately. They gave formulae to show the distance between the eddies depending upon the diameter of the cylinder and the velocity and character of the fluid.

Subsequently in 1921 Ower and Relf in a report to the British Aeronautical Research Committee* gave the law

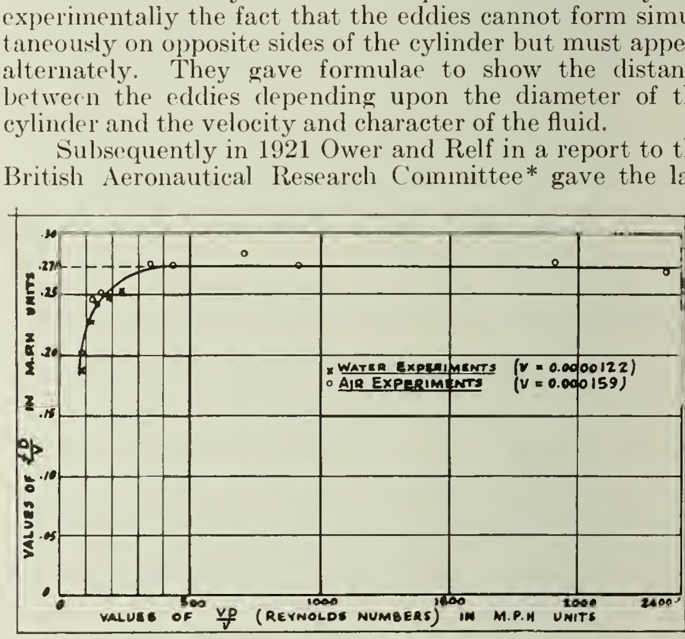


Fig. 8.

governing the frequency of the eddies produced by air flowing past a stationary cylinder. This law is expressed as shown in Fig. 8 where

V = Velocity of wind in miles per hour

D = Diameter of cylinder in feet

f = Frequency of the wind eddies in cycles per second

$$= \frac{.271}{D} V$$

*"The Singing Circular of Circular and Streamline Wires," Aeronautical Research Com. Reports' and Memoranda No. 825, March 1921.

The factor .271 is constant throughout a large range of wind velocity and diameter of cylinder but it is affected by the absolute viscosity of the air and also by the air density at the surface of the cylinder. The viscosity depends principally upon the air temperature, which for the present problem does not change rapidly enough to greatly influence the result. The density is not subject to rapid change at the surface of the cylinder, provided the latter is stationary.

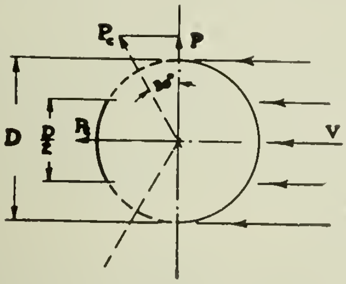


Fig. 9.

The wind blowing against a flat surface normal to its direction produces a pressure according to the expressions in Fig. 9.

P_F = Pressure in pounds per foot of length of flat surface.
= $.005\ V^2D$
V = Velocity of wind in miles per hour
D = Width of flat surface

Various experimenters have measured the wind pressure on cylinders but the investigations of Buck are generally accepted. According to Buck the pressure on a cylinder, the axis of which is perpendicular to the wind, is:—

P_c = Pressure per foot of length of cylinder
= $.0025\ V^2D$
D = Diameter of cylinder in feet

Bate of Australia, in an excellent paper published in 1930,* reasons that the resulting pressure against the cylinder, P_c, is the difference between the balanced pressure, P_F, acting on both sides of the cylinder and a rarefied pressure area on the leeward side covering half the diameter.

Since this rarefied area is produced by the eddies and since these eddies by the Karman theory must oscillate, the rarefied area oscillates from one side to the other. Bate ends his discussion on this phenomenon by assuming that the maximum nominal value of this transverse oscillatory force is limited by and may equal the full value of P_c. Referring to the figure it is the author's opinion that the maximum value of this transverse oscillatory force is more probably:—

$$P = P_c \cos 30° = .00217\ V^2D$$

If the cylinder is free to oscillate under the influence of the transverse oscillatory driving force of the wind, in the manner of a pendulum or a spring supported mass, the driving force acts against the inertia of the mass, the friction of the system and the resisting force of gravity or the spring.

The effect of a uniform oscillatory harmonic force upon a simple mass free to vibrate under the influence of a restoring force has been graphically given by Robertson.

In Fig. 10 the various characters have the following meanings:—

f = Frequency of driving force
w = Angular velocity of driving force
= $2\pi f$
P = Maximum value of driving force
w_1 = Natural angular velocity of vibrating system
ϕ = Angle between driving force and displacement of vibrating system
P_E = Energy component of P
= $P \sin \phi$
P_t = Tuning component of P
= $P \cos \phi$
a = Displacement of vibrating system from its neutral position
V = Velocity of vibrating system (V and a are always 90 degrees apart)
a = Friction factor of vibrating system
M = Mass of vibrating system

When the driving force is first applied the vibration of the system consists of two parts, viz., a steady vibration and a transient vibration.

w_s = Angular velocity of steady vibration of system
= w
a_s = Displacement of vibrating system under steady vibration

$$= \frac{P}{M} \frac{1}{((w_1^2 - w^2)^2 + 4\,a^2w^2)^{1/2}}$$

w_t = Angular velocity of transient vibration
= $(w_1^2 - a^2)^{1/2}$

If $w = w_t$ the vibration gradually grows up to a steady state.

If a has a small value and w is different from w_t the displacement of the vibrating system alternately increases and decreases, forming "beats."

After the lapse of sufficient time the transient vibration dies away but in the interval the displacement may reach double that of the steady displacement given above. It is at this moment that the stress in the supporting member of the vibrating system may reach dangerous limits.

H = Mean energy input per cycle over long period of time
= $\pi a P \sin \phi$
H_w = Mean energy absorbed per cycle by vibrating system
= $2\,\pi a w a^2 M$
a = Mean value of displacement of vibrating system

$$= \frac{P \sin \phi}{2\,awM}$$

When $w < w_1$ $\phi < 90°$
When $w = w_1$ $\phi = 90°$
When $w > w_1$ $\phi > 90°$

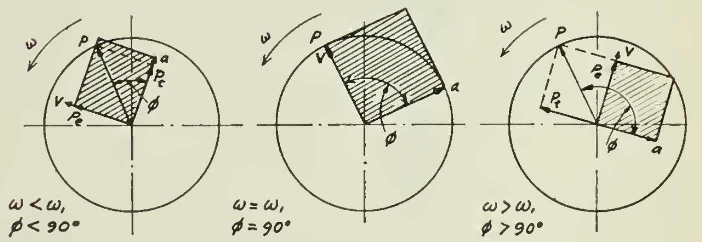


Fig. 10.

The values of H and a are maximum at resonance when ϕ = 90 degrees.

The shaded areas in the figure show the relative magnitudes of H.

From the foregoing discussion it is apparent that any protective device which merely absorbs the mean wind energy does not insure against occasional excessive displacements ("beats") which may damage the supporting member of the vibrating system. Therefore, any system of conductor damper design based upon the energy per loop per cycle is not sufficient. The direct solution lies in de-

*E. Bate, "The Vibration of Transmission Line Conductors," Trans. of Institution of Engrs. of Australia, vol. II, 1930.

termining the equivalent maximum value of the total oscillatory wind force acting upon a conductor span when concentrated at certain points in the span and then applying at those points a device which will automatically provide an equivalent counteracting force. By such means only can the vibration in the span be eliminated.

When a horizontal gust of wind strikes a suspended conductor a small transverse travelling wave is set up. The effect of these impulses upon each consecutive section of

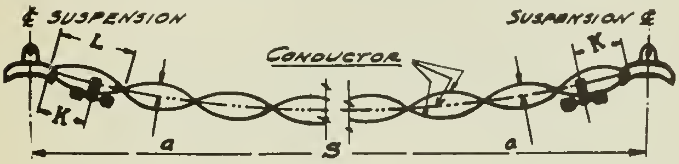


Fig. 11.

the conductor is at first heterogeneous because there is nothing at first to insure that they act together. In time these impulses get into step and the travelling waves reflected from other points in the span build up into small standing waves with nodes and loops.

It is convenient to locate the damper at each end of the span and at a distance from each support of three-quarters of the length of the shortest loop likely to occur in service. This occurs at maximum resonant wind velocity and minimum temperature. (See Fig. 11.)

The design of the damper depends upon the equivalent mass of the half span and the force acting upon it which is the equivalent force of the wind acting on the half span. These quantities are determined as follows:—

P = Maximum value of oscillatory force of wind on conductor per foot
M = Mass of conductor per foot
L = Length of loop
a = Half amplitude at centre of loop
w = Angular velocity of wind eddy on conductor
N = Number of loops in span
S = Length of span
K = Distance from support to damper

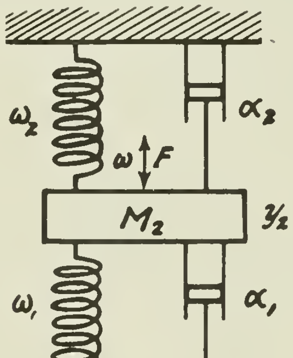


Fig. 12—Compound System with Damping.

E_L = Energy of vibration of loop
$= \frac{1}{4} w_2{}^2 a^2 ML$

E_S = Energy of vibration of half span
$= \frac{1}{8} w_2{}^2 a^2 MLN$

E_d = Equivalent energy concentrated at damper
$= \frac{1}{2} w^2{}_2 a^2 \sin^2 \frac{\pi K}{L} M_2$

M_2 = Equivalent mass of half span concentrated at damper
$= \dfrac{MS}{4 \sin^2 \frac{\pi K}{L}}$

ϕ = Angle between P and a

H_L = Mean energy input of wind per cycle per loop
$= 2\,PaL \sin \phi$

H_s = Mean energy input of wind per cycle per half span
$= PaLN \sin \phi$

H_d = Equivalent energy input per cycle at damper
$= \pi Fa \sin \frac{\pi K}{L} \sin \phi$

F = Equivalent force of wind on half span at damper
$= \dfrac{PS}{\pi \sin \frac{\pi K}{L}}$

The problem is thus reduced to a damper mass supported from the conductor by a resilient means having a natural period and a friction factor. The conductor mass in turn is attached to a rigid support by another resilient member having a natural period and a friction factor.

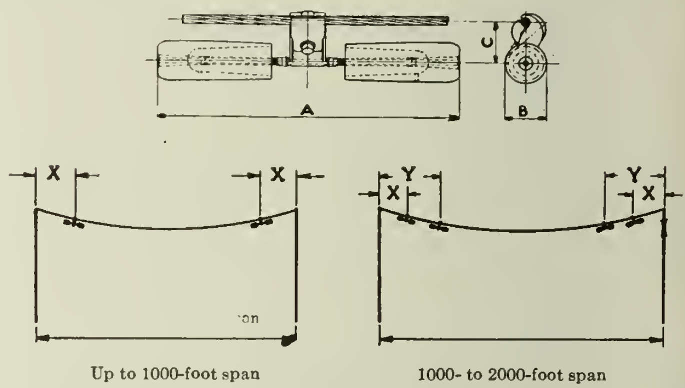


Fig. 13—Stockbridge Damper.

The motions of such a compound elastic system can be determined by the application of d'Alembert's principle as explained by A. L. Kimball in his book, "Vibration Prevention in Engineering." (See Fig. 12.)

w_2 = Angular velocity of conductor loop
a_2 = Friction factor of conductor
M_2 = Mass of half span at damper
w_1 = Natural angular velocity of damper
a_1 = Friction factor of damper
M_1 = Mass of damper
w = Angular velocity of wind eddy
F = Concentrated force of wind at damper
$= \dfrac{PS}{4 \sin \left(\frac{\pi K}{L} \right)}$

d'Alembert factor $A = 2\, a_2 M_2 w$
" " $B = M_1 w_1{}^2$
" " $C = M_1 w^2$
" " $D = 2\, a_1 M_1 w$
" " $P = -BC - AD$
" " $Q = AB - AC - CD$

y_2 = Displacement of conductor at damper
$= F \dfrac{((B-C)^2 + D^2)^{1/2}}{(P^2 + Q^2)^{1/2}}$

y_1 = Displacement of damper mass
$= F \dfrac{(B^2 + D^2)^{1/2}}{(P^2 + Q^2)^{1/2}}$

The values of M_1, a_1 and w_1 are determined in the laboratory and are so chosen as to reduce y_2 to negligible limits throughout the range of resonant wind velocities, that is, from 1 to about 10 m.p.h.

The quantities a_2 and M_2 affect the problem only to a minor degree.

Another reason for believing this static force method of solution superior to others is that the motion of the conductor has a reflex action on the wind eddy frequency,

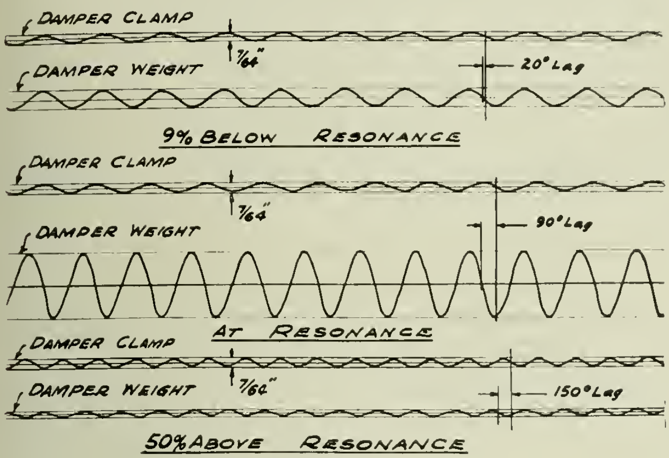


Fig. 14.

changing it from the value it would have if the conductor were stationary by reason of the change in air density close to the moving conductor. When this occurs the energy imparted to a loop is very difficult of calculation, whereas, by the static method the forces are balanced and the loop is practically stationary.

The Stockbridge damper is the outstanding example of that type of protector which acts to suppress vibration by exerting forces in opposition to the oscillatory wind impulses concentrated upon it by the conductor. This action "nips in the bud," so to speak, the vibration and kills it. Figure 13 illustrates a Stockbridge damper and Table II indicates the size and location of the dampers suitable for a number of sizes of conductor and span lengths.

Table II

A.C.S.R. Size	Nominal Damper Wt. (Lbs.)	Dimensions in Inches			Damper Spacing Feet	
		A	*B*	*C*	*X*	*Y*
1/0	4	13.875	1.875	2.125	1.75	3.50
4/0	6	17.000	2.031	2.375	2.75	5.50
336,400	10	20.250	2.406	2.937	3.50	7.00
397,500	10	20.250	2.406	2.937	3.75	7.50
605,000	12	21.812	2.500	3.062	4.25	8.50
795,000	14	24.125	2.562	3.250	4.75	9.50

The dimension "*X*" in Table II is equal to "*K*" used in the discussion, increased by half the length of the suspension clamp.

There is a machine made for use in the laboratory for determining the characteristics of dampers of the Stockbridge type. It consists of a substantial vertical plunger operating in guides giving a correct harmonic motion. Its travel can be adjusted over a range from practically zero to about one-half inch double amplitude. Its speed can be varied by motor field control and cone pulleys from about 100 to about 2,000 r.p.m. The central clamp of the damper is firmly bolted to the cross head of the plunger. A stylus is attached to the cross head and another is fixed at the centre of gravity of the damper weight. Both recording points make sine waves on a piece of paper carried by a drum which is driven by a small motor at a fixed speed. By this means charts are obtained which give accurate records of the amplitudes and frequencies of the damper conductor clamp and the weights as well as the correct phase relations between the two.

The method of test is as follows. With the machine at rest the damper weights are pulled downward by means of a string and released. They oscillate at their natural frequency and the weight stylus draws a sine wave on the drum, gradually decelerating to a straight line. This gives the natural frequency of the damper and also its friction constant.

Next, the machine is operated at some speed below the natural frequency of the damper. Next, at the same frequency which is resonance and then at a higher frequency than resonance.

Figure 14 illustrates charts taken on a damper, the natural frequency of which is 6.68 cycles per second or 400 r.p.m. It was first operated at 9 per cent below resonance or about 365 r.p.m. The double amplitude of the cross head was 7/64 inch and the damper weight lagged 20 degrees behind the cross head. This is shown in the upper chart in the picture.

At resonance the damper behaved as it should and lagged 90 degrees, as shown in the middle chart. At 50 per cent above resonance the damper lagged 150 degrees, as shown in the lower chart.

The chart in Fig. 15 shows the lag angles below and above resonance. The damper is efficient in its opposition to the wind forces in a conductor when it is operated above its resonant speed. Theoretically, the lag increases to 180 degrees only at infinite speed but it quickly increases to a very considerable value with small increases of speed above resonance. The natural frequencies of the dampers are chosen so as always to be below the conductor frequencies likely to occur in practice.

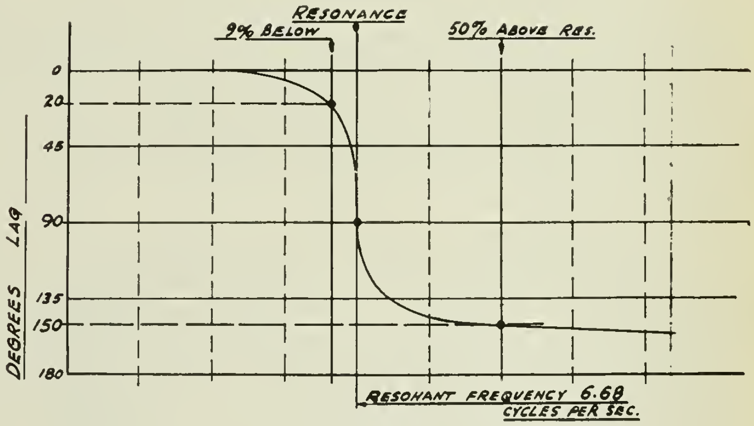


Fig. 15.

Although probably everybody has heard the singing in the wind of telephone and other small wires, the vibrations in larger conductors are of lower pitch and usually not audible. When trouble from broken transmission conductor strands was first observed some years ago, trouble was experienced in obtaining actual records of wind vibration. This is due to the fact that these resonant vibrations only occur at low wind velocities and the air must be free from turbulence to a large extent. Such conditions usually occur at certain times of the day and principally at night when they cannot be seen.

Figure 16 illustrates a small recording device containing a clock-driven paper disc and a pendulum element similar to the ordinary pocket pedometer. It is attached to a conductor and left for twenty-four hours or more. The device illustrated is a twenty-four hour recorder made by an American company. This device can be attached and removed by means of live line tools, and is very useful in obtaining vibration records on high tension lines in service.

Figure 17 shows comparative charts taken simultaneously on parallel wires. The righthand chart records the vibration of the conductor with no damper and the lefthand chart shows the entire absence of vibration when a Stockbridge damper is attached. This chart was taken by an eight-day recorder of European make. This type of recorder shows the presence of vibration and its relative amplitude

Fig. 16—Servis Vibration Recorder.

and persistence. It does not record the exact amplitude or the frequency.

The question naturally arises as to whether some kinds of conductor vibrate more than others and whether some types are immune. Experience has shown that all kinds and sizes of aerial wires vibrate more or less. Some have been in service for years without giving trouble and others have broken in a few months.

The explanation of the fact that this trouble has appeared in serious proportions only in recent years lies in the size and importance of transmission lines and the ever-increasing demands for efficiency, which require longer spans, higher tensions and fewer insulated supports.

As evidence that vibration exists in many kinds and sizes of conductors the upper table in Fig. 18 gives the

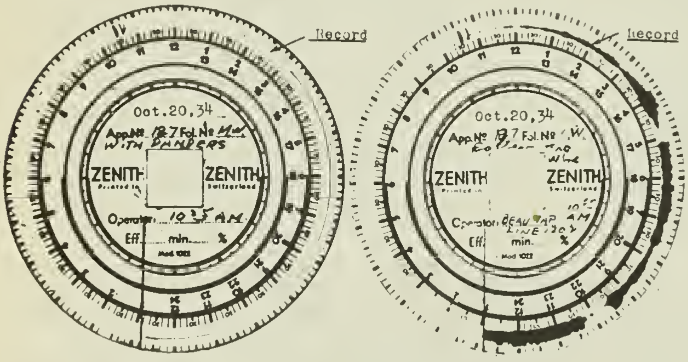


Fig. 17.

actual wave form, amplitude and frequencies of several A.C.S.R. lines.

The "beats" in most of them are very marked. These are the oscillations which lead to trouble because of their large amplitude. If the wind blew absolutely uniformly long enough these "beats" would disappear and the wave would be a simple sine curve of comparatively small amplitude. It is the suppression of the initial impulses which develop into these "beats" which constitute the truly remarkable performance of the Stockbridge damper.

The lower table of this figure illustrates actual vibration in a number of conductors and groundwires of material other than A.C.S.R. That they vibrate cannot be questioned. That they will all break in time, if not protected, is also a proven fact. Case No. 3 in the lower table is that of an important copper conductor line in the United States which is now equipped with Stockbridge dampers.

"Dancing Conductors"

A special form of vibration of transmission line conductors occurs under special conditions in which the conductors oscillate in irregular transverse orbits, usually in a vertical plane, although sometimes in a horizontal plane and occasionally in combinations of both. In the latter case the motion becomes roughly elliptical in shape. These oscillations are characterized by a low frequency, approximately one or two cycles per second, with very large amplitudes. The loops are of great length, usually only one or two per span.

These oscillations have been studied experimentally and theoretically by A. E. Davison of Toronto, Professor J. P. Den Hartog of Harvard University and others.

It is generally conceded that the impulses which set up these rhythmical oscillations are approximately vertical and

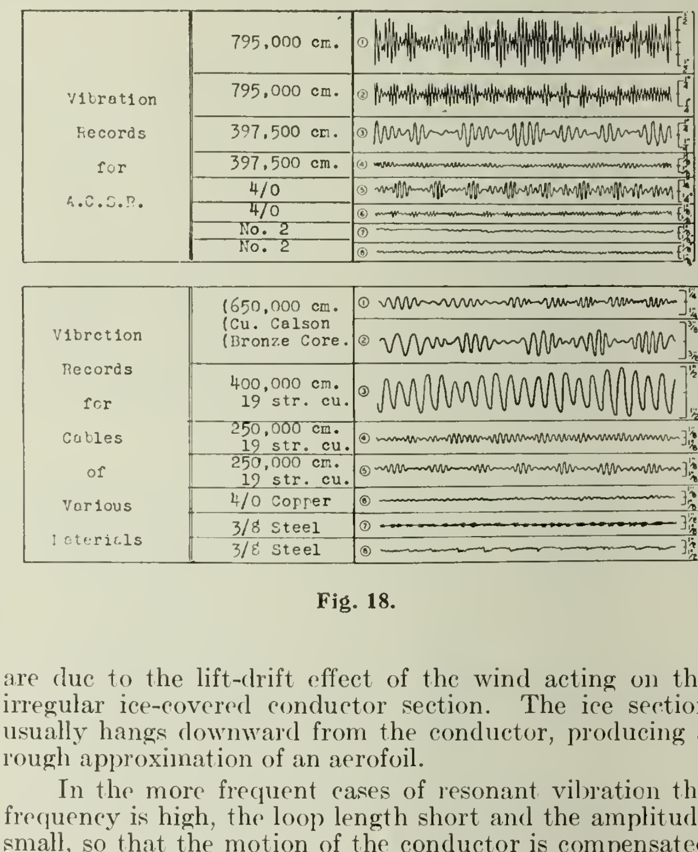


Fig. 18.

are due to the lift-drift effect of the wind acting on the irregular ice-covered conductor section. The ice section usually hangs downward from the conductor, producing a rough approximation of an aerofoil.

In the more frequent cases of resonant vibration the frequency is high, the loop length short and the amplitude small, so that the motion of the conductor is compensated by the elastic lengthening and shortening of the conductor. The node points in this case at the supports are stationary but in the case of dancing the spans usually shift bodily back and forth lengthwise, producing corresponding longitudinal oscillations of the points of support. While it is conceivable that dancing might occur in the case of heavily loaded spans dead-ended to massive and immovable supports, the action is greatly amplified by the motion of more or less flexible supports. Even when the spans are attached to the bracket arms of a tower by strings of dead-end insulators, the support is sufficiently elastic to permit the extremities of the bracket arms to move lengthwise of the line, thus setting up a torsional oscillation in the body of the tower. On the other hand, when the conductor is supported from the tower arm by strings of suspension insulators, the latter swing like pendulums, thus permitting a longitudinal oscillation of the suspension clamp, which motion is sometimes even further amplified by torsional oscillation of the tower.

The period of this dancing action frequently coincides with a natural period of an entire section of a transmission line so that consecutive spans and towers have been observed in motion over long distances. In these cases the gyrations of the conductors reach large amplitudes and short circuits between phases sometimes occur.

A suitable device to prevent dancing can probably be developed and in certain localities its use would perhaps be warranted.

The author is indebted to Messrs. J. E. Thicke, A. A. Defoe, M. Geddes and J. S. Luck of Aluminium Limited for assistance in preparing this paper and the accompanying figures.

Appendix I

220 Kv. A.C.S.R. Transmission Lines in North America

Name of Company	Conductor—A.C.S.R. Size and Stranding	Conductor—A.C.S.R. Weight Pounds Per Foot	Length of Line Miles	No. of Tower Lines	No. of Circuits Per Tower	Normal Span Feet	Maximum Span Feet	Suspension Insulators No. of Insulators Per String	Weight of Std. Suspension Tower Including Footings Pounds	Date of Erection
Hydro Electric Power Commission of Ontario	795,000 C.M. 54/7	1.020	203.0	3	1	1056	2263	18	10,500	1st-1928 2nd-1930 3rd-1931
	795,000 C.M. 54/7	1.020	100.1	1	1	1056	....	18	10,500	1932
Beauharnois Light Heat and Power Company	795,000 C.M. 54/7	1.020	25.0	1	1	1000	1300	18	10,876	1932
Gatineau Power Company	795,000 C.M. 54/7	1.020	25.7	2	1	950	....	16 17 Outside Cond's. 16 Middle Cond.	10,850	1st-1928 2nd-1930
Shawinigan Water and Power Company	795,000 C.M. 54/7	1.020	87.0	1	1	1050	2800	16	10,000	1929
Public Service Electric and Gas Company of New Jersey	795,000 C.M. 30/19	1.230	45.8	1	1	1150	2665	16	16,000 Exclusive of footings	1929
	795,000 C.M. 30/19	1.230	46.24	1	1	1040	1600	16	16,000 Exclusive of footings	1930
The Philadelphia Electric Company	795,000 C.M. 30/19	1.230	29.57	1	1	1080	1435	16	13,980	1930
	795,000 C.M. 30/19	1.230	57.59	2	1	1175	2256	14	16,260	1928
	795,000 C.M. 30/19	1.230	9.85	1	1	930	1240	16	12,632	1928
	795,000 C.M. 30/19	1.230	2.86	1	*3 2-66 Kv. 1-220 Kv.	1050	....			1928
Pennsylvania Power and Light Company	795,000 C.M. 54/7	1.020	67.0	1	1	1100 950	2400	14 and 16	7,730 Exclusive of footings	1925
	795,000 C.M. 30/19	1.230	39.0	1	1	1100	1726	16	12,270	1928
Pennsylvania Water and Power Company	795,000 C.M. 30/19	1.230	69.9	1	1	1060	2200	20	11,523 Exclusive of footings	1931
	795,000 C.M. 30/19	1.230	21.8	1	1	943	1525	20	11,912	1933
Connecticut River Power Company (New England Power Association)	795,000 C.M. 54/7	1.020	126.4	2	1	593	1176	15	6,425	1930
The Great Western Power Company	795,000 C.M. 54/7	1.020	20.0	1	1	750	1537	14	6,722	1927
	795,000 C.M. 54/7	1.020	79.2	1	2 (1 Installed)	750	1537	13	9,825	1926
	795,000 C.M. 54/7	1.020	103.0	1	2 (1 Copper)	800	1313	14	9,825	1926 (Copper circuit 1931)

(*Continued on next page*)

Appendix I—Continued

220 Kv. A.C.S.R. Transmission Lines in North America

Name of Company	Conductor—A.C.S.R.		Length of Line Miles	No. of Tower Lines	No. of Circuits Per Tower	Normal Span Feet	Maximum Span Feet	Suspension Insulators	Weight of Std. Suspension Tower Including Footings Pounds	Date of Erection
	Size and Stranding	Weight Pounds Per Foot						No. of Insulators Per String		
Southern California Edison Company	1,033,500C.M.54/7	1.327	223.0	1	1	850 1200	5191	13	11,930	1926
	605,000 C.M. 54/7	0.776	240.0	2	1	660 550 at Altitudes over 2,000 Ft.	2870	12	6,000	1913
	666,600 C.M. 54/7	0.856	26.0	2	1	1250	2700	15	10,300	1923
	1,033,500C.M.54/7	1.327	11.0	2	1	1250		15	10,900	1929
	666,600 C.M. 54/7	0.856	9.0	1	2	1250	1400	15	29,000	1929
Pacific Gas and Electric Company	518,000 C.M. 42/19	1.111	27.5	2	1	500	1775	13	5,100	1921
	518,000 C.M. 42/19	1.111	8.5	2	1	600 800	2363	13	5,100	1925
	518,000 C.M. 42/19	1.111	27.0	2-11 miles 1-16 miles	1 2	500	1500	13	5,160	1930
San Joaquin Light and Power Company	795,000 C.M. 54/7	1.020	43.5	1	2 (1 Installed)	750	780	14 Initially 7 for 110-Kv.	8,395 Exclusive of footings	1930

220 Kv. Copper Transmission Lines in North America

Name of Company	Conductor—Copper		Length of Line Miles	No. of Tower Lines	No. of Circuits Per Tower	Normal Span Feet	Maximum Span Feet	Suspension Insulators	Weight of Std. Suspension Tower Including Footings Pounds	Date of Erection
	Size and Stranding	Weight Pounds Per Foot						No. of Insulators Per String		
Pacific Gas and Electric Company	500,000 C.M. 7 × 7 × .101	1.543	32.5	2	1	500		13	5100	1922
	500,000 C.M. 7 × 7 × .101	1.543	142.0	1	2	800		13	8110	1921
	500,000 C.M. 50 × .097″ Copper 0.612″ Copper I-Beam	1.612	82.0	1	2	800	1000	13	10,300	1930
The Great Western Power Company	500,000 C.M. 50 × .097″ Copper 0.612″ Copper I-Beam	1.612	103.0	1	2 1 A.C.S.R.	800	1313	14	9825	1931
Southern California Edison Company	650,000 C.M. 42 × .1245 Copper 19 × .1245″ Calson Bronze	2.007	10.0	1	2	1100	1300	.		1928-29
City of Los Angeles Dept. of Water and Power	512,000 C.M. (Hollow Core Heddernheim Type)	1.57	225.3 40.8	2 1	1 2	1000 850	1811 1620	24	18,100 23,000 Exclusive of footings	Now being erected
San Joaquin Light and Power Company	500,000 C.M. 50 × .097″ Copper ·0.612″ Copper I-Beam	1.612				600	1000	14	10,300	

Highways and Passenger Transportation

A. H. Foster[1]

DISCUSSION

by E. G. Adams, Jr.E.I.C.[2]

With some of Mr. Foster's conclusions the writer is in agreement. With others, it is thought that they have not been pursued to their logical conclusion; and on some questions it is believed that there is equal, if not better authority for arriving at entirely opposite conclusions.

In the main, the paper covered three major items:—

I. The design of highways and the effect of heavy commercial vehicles thereon.

II. Highway costs and their relation to taxation of motor vehicles.

III. The relation of highway passenger transport to railway passenger services.

It is proposed to discuss each of these items in relation to such authoritative opinion and facts as are available, so that the subject may be clarified and both sides presented to those interested in this frequently discussed question.

I. *The design of highways and the effect of heavy commercial vehicles thereon.*

The basic point in Mr. Foster's discussion on this subject is his statement that the design of any given highway is not determined by the weight of the vehicles using that highway. He says the effect of vehicle weight on a roadway is related not to the deadweight of the vehicle, but to the distribution of that weight to the roadway, and the determining factors in highway design in a country such as Canada are not traffic, but climate and soil conditions. Consequently he holds that heavy commercial vehicles have not necessitated the building of a heavier type of roadway than would have sufficed for the operation of the private motor car. In the following paragraphs it will be shown that there is an important body of authoritative opinion which does not support these views. Furthermore, there are other considerations relating to the motor vehicles' use of the highways and the resulting effect on highway costs which should not be neglected in discussing this question.

The opinion of several eminent highway engineers is that for ordinary motor traffic, such as provided by pleasure cars and light trucks, the so-called flexible or bituminous pavements are entirely adequate. It is only for the heavier types of vehicle that concrete pavements become imperative. On this question, Charles B. Breed, consulting engineer, Massachusetts Institute of Technology, has remarked as follows:

> "Park roads, where commercial vehicles and buses are excluded, are not constructed of cement no matter how dense the traffic may be, for the reason that the gravel and bituminous bound broken stone pavements which are almost universally built in park systems are entirely satisfactory for any density of that type of traffic."[3]

Also:—

> "The real urge for concrete roads on the trunk lines, especially in New England and the Middle States, has been because of the rapid increase in numbers of buses and heavy trucks."[4]

It is true that, whereas the bituminous or flexible pavement rises and falls with changes in the subsoil and so adapts itself to changes in contour brought about by climate where the subsoil subsides, the concrete pavement is really a bridge at that point, until climatic conditions have brought the subsoil back to its former level. It is then necessary for the concrete itself to have adequate strength to carry all loads without proper support.

Now, since bituminous flexible pavement can be designed for various densities of light traffic and heavy traffic, it has the following advantages making it less expensive to construct. The minimum thickness is very much less than for concrete, and as traffic increases it can be built up by applying successive layers of surface materials. On the other hand, if concrete is used (and apart from the inaccessibility of bituminous materials, it is only justified for the very heavy traffic) a high minimum strength is required even for light traffic, as Mr. Breed's report states.

> "Cement pavements, on the other hand, have to be built quite substantially even for light traffic for the reason that they are not flexible and therefore will not conform to the subgrade."[5]

But even the minimum thickness necessary to meet climatic conditions is not sufficient to carry the heavy vehicles. Mr. Clifford Older, consulting civil engineer, formerly chief highway engineer of the Illinois State Highway Department, who conducted the "Bates Tests," concludes from his tests that a 4-inch pavement is sufficient to withstand normal natural forces, if used only by passenger automobiles and light trucks. In giving evidence before the Interstate Commerce Commission under I.C.C. Docket 23400 in 1931, he said, in effect:—

> "My conclusion as a result of these tests leads me to the thought and belief that concrete roads constructed sufficient to bear ordinary passenger carrying automobile traffic would not have to be as thick as highways constructed to carry trucks, buses and heavy vehicles."[6]

Another authority of the same opinion is W. S. Downs, consulting highway engineer and Professor of Railway and Highway Engineering at West Virginia University.[7]

Moreover, there are additional features which must be taken into consideration, according to these engineers, in building pavements for the heavier traffic. First, grades must be lower for the heavy traffic than for the light traffic. Further, the width of roadways must be increased to provide for the trucks and buses which are of greater width than the pleasure automobile. Mr. Downs' findings are interesting on this question:—

> "It would appear, therefore, since the average traffic lane is 10 feet wide, that buses and trucks are responsible for the addition of two feet to the width of the average present-day, two-lane highway; but if a sufficient proportion of the present-day traffic consisted of vehicles eight feet wide, two more feet would be necessary."
>
> "If these deductions are sound, then approximately 11 per cent of the width of the highway is chargeable

[1] Paper presented before the Annual General Professional Meeting of The Engineering Institute of Canada, at Hamilton, Ont. on February 6th, 1936, and published in the March, 1936, issue of The Journal.

[2] Economist, Canadian Pacific Railway Company, Montreal.

[3] Report of Charles B. Breed, "Relative Road Costs for Heavy Motor Vehicles as Compared with Automobiles and Light Trucks," November, 1933, p. 2.

[4] Ibid, p. 25.

[5] Ibid, p. 21.

[6] "An Economic Survey of Motor Vehicle Transportation in the U.S.," Bureau of Railway Economics, 1933, p. 79.

[7] See the Report of W. S. Downs, "The Cost of Providing Highways Suitable for Various Classes of Vehicles," 1933.

to a few wide vehicles; and as the wide vehicles increase in number, it will ultimately amount to an increment of 22 per cent.[8]

The additional fact that heavy commercial vehicles necessitate wider and heavier bridges and culverts is usually overlooked, although important from the point of view of cost. The Governor of Virginia, in a statement on the highways of Virginia, said in 1931:—

"I am having an inquiry made as to the cost of replacing the old bridges with modern structures. From present information it appears that it would involve an expense of $10,000,000. These bridges will be built just as rapidly as possible, but it would be manifestly unfair to divert all the road funds to this purpose when, as I have said, the present bridges are adequate for 98 per cent of the traffic, and the modern bridges are imperative solely for the accommodation of the heavy bus and truck traffic."[9]

It is worth noting in passing the effect of multi-axle trucks on bridge stresses. Mr. Downs found that with two rear axles spaced 48 inches apart, bearing the same wheel load as that of a two-axle vehicle with a single rear axle, the maximum stresses on bridges produced with the same wheel load are 60 per cent greater in the case of the multi-axle truck.

Not only does this apply to bridge and culvert costs, but the tendencies of concrete pavement in certain seasons to become a bridge, lend themselves to the suggestion that, while wheel load may be important in determining the effect of the traffic on pavements, yet the effect on concrete pavements may in certain seasons of the year be greatly increased by the multi-axle truck.

Mr. T. H. Macdonald of the U.S. Bureau of Public Roads, in giving evidence under I.C.C. Docket 23400, said that:—

"...the design must be based upon not the load of the wheel itself, but the blow which that wheel delivers to the road in operating over it."[10]

Other highway engineers believe that weight is a much more important factor in considering the effect of traffic on highways, than is impact.[11]

Charles H. Moorefield, chief engineer, State Highway Department of South Carolina, is even more emphatic on this subject:—

"In my judgment, the damage caused our roads by the heavy vehicles is in general out of proportion to the weight of the vehicles; that is, I believe that a 5-ton truck will do more than five times the damage that a 1-ton truck will do, and this belief is based on observation of and experience with the State Highway work in South Caroline."[12]

Even Mr. Macdonald admits that the heavy vehicles necessitate thicker pavement than passenger cars and light trucks. He said that the thinnest slab required for these light vehicles:—

"...would have an edge thickness of 6 inches, 5 inches at the centre, an average thickness of 5½ inches...for the heavier trucks, the four or five-ton, we step up to seven and three-quarter inches (average thickness)."[13]

[8] Ibid, p. 60.

[9] Statement of J. G. Pollard, Governor of Virginia, April 25, 1931, reprinted in "An Economic Survey of Motor Vehicle Transportation in the United States," 1933, p. 80.

[10] Evidence reprinted in "An Economic Survey of Motor Vehicle Transportation in the United States," 1933, p. 78.

[11] See Clifford Older's memorandum on this subject in 1933.

[12] Statement before the South Carolina Railroad Commission, February 4, 1931, reprinted in "An Economic Survey of Motor Vehicle Transportation in the United States," 1933, p. 80.

[13] Testimony before Senate Committee on Interstate Commerce in Hearings on S. 2793, March 7, 1932, pp. 231-2.

What the actual additional cost of the thicker surfaces and more expensive construction required by heavy commercial vehicles amounts to cannot be determined for the country as a whole, because of varying local conditions. Mr. Breed in summing up his investigations, however, found that highways adequate for passenger automobiles and other motor vehicles weighing not in excess of 6,000 pounds gross, or 4,000 pounds per axle, can be constructed and maintained for from one-third to two-thirds of the cost of highways required for vehicles having maximum gross weights ranging from 20,000 to 40,000 pounds, or axle loads of 16,000 to 18,000 pounds. The difference between the one-third and two-thirds is due to local conditions, where materials may or may not be readily available for bituminous pavements. Where bituminous cannot be used, and the minimum rigid concrete pavement is required, the larger figure of two-thirds is applicable.

The fact that there is an important operating saving which accrues principally to the commercial vehicles through the improvement of highways should be considered in relation to the question of the total highway cost which should be borne by them.

Improved highways not only save a great amount of time for users due to the higher speeds of vehicle operation which they make possible, but they also reduce the cost of operating these vehicles to the great benefit of business users of the highways. The effect of these improvements upon truck operating costs was estimated in a transportation survey of the State of Pennsylvania, conducted by the Federal Bureau of Public Roads and the state authorities.

"The average costs of operating the vehicles that compose the traffic are probably not less than 10 cents per vehicle mile for passenger cars and 25 cents per vehicle mile for trucks, and it is estimated by the Pennsylvania Department of Highways that the reduction in these costs made possible by the improvement of the highways, is approximately 2.5 cents per passenger car mile and 5 cents per truck mile..."[14]

Apart altogether from the controversy about the effect of heavy vehicles on highway design, however, the effect of soil and climate is really no argument against assessing the cost of pavements against the motor vehicle, for these are conditions with which we have to contend. One might as well suggest that because the paint on the outside of a business institution deteriorates because of weather conditions, the cost of it should be charged up to the general public; surely, it is the cost of doing business. If the highways must be paved, and above all, because of the heavy vehicle, must be paved by concrete, surely the effect of climate which is much more marked in that case, is part of the cost of providing the highway for that traffic.

II. *Highway costs and their relation to the taxation of motor vehicles.*

There are possibly two matters in Mr. Foster's paper falling under this heading, which warrant some attention. First and most important of these is his denial that motor vehicle transport has been subsidized by providing it with a right-of-way at the expense of taxpayers at large.

The figures used in dealing with this question need close scrutiny to make their true meaning clear. Mr. Foster arrives at the annual cost of highways on the basis of taking the amount of the interest on provincial highway debt, plus the present inadequate sinking fund, and adding it to the cost of maintenance, and uses that as the total cost against which he places the known revenue. He thus arrives at a credit balance for all Canada in favour of the motor vehicle in the following words:—

[14] "The Motor Truck Red Book," 1935, Traffic Publishing Co., New York, p. 22.

> "The margin of provincial highway revenue over current expenditures is in excess of $12,000,000."

There are several reasons why such a conclusion is unwarranted on the basis of the given data:—

(*a*) The figure given for total provincial highway debts outstanding ($462,182,328) does not by any means cover the total cost of our highways. The Dominion Bureau of Statistics report, from which Mr. Foster presumably took his total debt figure, specifically says on the page where this figure is given:—

> "These data do not include any debt or interest payments by rural municipalities which undoubtedly would increase these totals by considerable amounts."[15]

Furthermore, not all of our capital expenditures on highways have been ear-marked. In addition, of course, is the very large investment in city streets, some portion of which can certainly be attributed to the widespread use of motor vehicles. Thus the figure of $462,182,328 covering highway debt grossly understates the country's investment in highways, the carrying charges on which have to be borne by someone.

(*b*) The sinking fund payments as quoted by Mr. Foster ("principal and sinking fund payments of $553,656") are entirely inadequate for even the portion of total debt which is directly traceable to highways. The above mentioned Dominion Bureau of Statistics report specifically states that "payments on principal were made only in the Maritime Provinces and in Alberta and British Columbia."[16] In these provinces this payment only amounted to 0.36 per cent of their combined highway debt, and the provinces which made no principal payments whatever were responsible for 67.4 per cent of the given total highway debt. That is, the principal and sinking fund payments made in 1934 amounted to only 0.12 per cent of the given highway debt.

(*c*) The accuracy of Mr. Foster's maintenance figure of $15,382,969 is questioned. The above mentioned Dominion Bureau of Statistics report gives the total maintenance expense for 1934 (including $1,867,377 for plant and equipment) as $20,881,965.[17] And these maintenance figures, as explained in the Canada Year Book, do not cover all roads:—

> "These expenditures cover only national and provincial highways, secondary highways and other important roads to which the provincial governments contribute, together with the bridges or ferries necessary to such highways. The figures do not include expenditures on roads or streets within urban municipalities nor expenditures by rural municipalities on local roads to which no contribution is made by the provincial governments. Expenditures for both construction and maintenance of municipal roads receiving subsidies are often made over and above the amounts upon which subsidies are granted and these extra expenditures are not included."[18]

There is a further consideration which indicates additional understatement of maintenance costs. This is the fact that of the expenditure made to improve existing highways which is charged to capital, some in effect takes care of the maintenance which would be necessitated on the worn-out inferior highway to be improved.

(*d*) Further items omitted from highway costs are those for policing, inspection and the administration by the various authorities dealing with highway matters.

(*e*) Mr. Foster's revenue figure includes all the revenue derived by governments from highway operations. It is incorrect to label this "provincial revenue" and apply it only against provincial expenditures for highways, since there is no offsetting revenue from highway usage to apply against Dominion and municipal highway expenditures.

In effect, therefore, Mr. Foster's comparison of expenditures and revenues includes all the revenue but only part of the total costs. The figures examined in the above paragraphs apply to the whole of Canada, but the same general criticisms apply to the figures and conclusions regarding Ontario highways as well. Consequently, the conclusion that motor vehicles are paying their way is unsound.

Before leaving the subject of taxation, there is another item to which reference should be made. The railways have not, as Mr. Foster seems to infer, specifically singled out the motor coach and stated that it is not paying its way.

The railways have, however, pointed out that the cost to them of providing their roadbed is between 30 and 40 per cent of their gross revenue. Mr. Foster makes considerable point of the fact that coach operators on the average in Ontario pay approximately 10 per cent of their gross revenue in direct highway taxes. The fallacy of considering this as a tax is, that they get for 10 per cent of their gross revenue something for which the railways as an operating expense have to pay between 30 and 40 per cent of their gross revenue. Therefore, if the cost of the highways which form the roadbed for motor vehicles is not borne by the motor vehicle, and, in addition, if a contribution to the cost of government in the form of a real tax is not made, there is a substantial subsidy in favour of those motor vehicles.

Turning to specific figures, it is believed that there are considerations which lead to the conclusion that the figure of $1,145, quoted by Mr. Foster as the tax bill of a typical coach in Ontario, is very misleading as an indication of the average tax paid by motor coaches or their total contribution to highway revenues, for the following reasons:—

(*a*) The twenty-nine passenger bus is not by any means the average size. In 1931 in Ontario, for instance, 71 per cent of the buses were twenty-one to thirty passenger, 28 per cent were under twenty-one passenger, and 1 per cent over thirty passenger size.[19] In 1934, the Dominion Bureau of Statistics reported 665 intercity buses registered in Ontario.[20] Total registration fees collected were $59,049.[21] Thus the average bus paid $88.80—not $165, as suggested in Mr. Foster's paper. Actually, in the Annual Report of the Department of Highways for Ontario for the fiscal year ending October 31, 1934, seven buses are listed as paying $180 registration fee, 21 paying $165, and 640 paid fees ranging from $10 to $130. The average for all buses was $88.36.

(*b*) Not all coach routes traverse provincial highways—in 1931 almost 20 per cent of total bus mileage per day was on county and other roads. A seat tax of 1½ cent per mile, therefore, is considerably higher than the average paid. Furthermore, this seat tax is not collected on the mileage operated through incorporated municipalities, i.e., it is not collected on anything like the total bus miles operated. As a matter of fact, for one large operating company in Ontario which has a total annual bus mileage in excess of 2,000,000, the cost per bus mile for seat tax was only 0.86 cent, which, because it takes into consideration the mileage for which the tax is not charged, is a more nearly accurate picture of the average tax.

(*c*) Using the same assumptions as Mr. Foster, of 6 miles per gallon and average bus mileage of 40,000 per year (both of which undoubtedly give too large a tax bill for the average bus), we have a gasoline tax of $400 per bus.

---

[15] "The Highway and Motor Vehicle in Canada," 1934, p. 3.
[16] Ibid, p. 3.
[17] "The Highway and Motor Vehicle in Canada," 1934, p. 8.
[18] Canada Year Book, 1934-35, p. 735.

[19] Figures from Ontario Department of Highways.
[20] "The Highway and Motor Vehicle in Canada," 1934, p. 21.
[21] Ibid, p. 31.

(*d*) To arrive at a fair average total cost including all items of taxes, one again turns to the large operating company above referred to. The average cost for all taxes, including general taxes, an item not allowed for by Mr. Foster, in the year 1934-35 was 2.41 cents per bus mile. Applying this to Mr. Foster's average of 40,000 miles per bus, the total taxes paid by this concern would amount to $964, instead of the $1,145 which he infers is an average tax.

Nevertheless, the real test is, what is the total yield in taxes related to the total number of buses producing that yield. The figures for the average registration fees were given above under sub-paragraph (*a*). The average collection as reported by the Dominion Bureau of Statistics for public service vehicle taxes, i.e., the seat tax, amounted to $92,848, and there are reported to have been 665 public vehicles registered, so that the average yield for seat tax was $139.62 per bus. If the figure 0.86 cent per bus mile is generally true, the average total miles per bus would appear to be only 16,235 per annum, and not 40,000 as Mr. Foster infers. It is, of course, true that a number of these buses were doing low mileage in charter business and the like, but it is an average which indicates the total yield. On the Dominion Bureau of Statistics figures, therefore, and accepting Mr. Foster's figure for gasoline tax, the average yield per bus would be $628.42, as against his figure of $1,145.

If one accepts Mr. Foster's average tax of $40 per vehicle as applying to the private autos, the following comparison of taxes on a ton-mile basis is interesting. Assuming the average pleasure automobile weighs 1½ tons and travels 10,000 miles a year (probably considerably high for the average car), of which, say, one-half is on the provincial highways, we have approximately 7,500 ton-miles. On the other hand, a standard 21-passenger bus which is smaller possibly than the average, would weigh about 4½ tons. The addition of an average of 12 passengers at 150 pounds each, would give approximately another ton, or a total weight of about 5½ tons. Assuming 30,000 miles on provincial highways, we have total ton-miles of 165,000, or 22 times the use on a ton-mile basis of the pleasure car. Therefore, the average bus should yield $880 a year on a strictly use basis, without allowing anything for the operating savings resulting from the improved highways, extra damage done to the surface of the roads by the heavier vehicle, the extra cost of building highways for them and no fee for the commercial use, nor any general tax which the average private motor vehicle owner pays in many different ways.

Next, one should consider Mr. Foster's reference to the finding of the Royal Commission on Transport in Great Britain, subsequently endorsed by the Royal Commission in Canada, known as the Duff Commission, in 1932, in both of which it was said that the fair proportion of total highway costs which should be borne by the motor vehicle approximated two-thirds.

The Royal Commission on Transport, which commenced its studies in 1929 and made its final report in 1931, used a figure of £60,000,000, as the annual cost of highways in Great Britain. There is nothing in the report to show accurately how this figure was obtained. When the report of the Conference on Rail and Road Transport (generally referred to as the Salter Report), was issued in July of 1932, much more light was thrown upon it. The cost figure used in this report was also £60,000,000 per annum, and its derivation appears in Appendix "A" of the report. One may, therefore, assume that the basis of the figure used by the Royal Commission was the same as that appearing in the Salter Report. If that is so, and it seems conclusive, the method of arriving at the total cost in the Salter Report is applicable to both.

Upon referring to Appendix "A" of the Salter Report, we find that the £60,000,000 was made up by taking the average of the expenditures on capital and maintenance account for five years, plus the cost of traffic police, etc., and deducting a specified sum labelled as "recoverable expenditure." There are two points which arise in this connection.

(1) Mr. Foster's figures for Canada are not based upon the same elements of cost as were either the Royal Commission Report or the Salter Report.

(2) The Salter Report is at variance with that of the Royal Commission on the question as to what proportion of the total cost of £60,000,000 a year should be assessed against the motor vehicles.

It was to avoid all of the difficulties involved in arriving at total investment in highways and at the same time to arrive at a true picture of the annual cost of highways that the method adopted in the Salter Report was used. Such troublesome questions as what properly constitutes maintenance and what should be capital expenditure, as well as the almost impossible task of determining in advance, without accurate data either as to the character or amount of the traffic to be using a particular highway, what its life should be for sinking fund purposes, were eliminated in this report, where the annual capital charges plus maintenance, police and administration charges were taken as total costs. Therefore, it appears that when Mr. Foster endorses the two-thirds principle found by the Royal Commission, he must also be taken to have endorsed the method used in arriving at the total cost. On this basis, the average cost of capital and maintenance upon highways in Canada for the five years ending 1934 amounted to $71,759,040, and the average revenue for the same period was $46,183,330 per annum. Applying the two-thirds principle to this figure of cost, we find two-thirds of the five-year average cost figure for the whole of Canada amounted to about $48,000,000 per year, so that even on Mr. Foster's basis, there was a deficit for all Canada of something like $2,000,000 per year. When one adds to this a fair proportion of the road cost of municipalities and the substantial cost of administering and policing the highways, one is forced to the conclusion that the deficit is large.

As applied to Ontario, the average cost on this basis for the same five years was $31,514,820, and the average revenue $19,328,197. Two-thirds of the average cost is therefore something in excess of $21,000,000 per annum, as against the average annual revenue of $19,328,197, or a deficit of nearly $1,700,000 per annum.

As to the second point, in which reference is made to variation between the Salter Report and that of the Royal Commission, it should be pointed out that whereas the Royal Commission was making a study of the whole subject of control and co-ordination of transport, the Salter Report was directed to one particular problem, namely, the incidence of highway costs in relation to the contributions of the different classes of mechanically-propelled vehicles, and the nature and extent of the regulation in view of modern developments which should be applied to goods transport by road and rail. At the Salter Conference, besides the Chairman, Sir Arthur Salter, there were eight others, four of whom were railway representatives and the other four, representatives of goods transport by road. It is significant that this report was unanimously adopted and signed by all of the representatives, including those of highway transport. So that when the Salter Report is found to be at variance with that of the Royal Commission on the particular study to which it refers, one would expect that inasmuch as it was confined to that particular question and was unanimously endorsed by the highway representatives, it was a much more effective determination of a controversial subject than that of the Royal Commission which dealt with highway costs as an incident only to a much broader report. The Salter Report found that the total cost of £60,000,000 per year should be assessed against the motor vehicles; not two-thirds of this as previously recommended by the Royal Commission. The basis of their finding is most interesting.

One of the greatest problems which meets the student of this subject is what allowance is to be made for that use of the highways to which in the past the public was entitled, and which uses continue despite the advent of the motor vehicle. Such uses are access to property by pedestrians, bicycles, horse-drawn traffic, the movement of troops, telegraph and telephone poles, water, drainage and gas pipes, tramways and the like, all of which may be conveniently described as community uses. The Salter Report found the answer to this question in the fact that in the past there had been developed a network of highways upon which there had been expended for permanent right-of-way large sums of money, and upon which certain foundation, drainage and other work of a permanent nature had already been done. This was described as the "legacy from the past," and their difficulty was properly to assess the value of that legacy, some of the cost of which was still being paid for and for many years will continue to be paid for, until all of the outstanding bonds have been retired.

The Salter Commission came to the conclusion that as neither of them could be accurately assessed, it seemed reasonable that community uses and the permanent legacy from the past might very well be taken to balance each other, and in the result, therefore, these two items were set off, and highway costs as found do not include either of them, but rather the average of the current expenditures. Now, if the Salter basis of 100 per cent of these costs were applied to Canada, the figures given previously of about $72,000,000 as an average expenditure for the last five years and the average revenue of something over $46,000,000, would show an annual deficit in Canada which is, in effect, a subsidy in favour of the motor vehicle user of no less than $26,000,000 per year, and in the province of Ontario, a deficit of more than $12,000,000.

As previously explained, these are not all the costs. Municipal streets and roadways, policing, administration and the like are not included. It seems, therefore, that the statement that the commercial motor vehicle is not subsidized by the taxpayer of this country is unjustified.

III. *The relation of highway passenger transport to railway passenger services.*

One might heartily agree with Mr. Foster's statement that "rail and motor coach passenger services are almost entirely supplementary, rather than antagonistic," if he were speaking of the relationship that should hold true, rather than that which exists at present. It is difficult to see how these services can avoid being antagonistic under present conditions, however, where almost every mile of railway line in inhabited sections is paralleled by bus routes.

Mr. Foster becomes greatly exercised over his allegation that someone (presumably the railways) desire "punitive restriction by legislation" of motor coach services which is "designed to assist the railway." Surely the railways have enough commonsense to realize that an economically justifiable agency of transport cannot be artificially restrained from developing to its rightful position, if for no other reason than that the past experience of the railways themselves when they replaced the stagecoach and canal barge shows this to be true. Consequently, the railways have not based any of their arguments for regulation upon the amount of traffic lost to buses, except to emphasize that insofar as the traffic loss is due to unfair competition which can be remedied by regulation, it is reasonable to ask for that regulation.

In concluding, Mr. Foster makes a plea for co-ordination in the following words:—

> "Is not, then, the answer to the railway passenger problem to be found in a more efficient co-ordination of rail and highway passenger services? Wherever short-haul rail passenger service is unprofitable and wherever it interferes with the speedy and efficient handling of long-haul business, should not there be a definite integration of coach and train operations?"

With this the writer hastens to agree, but it is doubtful whether Mr. Foster realizes that the railways have gone a great deal further in this way than have the motor bus companies.

In England, the railways have taken up to 50 per cent interest in a number of the stronger and better operated bus companies, and have co-ordinated their activities with the railway services, through staggered schedules, inter-availability of tickets and the like. In the United States, a number of the railways have likewise taken an interest in some of the outstanding highway passenger enterprises. As an example, out of the thirteen affiliated Greyhound Companies, operating over 46,000 route miles, the railways are interested to varying extents, and average about 50 per cent ownership in six of the companies which operate well over half of the total mileage.

In 1935, the Greyhound operating companies together showed a total revenue of about $38,000,000, 75 per cent of which was obtained by those companies in which the railways had an interest. Total net profits amounted to about $8,000,000, nearly 79 per cent of which came from the companies connected with the railways. This is direct evidence of the very active interest which the United States railways are taking in highway passenger transport co-ordination.

Conditions are somewhat different in this country from those existing in the United States or England, and it may be that some time will elapse before sufficient stability has been reached in the industry in Canada to warrant extensive railway participation in such operations. The point, nevertheless, is still sound that where co-ordination has taken place, it has taken place by virtue of railway initiative and not by action on the part of highway operators themselves. Mr. Foster's plea, therefore, seems to be lip service to an accepted principle rather than an attempt to suggest a means by which the end which he seeks can be accomplished in practice.

There would appear to be no reason, for instance, why applications for permits should in practically all cases cover areas directly parallel to railways, where good railway service is available. Neither does it appear to have been the policy on the part of motor coach operators to arrange their schedules or attempt to provide interline ticket arrangements with railway services.

The arguments of the railways, as they have been recently presented, will bear the closest possible scrutiny, when measured by the analysis upon which this discussion has been based. On the other hand, while there has been much general appearance of agreement on the part of motor vehicle operators as to principle, yet when their expressions are subjected to analysis, they do not offer a constructive solution, nor do they indicate either a complete understanding of the railways' position, nor a willingness to concede that they and the railways have many interests in common.

THE
ENGINEERING JOURNAL
THE JOURNAL OF
THE ENGINEERING INSTITUTE
OF CANADA

VOLUME XIX SEPTEMBER 1936 No. 9

The Third World Power Conference 1936

The Third World Power Conference which commences its sessions in Washington on September 7th is of special interest as being the first of these conferences to which the invitations have been issued by a national government.

The first plenary meeting of the World Power Conference was held in London in 1924; the second in Berlin in 1930 and the third is being held this year in Washington, at the invitation of the President of the United States. Sectional meetings of more limited scope have also been held in Basle, London, Barcelona, Tokio and Stockholm.

Under the auspices of the World Power Conference, the International Commission on Large Dams has been organized and its Second Congress will be held in Washington concurrently with the Third World Power Conference.

The First and Second World Power Conferences were attended by delegates representing national, technical and engineering organizations. The Third World Power Conference has as its official members delegates accredited by the governments of some fifty countries. Its membership also includes a large number of engineers and scientific men interested in the subjects under discussion who are attending in unofficial capacities. It is expected that some seven hundred official members will be present from Europe alone, and some three thousand altogether may be in attendance in Washington. English, French, German and Spanish will be the official languages at the Conference.

This Conference, the first to be held in America, is noteworthy as the first to stress the economic, rather than the technical problems of power. The decision to feature this aspect of the power problem has been due, in a considerable degree, to the widespread feeling that our economic and social progress has lagged behind our technological development. Thus, the general topic of the Washington Conference will be National Power Economy, which will be discussed in relation to its physical and statistical basis; its technical, economic and social trends; the relation thereto of the fuel-producing, processing and distribution industries, and of electric and gas utilities; methods of public regulation; national and regional planning of power development and use; conservation of fuel and water resources; rationalization of the distribution of gas and electricity; and national power and resources policies.

But the technical aspects of power production and utilization will by no means be neglected. In the first place, the programme of the Second Congress on Large Dams will be strictly technical. It includes such topics as the study of special cements for water-retaining structures, the design and waterproofing of expansion joints, geotechnical studies of foundation materials and the stability of dams.

Then, in addition to the formal sessions of the Conference, there will be a valuable supplemental technical programme in connection with a series of study tours, which will be led by experts, and have been planned to deal with special technical problems of interest to various groups of delegates.

During the tours the public utilities of New York, the General Electric and Westinghouse factories, the steel mills of Pittsburgh, Detroit's automobile factories, the great dams of the west, the San Francisco bridges and the Tennessee Valley will be visited. As the tours move from city to city, data will be collected, and at the end of each tour a carefully planned round table discussion will be held comparing American and foreign methods and theories. The subjects of the tours cover respectively, mineral sources of energy; hydraulic sources of energy; metropolitan areas' utilities; railroad transport and major construction projects.

The plan of paper presentation is to have each participating country submit one or more papers on each of the programme topics with which it has any concern. These papers are being condensed into reports to be presented at the conference by official reporters, to be followed by open discussion. These papers and reports are placed in the hands of members of the Conference well in advance of the meeting.

Effective Canadian participation in the Third World Power Conference is assured. The Canadian Committee, under the chairmanship of Dr. Charles Camsell, M.E.I.C., Deputy Minister of Mines, has arranged for the presentation of a number of authoritative Canadian papers in accordance with the programme of the American National Committee. Arrangements are also being made for the attendance as official delegates of engineers prominent in the field of power and power resources in the Dominion. In addition to the official delegates it is expected that a large number of Canadians will be present as members of the conference.

The presiding officer of this international gathering has no easy task, and it is fortunate that Dr. William Durand is available to act as chairman of the Third World Power Conference meetings. Dr. Durand is Professor Emeritus of Mechanical Engineering at Stanford University, California; is a scientist and engineer of world-wide repute, the author of numerous books on engineering, particularly as regards means of transport by air and water, and rendered valuable technical services to his government during the war. He will make his address of welcome in the four official languages of the Conference.

At the time of writing some fifty countries have announced participation in the Conference, which will therefore bring to the United States a group of distinguished scientists, engineers, industrialists and economists from all parts of the world. This great gathering has been sponsored and financed jointly by the private electrical industry and the Government of the United States, whose joint contributions towards its expenses amount to nearly $200,000. The scale on which preparations have been made will be evident from the fact that the official banquet to be held in Washington on September 10th will take place in the Union Station, the only place in the city large enough to house it. The main waiting room of the station will be redecorated and converted into a banquet hall, in which provision is being made for the probable attendance of three thousand people at the largest dinner party Washington has ever seen.

Previous to the Conference, the American National Committee, with the approval of the National Executive Council, prepared and sent to the other National Committees an official programme sketching in considerable detail a proposed series of thirteen papers, and suggesting the method of treatment for each subject. In doing this the committee's purpose was to secure such uniformity of presentation, particularly as regards statistical data, as is needed to make the papers from different countries readily comparable. The hope was expressed that the ensuing discussions will "point the way to wider and wiser distribution and use of power" and "pool the experience and knowledge of the world on this subject." Accordingly it is expected that the papers from the various countries, while treating of the same subjects from different standpoints, will lend themselves to the analysis to which they will be subjected by the "reporter" who condenses them in preparation for discussion.

Some of the topics outlined by the committee may bring up questions of national policy which in some countries are already matters of controversy and even political dispute. The Conference, however, will afford an unequalled opportunity for debate in which personal or local prejudices will be laid aside. It is, in fact, the desire of those promoting the Conference that it shall be conducted as an "international forum where all sides of the questions growing up around public and private power policies can be presented to the entire world on a basis of frank discussion without personalities, politics or propaganda." This is a high objective; in striving to reach it the delegates from the nations of the world will be giving an example of co-operative effort for the benefit of mankind, which might well be followed elsewhere in respect to other and even more important aims.

Committee on Consolidation

Report for August, 1936

The twenty-first meeting of the Committee on Consolidation was convened at 9.30 a.m. on August 21st, 1936, and continued throughout the day, adjourning at 11.30 p.m.

This was a plenary meeting of the Committee, and there was present Messrs. J. B. Challies, M.E.I.C., A. B. Crealock, M.E.I.C., G. J. Desbarats, M.E.I.C., R. E. Jamieson, M.E.I.C., C. C. Kirby, M.E.I.C., O. O. Lefebvre, M.E.I.C., R. F. Legget, A.M.E.I.C., and G. McL. Pitts, A.M.E.I.C.

The Committee considered revisions to the by-laws of The Institute necessary to effect closer co-operation between The Institute and the various Provincial Professional Associations and Corporation, and tentatively approved certain amendments calculated to achieve this end. The Committee also prepared for the consideration of Council amendments to certain other sections of the by-laws which, in its opinion, it would be in the interest of The Institute to incorporate at this time.

The Committee requested a joint meeting with the Council to consider the proposed amendments in detail. This meeting has been called for September eighteenth.

It is hoped that the proposed revisions to the By-laws may be made available to the general membership at an early date in order that they may have an opportunity of considering the same well in advance of the discussions which will take place at the Annual Meeting of 1937.

Gordon McL. Pitts,
Chairman.

Semi-Centennial of The Institute

In June 1937 The Engineering Institute of Canada will celebrate the fiftieth anniversary of its incorporation. Council has decided that this occasion should be marked in a fitting manner, and with this in view has appointed a Semi-Centennial Committee consisting of the following members:

R. L. Dobbin, M.E.I.C.
A. Cousineau, A.M.E.I.C.
F. S. B. Heward, A.M.E.I.C.
R. Findlay, M.E.I.C.
J. L. Busfield, M.E.I.C., *Chairman.*

J. L. Busfield, M.E.I.C.

The dates, June 15th to 18th inclusive, have been selected as the most suitable for the principal functions which are to be held in Montreal and Ottawa.

The Committee is now actively engaged on the preparation of an attractive programme, and the October issue of The Journal will contain an announcement with full particulars.

Canada and the Third World Power Conference

The official Canadian delegation to the Third World Power Conference and the Second Congress on Large Dams to be held in Washington, D.C., on September 7th to 12th, 1936, will be headed by Charles Camsell, C.M.G., LL.D., M.E.I.C., Deputy Minister of Mines, and will consist of the following gentlemen: E. A. Cleveland, LL.D., M.E.I.C., President of The Engineering Institute of Canada, and Chief Commissioner, Greater Vancouver Water District, and Chairman of the Vancouver and Districts Joint Sewerage and Drainage Board, Vancouver, B.C., Julian C. Smith, LL.D., M.E.I.C., President, Shawinigan Water and Power Company, Montreal; J. T. Johnston, M.E.I.C., Director, Dominion Water Power and Hydrometric Bureau, Department of the Interior, Ottawa; T. H. Hogg, D.Eng., M.E.I.C., Chief Hydraulic Engineer, Hydro-Electric Power Commission of Ontario, Toronto; O. O. Lefebvre, D.Sc., M.E.I.C., Vice-Chairman, Quebec Electricity Commission, Montreal; Hon. A. S. MacMillan, Chairman, Nova Scotia Power Commission, Halifax; G. Gordon Gale, M.E.I.C., President, Gatineau Power Company, Ottawa; J. B. Challies, M.E.I.C., Manager, Water Resources Department, Shawinigan Water and Power Company, Montreal, and John Murphy, M.E.I.C., Electrical Engineer, Department of Railways and Canals, Ottawa.

It is expected that a large number of Canadians will go to Washington to attend this Conference, where they will meet nearly three thousand engineers, scientists and industrialists who have come from abroad to discuss the World's power problems.

An exceptional honour has been conferred on Dr. A. Surveyer, M.E.I.C., consulting engineer, Montreal, a Past-President of The Institute, who is to be one of three engineers who will speak just prior to President Roosevelt's address on Friday, September 11th. Dr. Surveyer will speak in French, his subject being "Power and Social Problems."

For three days following the Conference, Canada will have the privilege of welcoming some 300 of the foreign and American delegates to the Dominion. This has been made possible through the joint co-operation of the

Dr. Charles Camsell, M.E.I.C.

American National Committee and the Canadian National Committee, and is an opportunity greatly appreciated by all Canadian engineers. A special tour has been arranged which will visit some of the major power projects in the Dominion in the vicinity of Montreal, Ottawa, and Niagara Falls, Ontario.

This visit is summarized as follows:—

Tuesday, September 15th, 1936.

E.S.T.

7.00 a.m. The tours train containing those participating in tours Nos. II and V will arrive from New York at Windsor Station, Montreal.

7.45 a.m. The Shawinigan special train will leave Windsor Station on an excursion to the St. Maurice River Valley. This complimentary excursion is being tendered by the Shawinigan Water and Power Company. The hydro-electric stations at La Gabelle, Shawinigan Falls, Grand'Mere and Rapide Blanc will be visited.

The train will arrive back at Windsor Station about 6.00 p.m.

9.00 a.m. Arrangements have been made for a visit to the hydro-electric development of the Beauharnois Light, Heat and Power Company at Beauharnois. This complimentary trip is being tendered by the Company. Buses to conduct those who desire to visit the development will leave the Windsor Hotel, arriving back at the Hotel about 4.00 p.m. Luncheon will be furnished at Beauharnois.

7.00 p.m. The tours parties will be guests of the Provincial Government of Quebec at a reception and dinner at which the Prime Minister of the Province or a member of his cabinet will attend.

11.00 p.m. Train departs from Windsor Station, Montreal, for Ottawa.

Wednesday, September 16th, 1936.

6.45 a.m. Train arrives at the Union Station, Ottawa. Breakfast at Chateau Laurier Hotel.

8.45 a.m. Parties will be taken by special train provided by the Gatineau Power Company to visit three of its hydro-electric stations on the Gatineau river.

Lunch will be served at the Paugan plant and the train will then leave for the Chelsea and Farmers developments.

Those not taking the excursion to the Gatineau Valley will be free in the morning to visit points of interest in the city. Luncheon will be taken at the Chateau Laurier Hotel at 12.30 p.m.

1.45 p.m. Complimentary motor bus tour leaves Chateau Laurier to include points of interest in Ottawa and environs with afternoon tea served en route. Returns to Chateau Laurier about 5.00 p.m.

4.55 p.m. Arrive at Union Station, Ottawa, from tour.

6.30 p.m. The tours parties will be the guests of the Canadian Government at dinner at the Chateau Laurier Hotel. The Rt. Hon. the Prime Minister of Canada or a member of his cabinet will preside.

11.05 p.m. Train leaves Ottawa for Niagara Falls, Ont.

Thursday, September 17th, 1936.

9.00 a.m. Arrive at Niagara Falls. Breakfast on the train.

The visitors will be conveyed by buses to view the Falls and the power developments on the Canadian side of the Niagara river.

Following the visits, the tours parties will be the guests of the Hydro-Electric Power Commission of Ontario at luncheon where a representative of the Government of the Province of Ontario will formally welcome the visitors. Following the luncheon the tours parties will be conveyed by buses to Niagara Falls, N.Y.

At Niagara Falls, N.Y., the delegates will be able to attend the Niagara Falls Meeting of the American Society of Mechanical Engineers, which is being held there on September 17th to 19th, and to which members of The Engineering Institute have been invited by the Council of the A.S.M.E. An outline of the programme of this meeting was contained in the August issue of The Engineering Journal, and full particulars have been sent to those members of The Institute resident in Ontario and Montreal. John Murphy, M.E.I.C., chairman of The Institute's Committee on Relations with National Societies, and a past member of Council, will represent The Institute at the dinner to be held on Thursday, September 17th.

OBITUARIES

Moses Burpee, M.E.I.C.

Deep regret is expressed in placing on record the death at Houlton, Me., on August 18th, 1936, of Moses Burpee, M.E.I.C., a member of The Institute of many years standing.

Mr. Burpee was born at Sheffield, N.B., on February 25th, 1847. After graduation from the Sheffield Grammar School in 1865, he spent about three years in Philadelphia, and returning to New Brunswick in 1868 was engaged as a rodman on the construction work of the Fredericton Railway, now the Fredericton branch of the Canadian Pacific Railway. In 1870 and 1871 Mr. Burpee was on the engineer's staff constructing a railway branch from Fairville to Carleton, and in 1871 he was on the construction of the Prince Edward Island Railway. In 1872-1877 Mr. Burpee was transitman on surveys for the New Brunswick Railway as well as assistant engineer in charge of surveys. In 1879 he joined the staff of the draughting office of the Chicago and St. Paul Railway and remained with that company until 1883, when he returned to Canada, and was with the Canadian Pacific Railway on the line from Maple Creek to the base of the Rocky Mountains. In 1884 Mr. Burpee made a survey of the Central Railway of New Brunswick (Norton to Chipman) and then joined the New Brunswick Railway as engineer at McAdam. In 1887 he became chief engineer of the New Brunswick Railway and remained with that organization until 1891 when it was taken over by the Canadian Pacific Railway Company. Mr. Burpee later became chief engineer of the Bangor and Aroostook Railway, Houlton, Me., and held that position until 1927 when he became consulting engineer for the railway.

Mr. Burpee joined The Institute (then the Canadian Society of Civil Engineers) as a member on February 27th 1890, and was made a life member on August 27th, 1923.

Douglas Elliott McIntosh, S.E.I.C.

It is with deep regret that we place on record the untimely death, in an aeroplane crash in Egypt on July 8th, 1936, of Captain Douglas Elliott McIntosh, S.E.I.C.

Captain McIntosh was born at Esquimalt, B.C., on January 27th, 1909, and attended the Oak Bay High School in Victoria, B.C. He graduated from the Royal Military College, Kingston, in 1930, and from McGill ûniversity with the degree of B.Eng. in 1933. In 1932 Captain McIntosh was with the Royal Canadian Signals at Camp Borden with the rank of lieutenant, and in 1933 he joined the permanent forces of Canada, Department of National Defence. In October, 1935, Captain McIntosh went to England on exchange duty, and two months later was sent to Egypt, being with the 5th Divisional Signals, stationed at Alexandria.

Seven men, including Captain McIntosh, were killed, when a Royal Air Force troop-carrying plane crashed in landing after night manoeuvres.

Frederick Thomson, M.E.I.C.

Members of The Institute will learn with regret of the death at Montreal on August 8th, 1936, of Frederick Thomson, M.E.I.C., a member of many years standing.

Mr. Thomson was born at Manchester, England, on March 9th, 1855, and came to Philadelphia, Pa., at an early age. He was a member of the Franklin Institute in 1878-1880, and attended lectures regularly. From his early youth Mr. Thomson showed a keen aptitude for mechanics and electricity, and assisted his brother, Dr. Elihu Thomson, one of the organizers of the Thomson-Houston Company, in many of his experiments on dynamo machines and general electrical appliances. In 1881-1883 Mr. Thomson was electrician for the Philadelphia branch of the Thomson-Houston Company, and in 1883 came to Montreal as electrician for the Thomson-Houston Company of Canada. When this company became the Royal Electric Company, Mr. Thomson remained in the position of chief electrician. In 1893 he went into business for himself under the name of Fred. Thomson and Company, and remained president of this company until the time of his death.

Mr. Thomson was one of the first to project the idea of the power transmission line from Montmorency to Quebec City, and also prepared the original plans for the line from Chambly to Montreal. He experimented in the building of electric motors for street cars, and in 1892 installed the first trolley line in Montreal, ran the first electric car and instructed the first motormen. He also constructed the condensers, transformers, etc., for the first Marconi station at Glace Bay, N.S.

Mr. Thomson joined The Institute (then the Canadian Society of Civil Engineers) as a Member on December 19th, 1889.

PERSONALS

H. M. Bailey, A.M.E.I.C., formerly town engineer of Melville, Sask., has been appointed city engineer of Yorkton, Sask. Mr. Bailey was at one time superintendent of Public Works and Utilities for the town of Melfort, Sask.

T. W. Lazenby, A.M.E.I.C., is now chief draughtsman with the Vancouver Engineering Works Limited, Vancouver, B.C. Mr. Lazenby was formerly with the Department of Justice at Kingston Penetentiary, Kingston, Ont.

Alf. S. Mansbridge, A.M.E.I.C., has resigned from the Pacific Mills Limited, at Ocean Falls, B.C., to accept a position in the engineering department of the Consolidated Mining and Smelting Company at Tadanac, B.C.

W. J. Lecky, S.E.I.C., is now assistant superintendent of the Sigma Mines Limited, at Bourlamaque, Que. Mr. Lecky graduated from McGill University in 1932 with the degree of B.Eng., and was subsequently with Noranda Mines Limited at Noranda, Que. He was later on the staff of the Howey Gold Mines, at Red Lake, Ontario, and more recently with Holman Machines Limited, at Noranda, Que.

H. Lloyd Johnston, Jr., A.M.E.I.C., has joined the staff of Canadian Industries Limited, Montreal. Mr. Johnston graduated from McGill University in 1927 with the degree of B.Sc., and in the same year became connected with the Canada Power and Paper Corporation as engineer in charge of building construction, estimator, etc. In 1928 he was designing engineer, and from that time until accepting his present position he was plant engineer for the same company at Windsor Mills, Que.

J. F. Cunningham, A.M.E.I.C., who has for the past twelve years been in charge of commercial testing in the Department of Civil and Mechanical Laboratories of the University of Manitoba, Winnipeg, Man., has resigned to accept the appointment of senior inspector of dredges, Department of Public Works, Canada, in Manitoba, Saskatchewan, and Alberta. Mr. Cunningham takes a keen and active interest in Institute affairs, and is Secretary-Treasurer of the Winnipeg Branch.

G. H. Duggan, M.E.I.C., has resigned as president and managing director of the Dominion Bridge Company, and as president of Dominion Engineering Works, having held the former offices since 1919 and the latter since 1920.

G. H. Duggan, M.E.I.C.

Mr. Duggan now becomes Chairman of the Board, and will remain on the Executive.

Over a period of many years Mr. Duggan, who is a Past-President of The Engineering Institute, has occupied a position of prominence in the Dominion's engineering field, and has been personally responsible for many major structural achievements. He has also enjoyed a wide interest in Canadian industry generally and in finance. Mr. Duggan is a director and vice-president of the Royal Bank of Canada, and includes among his wide range of directorates Dominion Steel and Coal Corporation, Eastern Canada Steel and Iron Works, Steel Company of Canada, Shawinigan Water and Power, and the Montreal Trust Company.

G. Douglas Sauer, A.M.E.I.C., is now connected with the hydraulic department of the Phoenix Engineering Corporation, New York, N.Y. Mr. Sauer graduated from McGill University in 1931 with the degree of B.Sc., and following graduation joined the staff of the Beauharnois Construction Company and remained with that company until 1934 when he became designer on river control works and miscellaneous structures with the Beauharnois Light Heat and Power Company. He was later with the U.S. Engineer Office at Eastport, Maine.

C. V. Von Abo, A.M.E.I.C., who is connected with the South African Railways, is now system engineer at Pretoria, being in charge of all engineering work on the Eastern Transvaal system. Mr. Von Abo received the degrees of B.Sc. and M.A. from the University of Cape Town, and in 1922 that of Ph.D. in civil engineering from McGill University. In 1923-1925 he was lecturer in mechanical engineering and mathematics at Cape Technical College, Capetown, S.A., and in June 1925 joined the staff of the South African Railways and Harbours as assistant engineer in the chief civil engineer's department. In 1927 he became research engineer in the same department, and from 1928 to 1929 was research engineer and assistant chief draughtsman, later being appointed research engineer and district engineer (bridges). In 1935 Mr. Von Abo was sent to Durban as district engineer in charge of all permanent way, buildings, water supplies, etc., and in June of this year received his present appointment.

W. F. Angus, M.E.I.C., has been appointed president and managing director of the Dominion Bridge Company, and president of Dominion Engineering Works, succeeding G. H. Duggan, M.E.I.C., who has resigned from those offices.

Mr. Angus graduated from McGill University with the degree of B.Sc. in 1896, and in the same year was draughtsman and engineer with the Dominion Bridge Company. In 1897-99 he was chemist and metallurgist with the Canada Switch and Spring Company, later joining the staff of the Montreal Steel Works, of which organization he became general manager, and subsequently vice-president and managing director. The company after many years of successful operation was taken over by Canadian Steel Foundries, a subsidiary of Canadian Car and Foundry Company; Mr. Angus is vice-president and a director of both companies. He has been vice-president of the Dominion Bridge Company since 1916, and vice-president of the Dominion Engineering Works since 1920, and numbers among other of his directorates the Bell Telephone Company of Canada, the Royal Bank of Canada, the Canadian Locomotive Company, Northern Electric Company and the Foundation Company of Canada.

Research Committee on Urbanism

A copy of the interim report to the National Resources Committee, by the Research Committee on Urbanism, Washington, D.C., has been received.

This preliminary report, which has been developed during the last few months by a sub-committee under the chairmanship of Clarence Dykstra of Cincinnati, contains (1) a brief statement concerning the emergence of urban problems, (2) an analysis of the trends in the reporting of urban information by Federal agencies, (3) the conclusions and recommendations of the Research Committee on Urbanism pertaining to such reporting, and (4) as appendices, a suggested topical outline of subjects to be covered under an adequate programme of reporting urban affairs and a suggested minimum schedule of data not now available required for an adequate study of certain major urban problems.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Canadian Institute of Surveying: Proceedings 29th Annual Meeting, 1936.

Institution of Mechanical Engineers: Proceedings, vol. 131, 1935.

Reports, etc.

Quebec Harbour Commissioners: Report, year 1935.

Canada, Dept. of Mines, Mines Branch: Canadian Mineral Industry in 1935.

Technical Books, etc.

Psychrometric Notes and Tables, Elmer Torok. (*North American Rayon Corporation.*)

A Universal Stress Sag Chart, J. T. Hattingh. (*Blackie and Son Ltd.*)

Analysis and Design of Steel Structures, A. H. Fuller and Frank Kerches. (*D. Van Nostrand Co. Inc.*)

Blasters' Handbook. (*Canadian Industries Limited.*)

National Directory of the Canadian Pulp and Paper Industries, 1936. (*National Business Publications.*)

BULLETINS

Water Meters.—The Worthington-Gamon Meter Company, Harrison, N.J., have issued a four-page leaflet illustrating, and giving capacity, dimensions and weights of their meters for cold water services, disc type, turbine type, and compound type.

Pumps.—A four-page leaflet received from the Worthington Pump and Machinery Corporation, Harrison, N.J., give data, including sizes and capacities and specifications for the Worthington Horizontal simplex air and steam heating vacuum, pumps, types AE and AF.

Heating Equipment.—Worthington locomotive feedwater heating equipment, type SA is described and illustrated in a four-page pamphlet received from the Worthington Pump and Machinery Corporation, Harrison, N.J.

Motor Blowers.—Canadian Ingersoll-Rand Co., Montreal, have issued a 14-page booklet which contains a complete description of the company's "Motor Blower" for cupola blowing, with particular emphasis on its constant air-weight control. The booklet also contains technical material and an article entitled "Modern Theory and Practise in Cupola Blowing," by H. V. Crawford.

Seamless Steel.—A 28-page catalogue issued by Seamless Steel Equipment Corporation, New York, contains information regarding the various manufacturing processes and illustrates numerous high pressure seamless steel vessels of special design. Tables of the standard sizes of seamless steel containers and seamless steel square and rectangular tubes are listed.

List of New and Revised British Standard Specifications

(Issued during June, 1936).

B.S.S. No.

156—1936. *Enamelled High-Conductivity Annealed Copper Wire.* (Revision.)
The method of carrying out the pinhole test (electrical test) has been revised in the light of recent investigations.

168—1936. *Electrical Performance of Industrial Motors and Generators with Class A Insulation.* (Revision.)
Includes new Sections on tolerances, speeds and horsepowers.

231—1936. *Pressboard for Electrical Purposes (excluding "Built-Up" Pressboard).* (Revision.)
Applies to materials marketed as pressboard, presspahn or fuller-board, and supplied in a non-impregnated form suitable for electrical purposes.

679—1936. *Protective Glass for Welding and other Industrial Purposes.*
Provides for five grades of glass of varying density to cover the different radiation intensities encountered in welding operations. The optical requirements to ensure the elimination of radiation to a harmful degree are specified. A further grade of glass for the protection of ancillary workers is given in an Appendix.

Copies of the new specifications may be obtained from the Publications Department, British Standards Institution, 28 Victoria Street, London, S.W.1, and from the Canadian Engineering Standards Association, 79 Sussex Street, Ottawa, Ontario.

Annual Meeting of Highway Research Board

The Sixteenth Annual Meeting of the Highway Research Board of the National Research Council will be held in Washington, D.C., on November 18th to 20th, 1936.

BOOK REVIEWS

Alternating Current Machines

By A. F. Puchstein and T. C. Lloyd. John Wiley and Sons, New York (Renouf Publishing Company, Montreal), 1936. 6 by 9¼ inches, 582 pages. $5.00. Cloth.

Reviewed by Professor A. F. Baird, m.e.i.c.*

In spite of the many books available on this subject, this book is a distinct addition to the literature of this field. So many texts start out to give a comprehensive view of alternating current machinery, but become so involved with details of design, and points of interest to the author alone, that the major and important sections are often curtailed. This book gives a straightforward discussion of the generators of alternating current—the synchronous generator and transformer—and then takes up the machines to which such currents are applied—induction motors, synchronous motors, repulsion and series motors, rectifiers and synchronous converters. The book is not difficult and is, as the authors state, a book suitable for undergraduate reading. It can be easily followed by anyone with a good background in electricity and magnetism. It contains no difficult mathematics and is written in a clear and interesting style. One feature of very great value to the reviewer's mind, is the generous insertion of references, and the excellent bibliography enables one to follow up any subject in more detail than is possible in a book of this scope. It should be of interest to anyone in need of a good working knowledge of applied alternating currents.

**Electrical Engineering Department, University of New Brunswick, Fredericton, N.B.*

Empire Development and Proposals for the Establishment of an Empire Development Board

By Sir Robert Hadfield, Bart. Chapman and Hall Limited, London, 1935. 6¼ x 9¾ inches. 78 pages. Cloth. 2s. 6d.

Reviewed by Lesslie R. Thomson m.e.i.c.*

The name of the author of this work is one that commands the respect of all engineers. Sir Robert Hadfield's contributions to the advances made in the art and science of steel manufacture are so noteworthy as to need no comment.

The purpose of this brief booklet is well set out by quoting part of its opening sentence "to help on the great work of securing a systematic and co-ordinated development of the vast resources and opportunities of the British Empire by the foundation of a central body—an Empire Development Board—which should correlate and supplement the efforts which are already being exerted by individual citizens, business organizations and public bodies in all parts of the Empire." For many years Sir Robert Hadfield has espoused vigorously the policy of such an Imperial Board, and as a direct result it is of interest to Canadian engineers to know that the Council of the Institution of Civil Engineers of Great Britain has decided to take an early opportunity to press upon the British Government the necessity of undertaking energetic measures for the economic and technical development of overseas' resources. Indeed one of the striking features of this booklet is Sir Robert's suggestion that, due to inevitable slownesses of all governmental actions, the Empire Development Board might be initiated by the Institution of Civil Engineers!

In developing his plea for the establishment of an Empire Development Board, Sir Robert briefly analyzes in this work what he believes are the basic facts related to the proposal, the identity interests, the work of the Dominion Royal Commission (1917), the practicalities of the suggested plan, the scope of the Board's activities and the composition of its membership, the beneficial results to be expected, the financing involved, and the technique of appointments. The whole booklet is amply illustrated.

Whilst Sir Robert clearly shows on page 14 that he realizes that "political and fiscal matters belong properly to the Imperial Conferences and must definitely be excluded from the constitution, policy and actions of the Empire Development Board" nevertheless, at least to the present reviewer, it does not seem that Sir Robert is sufficiently conscious of all the many and varied practical consequences that flow from the changes in political status and outlook which have transpired following the post war acceptance and institution of the complete political and fiscal autonomy of each of the Overseas Dominions. It is not without significance to observe that throughout the whole booklet the words "Imperial" and "Empire" appear extremely frequently (obviously on account of the subject); yet there is practically no mention in the text and none at all in the index of such phrases as "Overseas Dominions" or "British Commonwealth of Nations"—words which describe more accurately the present day situation throughout the autonomous parts of what was formerly the "British Empire."

With this point made clear it must immediately be emphasized, however, that the conception of a voluntary, co-operative and centralized board to correlate and to make easily available all known technical and economic information regarding facilities, resources and commercial opportunities in the whole Commonwealth is obviously a plan pregnant with beneficial results and therefore to be highly commended. (Incidentally, could the functions of the Imperial Institute be expanded to embrace such enlarged and widened objects?) Consequently the present reviewer does commend a plea for the establishment of a modern Empire Development Board (the "Victorian" model is now a little antique), as being of great interest and probably of vast potential service. Perhaps the splendid vision of the distinguished author may be conveyed by this closing quotation:

> "Furthermore, and speaking in all seriousness, I believe that by acting now in the cause of co-ordinated Empire development, we shall render a great service to those who come after us; but if we neglect the opportunity, we shall merit and receive their condemnation. To-day the opportunities for systematic Empire development are incalculably great, but many will remain sterile and others will pass, never to return, if we fail to set up a suitable organization probably in the form of an Empire Board to help bring them to life and growth. The choice, as I see it, lies between providing a great and increasing volume of employment for our workers of all classes, or accepting responsibility for neglecting the greatest opportunity ever vouchsafed to a community of nations."

**Consulting Engineer, Montreal.*

Second International Congress of the International Association for Testing Materials, April 19th to 24th, 1937

At its first congress held in Zurich in September, 1931, the International Association for Testing Materials accepted an invitation from the Committee representing British members to hold the next Congress in Great Britain, and recently the Permanent International Committee approved the suggestion submitted by the British Committee that the Congress should be held in London from April 19th to 24th, 1937.

The object of the Congresses held by the International Association for Testing Materials is to obtain international co-operation in the study of materials and their testing, and to provide facilities for the exchange of views, experience and knowledge with regard to all matters connected with this subject. The London Congress should be of considerable scientific and industrial importance, particularly in view of the length of time which has elapsed since the study and testing of materials were last reviewed on an international basis.

The proceedings will be based on selected papers which, by invitation of the Group-Presidents appointed by the Permanent Committee have been contributed by leading authorities in their respective fields in the principal countries throughout the world. Most of these invitations have been issued and approximately one hundred and fifty papers are already promised.

The Executive Committee of the Congress Organizing Committee is composed as follows: Sir Frank Smith, k.c.b., c.b.e., Secretary of the Royal Society of Great Britain and Secretary of the Department of Scientific and Industrial Research, chairman, Sir William Larke, k.b.e., vice-chairman, Sir Harold Carpenter, f.r.s., Sir Alexander Gibb, f.r.s., m.e.i.c. Dr. H. J. Gough, f.r.s., Sir Nigel Gresley, c.b.e., Sir Clement Hindley, k.c.i.e., Mr. K. Headlam-Morley, Honorary Secretary.

Participation in the Congress will be open to all interested in the study of materials and their testing on payment of the membership fee. Detailed information about the Congress, including membership fee, list of papers, price of the Congress Book, particulars of excursions, visits and social functions, etc., will be issued in due course. All requests for further information and enquiries should be addressed to the Honorary Secretary of the Congress, Mr. K. Headlam-Morley, at the offices of the British Committee, the International Association for Testing Materials, 28 Victoria Street, London, S.W.1, England.

The General Electric Company Limited announce a new sound-level meter which will give a quantitative measure of noise independent of the personal element, and at the same time give results commensurate with the sensations experienced by the ear. The meter was developed to provide performance in accord with the newly adopted American Standards Association standards. Special precautions have been taken to make the amplifier unit of the instrument suitable for use in the neighbourhood of electrical machinery where stray magnetic fields are common. The complete instrument, including microphone, tripod, calibrating unit, and batteries is contained in a compact metal case 15¾ by 9½ by 8¼ inches. The carrying weight is approximately 39 pounds.

The microphone is a small, non-directive, piezo electric type with practically flat frequency response up to 8,000 cycles per second.

A convenient switch permits the selection of either a flat-frequency response to measure sound intensity, or a weighted response which approximates that of the ear at a loudness of 40 decibels. The sound level meter is calibrated to read in decibels above the standard reference level of 10-16 watts per square centimeter at 1,000 cycles. The range of the instrument is 30 to 120 decibels. This is sufficient for noises ranging from those in quiet country homes to sounds that are intense enough to be painful to the ear.

BRANCH NEWS

Ottawa Branch

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

CIVIL ENGINEERING AND CONTRACTING IN GREAT BRITAIN

A special midsummer noon luncheon meeting was held at the Chateau Laurier on August 20th, 1936, to take advantage of the presence in Ottawa of B. J. Meighan, managing director of Ruddick and Meighan, Burford House, Harrow View, a well known British civil engineer and contractor. E. Viens, M.E.I.C., chairman, presided and in addition head table guests included: His Worship the Mayor of Ottawa, G. Gordon Gale, M.E.I.C., Col. A. E. Dubuc, M.E.I.C., A. K. Hay, A.M.E.I.C., K. M. Cameron, M.E.I.C., R. F. Howard, M.E.I.C., N. B. MacRostie, A.M.E.I.C., W. E. Macdonald, A.M.E.I.C., H. B. McCulloch, M.P., Dr. R. W. Boyle, M.E.I.C., and C. M. Pitts, A.M.E.I.C.

Mr. Meighan spoke upon "Civil Engineering and Contracting in Great Britain," and dealt with problems of road and sewer construction, the construction of buildings, the construction of railways, and other engineering works. His address related particularly to the city of London and the Home Counties, and included references to the experiences of his firm, which is engaged in the development of new estates, construction of roads, sewerage schemes, water supply, and works of a general engineering nature.

Within the above area, he stated, private speculative development has been producing on the average since 1928—except for 1932 which was a slump year—175,000 housing units. If municipally constructed houses are added the figure would be well over 200,000. The whole of England is "town planned" and development is under control, twelve units being the largest number that can be made upon an acre. Construction proceeds rapidly and it is quite usual for building operations to start within fourteen days after the purchase of open property intended for development. The construction of roads, sewers, footpaths, kerbs, and lighting equipment is all at the expense of the developing company and is carried on as an essential part of the housing scheme.

A man earning as low as $15 per week can purchase his own home in London with a deposit of $100, paying the balance at $3.50 to $4 per week over a period of fifteen to sixteen years. Houses under these development schemes range in value from £450 to £1,000 or more.

The biggest problem in London today, stated the speaker, is that of traffic congestion. As an instance, on Oxford Street it might take as much as three-quarters of an hour to traverse three miles in a motor car. The continuous stream of double-decked busses is one contributing cause. In an effort to relieve this, no street parking is allowed for more than ten minutes. The last tram cars were recently taken off and electric busses with overhead wire have been substituted. The tracks will have to be taken up and the roads reconstructed. It is hoped to complete each section within seven days of the commencement of operations.

Road accidents are very heavy. In Great Britain, for the week ending July 29th last, for example, there were 154 killed and 5,324 injured. The underground railways are starting on a £30,000,000 programme of extension and eventually it is hoped to have a very fine network of lines leading into London, which should help to relieve congestion here. On the main lines there was very little expenditure.

Referring to the manner in which building construction in London has been advancing, Mr. Meighan stated that it is now impossible to find an open area within 15 miles of the centre of the city whereon one hundred houses could be erected. As for the advance in prices, land for which he had refused in 1930 to pay £90 per acre he had to pay in 1933 the sum of £1,250 per acre. Some counties, in order to house their own people have had to go as far as 10 miles beyond the borders of adjoining counties. In spite of congestion, however, the speaker stated that he had just seen in New York City slums the like of which they never hope to have in London. "We are years ahead of anything I have seen in Canada or the United States in building and design," he added. In other branches of engineering the British "could learn a thing or two" from Canada.

Speaking upon the subject of unemployment he stated that although it was quite serious two years ago, and although there are still a large number on the dole, it is difficult at times to get help in certain departments of the building trades.

Canadian Allis-Chalmers Limited announce an important development in power transmission in the form of a new vari-pitch texrope sheave. In this new sheave, by a simple adjustment, the pitch can be altered so as to give a variation in speed of from 15 to 25 per cent per sheave, the range of variation being doubled when both sheaves are of this type. Thus with the vari-pitch sheave it is possible to experiment with different speeds to ascertain at just what speed the machinery shows the greatest efficiency.

Delamere and Williams, Limited, Toronto, engineers, designers and manufacturers of automatic machinery, air conditioners and other equipment, have concluded arrangements with the Peters Machinery Company of Chicago, Ill., whereby they will manufacture and be exclusive agents in Canada for the packaging equipment made by the United States concern.

Large Areas in Alberta and Manitoba Being Mapped

Continuing the work commenced last year, the Geological Survey, Department of Mines, Ottawa, is mapping a 12,000-square mile area in the east-central portion and an 8,000-square mile portion of the drought belt in southeastern Alberta. A small area of oil and gas structures in the vicinity of Pekisko is being mapped also.

Two projects are underway in the east-central area. In the eastern portion, which extends from Vegreville to the Alberta-Saskatchewan boundary, an examination of the Battleview anticline northeast of Wainwright is being continued. Other sections of the large area are being examined also, with a view to outlining any favourable structures that may exist, and an investigation of the ground water resources.

The adjoining western portion of the east-central area extends from the south of Red Deer northwards beyond Edmonton, and is being mapped with special reference to the oil and gas possibilities.

In southeastern Alberta, a party is examining the surface geology and the ground water possibilities in a 5,000-square mile portion of the drought belt. This work will be valuable in the study of soils by agriculturists, and will afford useful information to ranchers and drillers. Another party is making a study of the economic resources of the area, and also of the adjoining 3,000-square mile area on the west. Particular attention is being given to the oil and gas possibilities and to artesian sources of water supply.

In Manitoba, a 16,000-square mile portion of the Canadian Shield lying between Lake Winnipeg and the Ontario boundary is being mapped. This partially prospected region lies between two actively productive mining camps, God's lake on the north and the Rice lake-Central Manitoba field on the south.

Approximately 120 square miles of territory contiguous to the Flin Flon deposits are being mapped in detail. This project is intended to furnish a comprehensive understanding of the various rock group and mineral deposit relationships.

A party is studying geological conditions affecting oil and gas accumulations in the Swan river-Pasquai area. The work will provide a basis for a four-mile map.

Boundaries of sediments and volcanics are being mapped in the Mink lake area. Lying between two active gold camps, God's lake in Manitoba on the west and Sachigo river in Ontario on the east, this area has been the scene of intensive prospecting.

Parties are continuing detailed studies in portions of the Rice lake and Central Manitoba fields. Work this year is confined largely to the examination of small areas in the vicinities of the San Antonio and Gunnar Gold properties. Particular attention is being given to an investigation of the relationships between various geological formations and the gold deposits, as an aid to future development.

The Proposed Transatlantic Air Service

In reply to a question in the House of Commons, on Thursday, July 30th, the Under-Secretary of State for Air (The Rt. Hon. Sir Philip Sassoon) announced that, as a result of a conference in Ottawa last November between representatives of the United Kingdom, Canada, the Irish Free State and Newfoundland, survey flights are to be made and an experimental air mail service is to be established across the Atlantic as soon as possible. These are eventually to be followed by a mail and passenger service on a minimum schedule of two flights a week in each direction. The scheme has been discussed with the United States government, and understandings "based upon the principle of full reciprocity" have been reached. A Joint Operating Company is to be established to carry on the services and will be incorporated by three companies, of which one will be nominated by each of the Governments of the United Kingdom, Canada, and the Irish Free State. Each country will also nominate three directors, the chairman and managing director being chosen from the United Kingdom representatives. As regards capital, the United Kingdom, Canada, and the Irish Free State will be interested to the extent of 51 per cent, 24.5 per cent, and 24.5 per cent, respectively. In return for landing facilities in the United States, Pan-American Airways will be granted landing facilities in the United Kingdom, Canada, the Irish Free State and Newfoundland. The direct route will be operated as far as possible, though it may be necessary to travel via Bermuda during the winter months. Experimental long-distance flights will be conducted by Imperial Airways Limited, pending the incorporation of the Joint Company, and this concern will also be given control of commercial, technical, and operating matters. The experimental flying operations will be financed by the Government of the United Kingdom, though when the Joint Company assumes responsibility, it will receive an annual subsidy, of which Canada's share will be 20 per cent, with a maximum of £75,000, and the Irish Free State's share, 5 per cent, with a maximum of £12,000. Newfoundland will also contribute a small sum, the remainder being made up by the United Kingdom. Each of the governments concerned has undertaken to grant the necessary landing and transit rights for a period of five years, and an Inter-Governmental Committee will be established to which all proposals relating to services which may affect national policy or international relationships will be referred.—*Engineering.*

Preliminary Notice

of Applications for Admission and for Transfer

August 28th, 1936

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

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

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

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

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

The Council will consider the applications herein described in October, 1936.

R. J. DURLEY, Secretary.

*The professional requirements are as follows:—

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

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

Every candidate who has not graduated from a school of engineering recognized by the Council shall be required to pass an examination before a board of examiners appointed by the Council. The candidate shall be examined on the theory and practice of engineering, with special reference to the branch ofengineering 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 year.

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 equiva ent standard.

A Student beshall 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 matriculat'on of an arts or science course in a school of engineering recognized by the Council.

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

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

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

FOR ADMISSION

BANCROFT—GILBERT HOWARD, of Trail, B.C., Born at Denholme, Yorks., England, Feb. 5th, 1899; Educ., 1915-21, Bradford Technical College. R.P.E. of B.C.; 1915-20, ap'ticeship, Messrs. Cole Marchent & Morley Ltd., Bradford, Yorks., Steam Eng. Mfrs. 1920-23, detail dfting, and 1923-25, desiging uniflow engines for same company; 1926-27, dftsman., Can. Grant Ltd., James Is.; 1927-34, dftsman., Powell River Co. Ltd., paper mill machy., pumps and piping, labour saving devices and gen. mech. design. 1929-32, leading mech. dftsman, and 1932-34, chief dftsman., 1934-36, chief dftsman. and designing engr., Vancouver Engineering Works Ltd., Vancouver, mining, logging and sawmill machy.; at present, mech. dftsman., Cons. Mining and Smelting Co. of Canada Ltd., Tadanac, B.C.

References: E. A. Wheatley, J. Robertson, R. Bell-Irving, P. Sandwell, P. H. Buchan, S. C. Montgomery, A. S. Mansbridge.

CHAMBERS—ROBERT JOHN, of 382 Richelieu St., Quebec, Que., Born at Winnipeg, Man., Sept. 21st, 1907; Educ., B.Sc., 1933, M.Sc., 1935, Queen's Univ.; Winter 1928-29, and summer 1934, part time on oil burning and draft control equipment; Summer 1931, time and stores keeper, Ryan Constrn. Co., at Ottawa; Winters 1933-35, demonstrator in dfting. and engine labs., Queen's Univ.; at present, mech. engr., Anglo-Canadian Pulp and Paper Co. Ltd., Quebec, Que.

References: J. O'Halloran, R. H. Farnsworth, L. M. Arkley, L. T. Rutledge, G. J. Smith.

DEMERS—GEORGES, of 7639 St. Hubert St., Montreal, Que., Born at Montreal, Feb. 16th, 1912; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1935; Since graduation, res. engr. and asst. divn. engr., Dept. of Roads, Prov. of Quebec, Riviere du Loup, Que.

References: A. Paradis, A. Frigon, O. O. Lefebvre, A. Mailhiot, A. Duperron, T. J. Lafreniere, A. Gratton, J. A. Lefebvre.

HUNT—EDWIN SIDNEY WHITELEY, of Flin Flon, Man., Born in Lower Egypt, August 9th, 1906; 1923-24, Technical College, Univ. of Wales. Private tuition; 1928-29, rodman, C.N.R.; 1929 to date, with the Hudson Bay Mining and Smelting Co. Ltd., as follows: 1929-30, junior engr., 1930-34, open pit engr., 1934 to July 1936, mine surveyor and in charge of river diversion at Island Falls, Sask., and at present, contract, cost and experimental engr.

References: A. W. Fosness, T. Kipp, E. V. Caton, N. M. Hall, F. S. Small.

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

EADIE—ROBERT SCOTT, of 4380 Mayfair Ave., Montreal, Que., Born at Hintonburgh, Ont., Aug. 29th, 1895; Educ., B.Sc., 1920, M.Sc., 1922, McGill Univ.; 1916-19, overseas, Lieut., Can. Engrs.; 1920-24, lecturer in mechs. and maths., Faculty of Applied Science, McGill University; Summers 1922 and 1923, and from May 1924 to date, with the Dominion Bridge Co. Ltd., Lachine, Que. 1924-25, designing misc. steel structures; 1925-29, design of Jacques Cartier Bridge, Montreal, and layout of erection schemes and equipment; 1929-31, special investigations under the vice-president in charge of constrn.; 1931 to date, in charge of desiging office at Lachine. Following are a few of the structures designed or checked during that period: Honoré Mercier Bridge, Sorel Bascule Bridge, Gaspe Bridge, Norwood Bridge, and many bldgs., etc. (*St. 1914, Jr. 1920, A.M. 1926.*)

References: F. P. Shearwood, F. Newell, P. L. Pratley, E. Brown, R. E. Jamieson, C. N. Monsarrat.

GARNETT—CHARLES ERNEST, of 10344-132nd St., Edmonton, Alta., Born at Manchester, England, April 21st, 1887; Educ., 1902-07, Manchester College of Technology; R.P.E. of Alta.; 1902-06, ap'tice, Manchester Electricity Works; 1906-07, improver, British Thomson Houston Co.; 1907-08, erector, British Westinghouse Co.; 1908-10, shift engr., Manchester Electricity Works; 1910-11, inspr., 1911-14, erecting engr., also part of 1917, with Canadian Westinghouse Co.; 1914-17, and 1917-19, overseas, Can. Engrs., and Lieut., Can. Mach. Gun Corps; 1919 to date, sales engr., Gorman's Ltd., Edmonton, Alta. In charge and responsible for all engrg., estimates and sales and installns. undertaken by this firm, including supervision and erection of Diesel power plants, refrigeration plants, and other work of similar nature. Also 1935 to date, district engr. for Saskatchewan, Alberta and N.W.T. for the English Electric Co. of Canada Ltd., in charge of all sales and installns. within this territory. (*A.M. 1931.*)

References: A. Ritchie, J. D. Baker, P. Ford-Smith, C. A. Robb, F. K. Beach.

LAWTON—FREDERIC LEWIS, of Chicoutimi, Que., Born at London, England, Dec. 14th, 1900; Educ., B.A.Sc. (E.E.), Univ. of Toronto, 1923; R.P.E. of Que.; 1923-24, test course, Gen. Elec. Co., Schenectady; 1924-25, transmission system power stability investigations and analysis, General Electric Lab., and engrg. general dept., Gen. Elec. Co., Schenectady; 1925-26, asst. to elec. engr., Quebec Development Co., on transmission system design and constrn.; 1926-27, i/c dfting on extensive hydro-electric survey, Quebec Development Co. and Duke-Price Power Co.; 1927-30, asst. to supt. of operation, engaged on hydro-electric system operating problems responsible for relay system design, extensive plant alterations, misc. investigations, etc., Duke-Price Power Co. Ltd.; 1930 to date, elec. engr., Duke-Price Power Co. Ltd. (now Saguenay Power Co. Ltd.), responsible for engrg. dept. Misc. hydraulic, electric, and mech'l. investigations, tests, etc.; design and layout housing development; large scale commercial electrical house-heating investigation; design and layout of electric boiler installns., substations, power house alterations and additions, etc. (*St. 1920, A.M. 1928.*)

References: D. A. Evans, S. J. Fisher, H. R. Wake, A. W. Whitaker, Jr., N. F. McCaghey, G. F. Layne, G. E. LaMothe.

FOR TRANSFER FROM THE CLASS OF JUNIOR

LANCTOT—RAYMOND, of Arvida, Que., Born at St. Hyacinthe, Que., April 25th, 1903; Educ., B.Sc. (M.E.), McGill Univ., 1924; 1920, on surveying party, Riordon Pulp and Paper Co.; 1921-26 (summers), ap'tice with Casavant Freres Ltd., St. Hyacinthe; 1924-25, with same company, designing, routing and erecting; 1925-26, designing elect'l. circuits and layouts, Montreal Water Board; 1926-30, gen. foreman in aluminum plant, Aluminum Co. of Canada; 1930-31, La Société de Construction Ouvrière de Chicoutimi, gen. constrn. works; 1931-32, designing and checking constrn. of elect'l. works, dept. of electricity, City of Montreal; 1932-35, private secretary to Mr. Albert Hudon, assisting in financial and administrative work; 1935 to date, asst. to aluminum plant supt., Aluminum Company of Canada, Arvida, Que. (*St. 1922, Jr. 1926.*)

References: C. J. Desbaillets, G. E. LaMothe, B. Pelletier, A. W. Whitaker, Jr.

PRINGLE—GEORGE HUGH, of 244 Caldwell St., Chillicothe, Ohio, Born at Pictou, N.S., July 1st, 1903; Educ., B.Sc. (Mech.), McGill Univ., 1926; 1922-23-24 (summers), Canada Iron Foundries, machine shop works, shipping and stores; 1925 (summer), International Paper Co., survey work on constrn.; 1926-27, Canada Paper Co., Windsor Mills, on design of new machine, beater and boiler house installn.; 1927-32, Mead Corpn., engrg. dept., design, field supervision, on mtce. and new constrn.; 1932 to date, Mead Corpn., asst. chief engr., direct responsibility on design, requisitioning of materials and field supervision on constrn. and mtce., magazine and specialty paper mills. (*St. 1923, Jr. 1927.*)

References: W. P. Copp, E. Brown, J. H. Fregeau, C. M. McKergow, A. R. Roberts

FOR TRANSFER FROM THE CLASS OF STUDENT

ANDERSON—RODERICK VICTOR, of Barranca, Bermeja, Colombia, S.A., Born at Revelstoke, B.C., July 20th, 1909; Educ., B.A.Sc. (C.E.), Univ. of B.C., 1931; 1928-29 (summers), asst., Geol. Survey of Canada; 1930 (summer), dftsman., Dominion Bridge Co., Vancouver; 1934-35, lab. asst., Imperial Oil Refineries, Sarnia, Ont.; 1935 to date, asst. refinery engr., Tropical Oil Co., Barranca, Bermeja, Colombia, S.A. (*St. 1928.*)

References: F. C. Tempest, A. S. Gentles, H. B. Muckleston, W. G. Swan, C. J. Oliver.

HARVEY—WILLIAM M., of Noranda, Que., Born at Victoria Mines, Ont., Dec. 12th, 1902; Educ., B.Sc. (Mech.), Queen's Univ., 1924; 1919-20, mach. shop work and machy. erection, British America Nickel Co., Sudbury; 1924-27, dftsman and designer, The Wabi Iron Works Ltd., New Liskeard, Ont.; 1928, instr'man. on flooded land surveys, Sutcliffe Co., New Liskeard; 1928-29, i/c party on forest surveys, Canada Power and Paper Corpn., Grand Mère, Que.; 1929-32, chief engr., The Wabi Iron Works Ltd.; with Noranda Mines Ltd. as follows: 1932-34, dftsman., 1934-35, estimator, 1935 to date, mech. engr., (*St. 1922.*)

References: H. W. Sutcliffe, L. T. Rutledge, L. M. Arkley, E. W. Neelands, J. R. Bradfield.

Economic Conditions in Germany

When dealing with a country in which a person gets a reduction in income tax if he buys a new car, it is well to remember that the expression "economic conditions" may have different meanings in different places. What the actual financial position of Germany is, few people either in or out of it know, and since its rulers clearly consider economic questions as a factor in high politics, it does not appear likely that precise information may be expected under present conditions. In terms of commonplace accountancy, all that can be said is that the budget of 1934-35 showed a deficit of RM. 2,554 million, and that for 1935-36 no budget has been published. Whatever value one cares to give to the mark, it is clear that the present deficit must be a very substantial sum, although perhaps not of a different order of magnitude from that which is shown by some other countries under the methods by which so many of them now conduct their affairs. So far as it is possible to express the matter in broad terms, the economic problem facing Germany is not any question of immediate solvency, but rather the possibility of carrying on indefinitely under her present methods.

The extent to which in Germany the principles of sound finance, or, indeed, of what we would call ordinary business, are neglected in the interests of political theory may be illustrated by reference to her imports of raw cotton, concerning which some interesting statistics are given in a recent Department of Overseas Trade report on *Economic Conditions in Germany*, compiled by Mr. E. C. Donaldson Rawlins. The imports of this commodity, which in 1933 reached 416,000 tons, dropped to 316,900 tons in 1934 and 310,000 tons in 1935. Last year, however, owing to the clearing arrangements in force, the cost was 27 per cent higher than in 1934. This rise was a concomitant of a change in the sources of supply. In 1933, the United States furnished three-quarters of Germany's imports of cotton. In 1935, she supplied one-quarter, a change-over being made to Latin America and other places having an active trade balance with Germany. The unit costs of the new sources of supply were considerably higher than those of the old. Mr. Rawlins comments: "The extraordinary conditions as to prices are demonstrated by the fact that while cotton from the United States, British India and Egypt cost RM. 0.80, RM. 0.67 and RM. 1 per kilogram, respectively, the price of supplies from Brazil was RM. 1.11 per kilogram and from Greece even RM. 1.24 per kilogram, although the quality of the latter did not appear to justify such quotations." In view of her efforts to sell manufactured goods abroad and maintain favourable trade balances, this type of transaction is apparently considered by the German authorities as profitable.

There would not appear to be any reason to suppose that such forced rises in the costs of his raw materials are likely to be welcomed by the individual manufacturer, especially as they are accompanied by increased works costs due to it being necessary to deal with new and at times inferior qualities. He apparently, however, has no choice in the matter. Although Mr. Rawlins states that German industry has not been nationalized, control is so extensive and rigid that the distinction between German procedure and that of Russia, where industry is definitely a State activity, may well appear to an outsider more one of procedure than method. The fostering of private property and personal initiative are declared to be part of National Socialist policy, but when the industrialist finds that he may be forbidden to increase productive capacity, may be compelled to utilize or not utilize certain ingredients in his manufacturing processes, is compelled to join a cartel, finds that his selling prices are controlled, may be forbidden to move the site of his works, has to refer to an outside committee if he wishes to dismiss employees, and so on—then may he well wonder what scope is left for his personal initiative.

The whole of German industry is controlled by a series of national corporations which deal, respectively, with agriculture, industry, handicrafts, transport, and labour. All have the same underlying principles, their structure being such that the government can guide and control them. They replace and unify the activities of trade and labour associations of all kinds, but are fundamentally different from the bodies they have replaced in that their specific purpose is the interest of the community—their own special interests are subordinated to national interests.—*Engineering.*

Electrical Interference with Broadcasting

At the Institution of Electrical Engineers on July 16th, Mr. C. C. Paterson made a statement regarding the report of the electrical interference with broadcasting. One of the difficulties of ensuring good reception, he explained, was that certain plant and apparatus, in common use, emitted radiation which appeared as noise in radio receivers. The Post Office had a staff for dealing with the matter, and at present it handled 40,000 complaints a year. It had no power to compel offending parties to prevent interference, but depended upon the good will of the general public. A few years ago the Institution of Electrical Engineers set up a committee composed of representatives of practically all interests affected to consider what could be done to eliminate electrical interference with radio reception. That report had now been published. The committee initiated researches for developing methods of measurement of interference and the best methods for its suppression. The British Standards Institution co-operated in issuing standard specifications covering this work.

The report discussed by Mr. Paterson states that there should be a difference of at least 40 decibels between the strength of the signal of wanted field and the interfering or unwanted field. A method or measurement has now been agreed upon and instruments have been developed which are capable of indicating with sufficient accuracy the amount of interference caused.

The apparatus which is likely to cause the most interference is comprised in the following groups. Most of the trouble from radio interference would be eliminated if these could be satisfactorily dealt with (1) lifts in buildings; (2) trolleybuses and trams; (3) household electrical appliances; (4) small electric motors used in commercial premises; (5) "Neon" display signs; (6) certain rectifiers for power plant; (7) electro-medical apparatus.

In addition to these items the ignition systems on automobiles must be mentioned, although at present there is no appreciable interference from automobile ignition with ordinary broadcast reception on its present wave lengths. If, however, such systems continue in use uncorrected, it is probable that there will be interference with television reception.

The first case in which radio-interference correction was in effect made compulsory was that of traffic signals. The Ministry of Transport require all traffic signals to be supplied to British Standard Specification No. 505-1933. The fitting of correcting components was from the first one of the requirements of this B.S. specification, and the result has thus been achieved without serious difficulty. A second case in which much practical progress has been made is that of trollybuses.

Although the cost of correcting existing apparatus is undoubtedly higher than the cost involved if the apparatus is designed initially to be "interference free" it has been found that the cost of effecting the required degree of suppression of existing apparatus or plant is usually but a small percentage of its original cost. Thus in the case of small apparatus it may amount to only a few shillings; for electric lifts in flats it will probably in many cases amount to £15 to £25.

—*The Engineer.*

EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada

2050 Mansfield Street, Montreal

Situations Vacant

POWER PLANT SUPERINTENDENT. The City of Edmonton will receive applications for the position of superintendent of municipal power plant. The plant is steam generating with a capacity of twenty-one thousand kilowatts which may be extended. Applications to be addressed to the City Commissioners, Civic Block, Edmonton, Alta.

MECHANICAL DESIGNER. Designing draughtsman with experience in the design of steam boilers and power plant equipment. Able to take charge of section of draughting room. Apply at once to Box No. 1369-V.

Civil Service of Canada

SENIOR ASSISTANT ENGINEER (ILLUMINATING)

List No. 666

25443.—A Senior Assistant Engineer (Illuminating) in the Civil Aviation Branch, Department of National Defence, Ottawa, salary of $2,820 per annum.

Duties.—To have charge, under the direction of the superintendent, airways, of the lighting equipment of Civil Government owned airports, airways and seaplane bases; to design, prepare specifications, inspect for acceptance from manufacturers and contractors lighting equipment and accessories such as beacons, lighting fixtures, transformers, engines, generating sets, small power houses, towers, fuel and heating systems, electric and other automatic devices and other like equipment; and, as required, to supervise the installation and maintenance thereof; to examine and approve for license signal and lighting equipment proposals submitted by municipalities, operating companies and private owners; and to perform other related work as required.

Qualifications required.—High school graduation; either graduation in engineering from a university of recognized standing, preferably in electrical engineering with specialized training in optics and illumination, and three years of practical experience, or eight years of practical engineering training and experience in the design or construction of optical and illuminating equipment; a knowledge of internal combustion engines including heavy oil engines; corporate membership in The Engineering Institute of Canada, or membership in a provincial association of professional engineers, or professional qualifications which would permit of such membership; ability to design equipment, prepare specifications and reports and make recommendations, organizing ability; interested in aviation, and willing to travel by air when required; good judgment; supervisory ability; tact.

Application forms properly filled in must be filed with the Civil Service Commission, Ottawa, **not later than September 24, 1936.** Application forms may be obtained from the offices of the Employment Service of Canada, from the Postmasters at any City Post Office, The Engineering Institute of Canada, or from the Secretary of the Civil Service Commission, Ottawa.

Situations Wanted

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

ENGINEER, A.M.E.I.C. Age 30. Single. Employed. Civil and mining experience, capable of designing and superintending construction of timber, concrete and steel structures, rock crushing and ore plants. Would consider position with mining or engineering company designing and building mills. Apply to Box No. 431-W.

MECHANICAL ENGINEER, B.Sc. Age 31. Married. Last ten years includes:—Mechanical structural and reinforced concrete design in pulp and paper mills, industrial plants, hydro-electric, mine, sewers and sewage disposal plant construction. My experience also includes shop production, steam plant combustion, fuel analysing, inspecting, supervising and instrument work on industrial construction. Permanent position preferred. Apply to Box No. 521-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aerophotographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

Situations Wanted

ELECTRICAL ENGINEER, B.Sc., 1926. One year maintenance, one year operating, large hydro-electric plant. Five years hydro-electric construction, as wireman and foreman, on relay, metal, and remote control installations. Also conduit and switches. Three years maintenance electrician, in pulp and paper mill. Also small power system. Desires position of responsibility. Sober, reliable and not afraid of work. Available at once. Excellent references. Apply to Box No. 636-W.

ELECTRICAL ENGINEER, B.Sc. '28; M. Eng. '35. Two years student apprenticeship at Can. Westinghouse Co., including test and electrical machine design. Also about two years experience in operating dept. of large electrical power organization. Available on short notice. Apply to Box No. 660-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

Mechanical Engineers

Mechanical designers and draughtsmen are still in demand and members with this experience, and also recent graduates in mechanical engineering, should not fail to register with the Employment Service Bureau.

In the province of Quebec openings for sales engineers speaking French, are continually being brought to our attention.

The number of known placements for the first eight months of this year, already exceeds the number for the year 1935.

ELECTRICAL AND CIVIL ENGINEER, B.Sc. Elec. '29, B.Sc. Civil '33. Jr.E.I.C. Age 29. Experience includes four months with Can. Gen. Elec. Co., approximately three years in engineering office of large electrical manufacturing company in Montreal, the last six months of which was spent as commercial engineer. For the last year and a half employed in electrical repair shop. Best of references. Apply to Box No. 693-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial. Apply to Box No. 724-W

YOUNG CIVIL ENGINEER, B.Sc. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No 728-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER, M.Sc., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering. Read, write and talk French. Married. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

RADIO AND ELECTRICAL ENGINEER, B.Sc., '31, Jr.E.I.C. Single. Age 29. One year and a half actual field experience in power and lighting equipment. Extensive work in telephone and radio layouts in switchboard and installation depts. Particularly interested and experienced in sales and traffic work in telephone and radio company. At present supervisor over sales and service of radio and electrical company. Available on short notice. Location immaterial. Apply to Box No. 740-W.

Situations Wanted

CIVIL ENGINEER, B.Sc. '29, A.M.E.I.C. Married. One year building construction. One year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

MANUFACTURERS' REPRESENTATIVE, at present doing business with leading industrial organizations in Canada, wishes to represent manufacturers of mechanical equipment. Such work as would involve technical data, and the preparation of plans where necessary, would be handled by an engineer whose experience with outstanding firms and projects, would be valuable to those seeking representation. Apply to Box No. 764-W.

PLANT ENGINEER or SUPERINTENDENT, capable of supervising all phases of industrial plant operation, graduate electrical, eleven years diversified industrial experience including test course, four years on large Quebec industrial development, on construction and operation, also six years with prominent consulting firm supervising electrical and mechanical engineering projects. Age 31, single. Apply to Box No. 795-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 32, married. Two years in pulp mills draughting and designing additions, maintenance and plant layout. Three and a half years in the Toronto Building Department, checking and designing for steel, reinforced concrete and ordinary structures. One and a half years as transitman and draughtsman on road location and maintenance work. Available at once. Location immaterial. Apply to Box No. 899-W.

CIVIL ENGINEER, B.Sc., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements Available at once. Apply to Box No. 950-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.Sc.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc , desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

MECHANICAL ENGINEER, B.Sc. (Queen's Univ. '28), age 36, married, desires position of trust and responsibility. Experience includes fitting and assembly of machine tools, production, draughting, and maintenance. Five years teaching draughting and mathematics. Available on reasonable notice. Location immaterial. Apply to Box No. 1210-W.

Synthetic Rubber and Rubber Substitutes

In the course of functions connected with the recent Chemical-Engineering Congress, several references were made to the production of synthetic rubber, as one of the greatest triumphs of the present day. Lord Rutherford at the banquet even went so far as to say that the chemical engineer was on the point of producing a material more rubbery than rubber. The production of such a substitute for natural rubber has indeed for long attracted wide attention. The matter is not only of scientific interest, but under some circumstances may be a matter of national importance, for rubber, or its substitute, comes in the same category as oil, as an essential in transport operations and in the aircraft, electrical, chemical and other industries. It is a necessity and a source of wealth, and supplies cannot be dispensed with in case of national emergency. The home production of such a commodity would be a valuable asset under circumstances when the availability of supplies was of paramount importance, and the economic cost but secondary. For these reasons the production of a substance having properties and of a cost comparable with natural rubber has long been the subject of research, but it was not until 1916, when some of the European powers were unable to obtain the natural product, that a synthetic substance was forthcoming, manufactured for commercial use.

The production of synthetic rubber had been a matter of considerable controversy for many years, due very largely, as a matter of fact, to the limit of our knowledge, not only regarding the synthetic product but even of the exact character of the natural product. The investigation of the properties of rubber itself is severely hampered by its highly complex constitution and structure, and this adds further difficulties to the study of the complicated synthesis of rubber. Ultimate success will only be attained when continued and persistent study of the subject leads ultimately to lower costs and improved methods of production.

The synthesis of isoprene and dimethylbutadiene presents one of the most fascinating chapters in organic chemistry. Early attempts at synthesizing rubber arose very largely from investigations into the constitution of natural rubber. As the result of the classic series of investigations, the composition of caoutchouc was well described by Faraday, subsequent researches having confirmed his results. Frequent statements made abroad tend to obscure early facts, but it should be emphasized that the pioneer researches on the synthesis of rubber were made by Tilden in England and Bouchardat in France. Tilden's discovery in 1892 of the polymerization of isoprene was made in this country and this paved the way to the masterly investigations of Perkin, Weizmann and Strange in co-operation with Synthetic Products, Limited. By all of these the importance of the colloidal aspects of the subject as distinguished from the chemical considerations was fully recognized. Tilden undoubtedly foresaw with remarkable intuition the successful commercial production of synthetic rubber and incidentally accurately stated the correct formula for isoprene. The product obtained by polymerizing isoprene is not identical with the natural product, since neither lævulinic acid nor lævulinic aldehyde is formed on submitting the ozonide to hydrolysis. Researches by Patrick and Katz on the production of synthetic rubber from halogenated ethylene derivatives and alkali polysulphides have now provided a fairly complete understanding of these complex products.

The present commercial position of the synthetic rubber industry has been well summarized by Dr. S. P. Schotz, who has stated that the production of synthetic rubber does not elicit much enthusiasm in British business circles, largely no doubt because the dominating power of Britain in the plantation-rubber industry was antagonistic to rearing a rival manufacture when it was itself endeavouring to find increased uses for its product. The development of synthetic rubber appears likely to follow a course similar to that of the synthetic dyestuffs, etc. Though initially produced at a high cost, subsequently improved technical experience, increased demand, and in some instances State protection for the industry, have resulted in greater outputs and consequently cheaper products. At present there is urgent need to find far wider applications for rubber and greater consumption. Persistent efforts have been made to this end, but the limited success attained has been due, at least in part, to the characteristics of the natural rubber. Greater success may perhaps be attained in the application of modifications of caoutchouc and synthetic rubber in the field of plastics; there is no doubt that the future of synthetic rubber will lie in the production of a product superior to the natural one and hence capable of commanding a higher price.—*Engineering.*

Tests on Large Columns

Progress in the science and art of constructional engineering frequently necessitates advance along unbeaten tracks that can be surveyed only with the aid of structural models, since the unknown factors usually involve quantities which are implicated in the assumptions found in the analytical treatment of the theory of structures. Experimental work in this sphere thus includes the consideration of such matters as the elastic characteristics of new materials, the design of structures having dimensions that exceed those encountered in practice, and the strength of built-up members compared with the value derived from experiments with standard test-pieces. All these factors entered, for instance, into the initial stages of the work connected with the George Washington bridge, at New York, in the construction of which about 33,000 tons of silicon steel were used in the towers and other parts of the structural system which supports a span of 3,500 feet. In view of the lack of experimental data relating to the behaviour of large columns when under load, the Port of New York Authority requested the Bureau of Standards, at Washington, to determine the strength and other properties of the large fabricated columns used in the bridge, and an interesting account of the investigation is given in the Journal of Research issued by the Bureau in September last, while in the March issue are recorded comparative tests on similar columns encased in concrete.

The first set of tests were conducted on six columns that were half-scale models of the actual structures, with the exception the of length, which was made 24 feet in order that the work could be undertaken with the largest available testing machine, having a capacity of 10,000,000 pounds. The research was therefore carried out on built-up columns 24 feet in length, 34½ inches overall in section, and having a moment of inertia amounting to 15,794-inch units. Symmetry of loading during the tests was ensured by milling the ends of the structures, and it was estimated that the error in the results obtained did not vary beyond the range of 2 per cent and 4 per cent.

The strain on the loaded structures was indicated by 16 micrometer dial-gauges placed symmetrically about the columns with respect to the sides and mid-length, in such a manner that it was possible to estimate variations within 0.0001 inch with a gauge length of 20 feet. In addition, eighteen "telemeters," having a gauge length of 8 inches, were placed at mid-length of the columns, to measure the local strain on the angles and plates forming the structures; eight of these instruments were attached to the principal members of each column. Further, the lateral deflection at mid-length of a column was measured with the aid of micrometer gauges used in conjunction with a fixed steel frame surrounding the member under test, by which means eleven readings were taken on each of the four sides of the structure, for increments of load equivalent to a stress of 4,000 pounds per square inch.

A series of independent experiments were carried out on standard test pieces, in the course of which the yield point was taken at the stress for which the strain was 0.002 greater than that computed from the stress and Young's modulus for the material, which also defines the yield strength of the columns. With reference to these standard tests, it is to be noted that the rate of movement of the head of the testing machine was arranged to be practically the same as that used in testing the structures referred to below, since one of the aims was that of determining the "efficiency" of the columns, which is given by dividing the yield strength of the structure by the statistically "weighted" yield strength obtained from the tensile tests of the standard specimens.

THE ENGINEERING JOURNAL

THE JOURNAL OF THE ENGINEERING INSTITUTE OF CANADA

Published monthly at 2050 Mansfield Street, Montreal, by The Engineering Institute of Canada, Incorporated in 1887 as The Canadian Society of Civil Engineers.

Entered at the Post Office, Montreal, as Second Class Matter.

"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."

October, 1936

CONTENTS

Volume XIX, No. 10

Price 50 cents a copy, $3.00 a year, in Canada, British Possessions, United States and Mexico. $4.50 a year in Foreign Countries.
To Members and Affiliates, 25 cents a copy, $2.00 a year.

Published Monthly at 2050 Mansfield St., Montreal

THE ENGINEERING INSTITUTE OF CANADA

Incorporated in 1887 as The Canadian Society of Civil Engineers

BRANCHES:

Halifax Branch, Halifax, N.S.
Cape Breton Branch, Sydney, Cape Breton.
Moncton, Branch, Moncton, N.B.
Saint John Branch, Saint John, N.B.
Saguenay Branch, Kenogami, Que.
Quebec Branch, Quebec, Que.
St. Maurice Valley Branch, Three Rivers, Que.
Montreal Branch, Montreal, Que.
Ottawa Branch, Ottawa, Ont.
Kingston Branch, Kingston, Ont.
Peterborough Branch, Peterborough, Ont.
Toronto Branch, Toronto, Ont.
Hamilton Branch, Hamilton, Ont.
Niagara Peninsula Branch, Niagara Falls, Ont.
London Branch, London, Ont.
Border Cities Branch, Windsor, Ont.
Sault Ste. Marie Branch, Sault Ste. Marie, Ont.
Lakehead Branch, Port Arthur, Ont.
Winnipeg Branch, Winnipeg, Man.
Saskatchewan Branch, Regina, Sask.
Lethbridge Branch, Lethbridge, Alta.
Edmonton Branch, Edmonton, Alta.
Calgary Branch, Calgary, Alta.
Vancouver Branch, Vancouver, B.C.
Victoria Branch, Victoria, B.C.

Members of Council 1936

PRESIDENT
E. A. CLEVELAND, Vancouver, B.C.

VICE-PRESIDENTS
*E. V. CATON, Winnipeg, Man.
†R. L. DOBBIN, Peterborough, Ont.
†H. W. McKIEL, Sackville, N.B.
†A. B. NORMANDIN, Quebec, Que.
*P. L. PRATLEY, Montreal, Que.

PAST-PRESIDENTS
F. A. GABY, Toronto, Ont.
O. O. LEFEBVRE, Montreal, Que.
F. P. SHEARWOOD, Montreal, Que.

COUNCILLORS
*C. G. R. ARMSTRONG, Windsor, Ont.
†Y. C. BARRINGTON, Sydney Mines, N.S.
*C. B. BROWN, Montreal, Que.
†G. S. BROWN, Lethbridge, Alta.
*G. H. BURBIDGE, Port Arthur, Ont.
†H. CIMON, Quebec, Que.
*A. COUSINEAU, Montreal, Que.
†A. B. CREALOCK, Toronto, Ont.
†T. H. DICKSON, Moncton, N.B.
†A. FRIGON, Montreal, Que.
†A. B. GATES, Peterborough, Ont.
*For 1936

*L. F. GOODWIN, Kingston, Ont.
*B. GRANDMONT, Three Rivers, Que.
†A. K. HAY, Ottawa, Ont.
‡F. S. B. HEWARD, Montreal, Que.
*G. H. KIRBY, Riverbend, Que.
*H. S. JOHNSTON, Halifax, N.S.
†T. C. MAIN, Winnipeg, Man.
†E. P. MUNTZ, Hamilton, Ont.
†E. P. MURPHY, Port Colborne, Ont.
†H. J. McLEAN, Calgary, Alta.
‡F. NEWELL, Montreal, Que.
†For 1936-37

†E. A. RYAN, Montreal, Que.
†F. SMALLWOOD, Sault Ste Marie, Ont.
*R. E. SMYTHE, Toronto, Ont.
*E. W. STEDMAN, Ottawa, Ont.
†H. L. SWAN, Victoria, B.C.
*J. A. VANCE, Woodstock, Ont.
*G. A. VANDERVOORT, Saint John, N.B.
*H. R. WEBB, Edmonton, Alta.
*A. S. WOOTTON, Vancouver, B.C.
*S. YOUNG, Regina, Sask.
‡For 1936-37-38

TREASURER
J. B. CHALLIES, Montreal, Que.

SECRETARY
R. J. DURLEY, Montreal, Que.

OFFICERS OF BRANCHES

HALIFAX
Chairman, C. S. BENNETT
Vice-Chair., C. SCRYMGEOUR
Sec.-Treas., R. R. MURRAY,
Wm. Stairs Son & Morrow, Ltd., Halifax, N.S.
Executive, J. R. KAYE, I. P. MACNAB, J. D. FRASER, J. F. F. MacKENZIE, W. H. NOONAN, J. W. McLEOD, J. B. HAYES
(Ex-Officio) H. FELLOWS, H. S. JOHNSTON

CAPE BRETON
Chairman, M. R. CHAPPELL
Sec.-Treas., S. C. MIFFLEN,
60 Whitney Ave., Sydney, N.S.
Executive, C. M. ANSON, S. G. NAISH, I. W. BUCKLEY, W. S. WILSON
(Ex-Officio) W. E. BOWN, Y. C. BARRINGTON

SAINT JOHN
Chairman, J. R. FREEMAN
Vice-Chair., G. H. THURBER
Sec.-Treas., F. A. PATRIQUEN,
P.O. Box 24, Saint John, N.B.
Executive, T. C. MACNABB, T. MOFFAT, S. HOGG
(Ex-Officio) V. S. CHESNUT, G. A. VANDERVOORT

MONCTON
Chairman, G. L. DICKSON
Vice-Chair., E. B. MARTIN
Sec.-Treas., V. C. BLACKETT,
Engrg. Dept., C.N.R., Moncton, N.B.
Executive, F. O. CONDON, C. S. G. ROGERS, R. H. EMMERSON, F. L. WEST, A. S. GUNN, G. C. TORRENS
(Ex-Officio) T. H. DICKSON, H. B. TITUS, H. W. McKIEL

SAGUENAY
Chairman, S. J. FISHER
Vice-Chair., F. L. LAWTON
Sec.-Treas., G. H. KIRBY
P.O. Box 22, Riverbend, Que.
Executive, G. F. LAYNE, H. PELLETIER, G. E. LAMOTHE, C. MILLER
(Ex-Officio) J. SHANLY, L. R. BEATH

QUEBEC
Hon. Chair., A. R. DECARY
Chairman, ALEX. LARIVIERE
Vice-Chair., J. T. F. KING
Sec.-Treas., J. JOYAL,
Quebec Public Service Comm., Court House, Quebec, Que.
Executive, R. WOOD, L. P. METHE, M. BOURGET, A. O. DUFRESNE, J. G. O'DONNELL, A. ROBERGE
(Ex-Officio) A. B. NORMANDIN, HECTOR CIMON

ST. MAURICE VALLEY
Chairman, B. GRANDMONT
Vice-Chair., J. E. FLEURY
Sec.-Treas., J. A. HAMEL,
642 Notre Dame St., Three Rivers, Que.
Executive, F. W. BRADSHAW, C. L. ARCAND, H. J. WARD

MONTREAL
Chairman, J. B. D'AETH
Vice-Chair., H. MASSUE
Sec.-Treas., C. K. McLEOD,
1440 St. Catherine St. W., Montreal, Que.
Executive, R. H. FINDLAY, C. C. LINDSAY, B. R. PERRY, T. C. THOMPSON, J. A. LALONDE, J. A. E. GOHIER
(Ex-Officio) F. S. B. HEWARD, A. COUSINEAU, C. B. BROWN, P. L. PRATLEY, O. O. LEFEBVRE, E. A. RYAN, F. NEWELL, A. FRIGON, F. P. SHEARWOOD

OTTAWA
Chairman, E. VIENS
Sec.-Treas., F. C. C. LYNCH,
Dept. of Mines, Victoria Memorial Museum, Ottawa, Ont.
Executive, E. M. DENNIS, T. A. McELHANNEY, N. B. MacROSTIE, G. R. TURNER, B. F. HAANEL
(Ex-Officio) E. W. STEDMAN, R. W. BOYLE, A. K. HAY

PETERBOROUGH
Chairman, H. R. SILLS
Sec.-Treas., W. T. FANJOY,
627 Homewood Ave., Peterborough, Ont.
Executive, V. R. CURRIE, A. L. KILLALY, E. J. DAVIES, W. M. CRUTHERS
(Ex-Officio) A. L. DICKIESON, A. B. GATES, R. L. DOBBIN

KINGSTON
Chairman, R. A. LOW
Vice-Chair., Lt.-Col. N. C. SHERMAN
Sec.-Treas., Major L. F. GRANT,
Royal Military College, Kingston, Ont.
Executive, G. G. CARR-HARRIS, S. STEPHENSON, J. E. GOODMAN
(Ex-Officio) W. CASEY, L. F. GOODWIN

TORONTO
Chairman, O. HOLDEN
Vice-Chair., A. U. SANDERSON
Sec.-Treas., W. S. WILSON,
Mining Bldg., University of Toronto, Toronto, Ont.
Executive, W. P. DOBSON, N. MacNICOL, W. E. P. DUNCAN, A. M. REID, D. D. WHITSON, C. E. SISSON
(Ex-Officio) W. E. BONN, A. B. CREALOCK, R. E. SMYTHE, F. A. GABY

HAMILTON
Chairman, W. HOLLINGWORTH
Vice-Chair., E. G. MacKAY
Sec.-Treas., A. LOVE,
40 Paisley Ave. S., Hamilton, Ont.
Executive, W. J. W. REID, A. R. HANNAFORD, V. S. THOMPSON, D. W. CALLANDER
(Ex-Officio) E. P. MUNTZ

LONDON
Chairman, JAS. FERGUSON
Vice-Chair., A. O. WOLFF
Sec.-Treas., D. S. SCRYMGEOUR,
London Structural Steel Co. Ltd., London, Ont.
Executive, E. V. BUCHANAN, W. C. MILLER, J. R. ROSTRON, H. A. McKAY, W. M. VEITCH
(Ex-Officio) S. W. ARCHIBALD, S. G. JOHRE, J. A. VANCE

NIAGARA PENINSULA
Chairman, G. H. WOOD
Vice-Chair., L. C. McMURTRY
Sec.-Treas., P. A. DEWEY,
1224 Ontario Ave., Niagara Falls, Ont.
Executive, S. HAIRSINE, W. D. BRACKEN, M. H. JONES, C. S. BOYD, R. A. BRADLEY, C. G. MOON, A. W. F. McQUEEN
(Ex-Officio) P. E. BUSS, E. P. MURPHY

BORDER CITIES
Chairman, T. H. JENKINS
Vice-Chair., C. F. DAVISON,
Sec.-Treas., BOYD CANDLISH,
170 Rankin Blvd., Sandwich, Ont.
Executive, E. M. KREBSER, D. T. ALEXANDER, C. G. WALTON
(Ex-Officio) C. G. R. ARMSTRONG, H. J. COULTER

SAULT STE. MARIE
Chairman, J. L. LANG
Vice-Chair., W. SEYMOUR
Sec.-Treas., N. C. COWIE,
15 Hearst St., Sault Ste. Marie, Ont.
Executive, E. M. MacQUARRIE, T. FOULKES, C. W. HOLMAN, H. W. SUTCLIFFE
(Ex-Officio) F. SMALLWOOD

LAKEHEAD
Chairman, F. C. GRAHAM
Vice-Chair., G. R. DUNCAN
Sec.-Treas., G. R. McLENNAN
80 North High St., Port Arthur, Ont.
Executive: H. G. O'LEARY, J. M. FLEMING, K. A. DUNPHY, E. A. KELLY, E. L. GOODALL, W. J. BISHOP
(Ex-Officio) G. H. BURBIDGE, R. J. ASKIN

WINNIPEG
Chairman, G. E. COLE
Vice-Chair., A. E. MacDONALD
Sec.-Treas., J. F. CUNNINGHAM,
918 Somerset Ave., Fort Garry, Man.
Executive, F. W. ALEXANDER, H. L. BRIGGS, W. D. HURST, R. W. McKINNON, W. F. RIDDELL
(Ex-Officio) E. V. CATON, F. V. SEIBERT, T. C. MAIN

SASKATCHEWAN
Chairman, W. E. LOVELL
Vice-Chair., STEWART YOUNG
Sec.-Treas., J. J. WHITE,
City Hall, Regina, Sask.
Executive, A. R. GREIG, J. W. D. FARRELL, J. McD. PATTON, H. S. CARPENTER, H. J. BYRD, S. R. MUIRHEAD
(Ex-Officio) A. P. LINTON

LETHBRIDGE
Chairman, P. M SAUDER
Vice-Chair., R. F. P. BOWMAN
Sec.-Treas., E. A. LAWRENCE,
207-7th St. S., Lethbridge, Alta.
Executive, J. M. CAMPBELL, J. B. DeHART, W. MELDRUM
(Ex-Officio) W. L. McKENZIE, G. S. BROWN, C. S. CLENDENING

EDMONTON
Chairman, E. STANSFIELD
Vice-Chair., A. RITCHIE
Sec.-Treas., M. L. GALE
9914-111 St. Edmonton Alta.
Executive, J. D. BAKER, W. E. CORNISH, C. E. GARNETT, A. J. GAYFER, E. NELSON
(Ex-Officio) F. K. BEACH, H. R. WEBB

CALGARY
Chairman, JOHN DOW
Vice-Chair., H. W. TOOKER
Sec.-Treas., JAS. McMILLAN,
506 Insurance Exchange Bldg., Calgary, Alta.
Executive, J. J. HANNA, W. T. McFARLANE, H. J. McEWEN
(Ex-Officio) J. HADDIN, F. M. STEEL, H. J. McLEAN

VANCOUVER
Chairman, JAS. ROBERTSON
Vice-Chair., H. N. MACPHERSON
Sec.-Treas., T. V. BERRY,
3007-36th Ave. W., Vancouver, B.C.
Executive, E. C. THRUPP, P. SANDWELL, G. L. BOOKER, J. P. MACKENZIE, P. H. BUCHAN, C. P. HAMILTON, F. O. MILLS
(Ex-Officio) G. M. GILBERT, E. A. CLEVELAND, A. S. WOOTTON

VICTORIA
Chairman, I. C. BARLTROP
Vice-Chair., J. C. MacDONALD
Sec.-Treas., KENNETH REID,
1336 Carnsew St., Victoria, B.C.
Executive, G. M. DUNCAN, G. M. IRWIN, G. M. TRIPP, C. D. SCHULTZ
(Ex-Officio) D. MacBRIDE, H. L. SWAN

THE ENGINEERING JOURNAL

The Institute as a body is not responsible either for the statements made or for the opinions expressed in the following pages.

Volume XIX | Montreal, October, 1936 | Number 10

Reconstruction of Berths 1, 2, 3, 4, Saint John Harbour, N.B.

V. S. Chesnut, A.M.E.I.C.,
Senior Engineer, Saint John Harbour Commission, Saint John, N.B.

Paper presented before the Maritime Professional Meeting of The Engineering Institute of Canada, Saint John, N.B., August 28th, 1936.

SUMMARY.—Describes the removal of the old, and the construction of the new, sub-structures and wharves forming four berths on the west side of Saint John harbour. The new concrete wharves are of the cylinder and deck-slab type. Difficulties due to the nature of the ground and the existence of previous wharves were overcome.

The harbour of Saint John includes both sides of the Saint John river, and is one of the oldest in Canada, dating from 1604 when it was discovered by Samuel de Champlain. The first wharf was built one hundred and sixty-five years later by the early English settlers Simonds, Hazen and Jarvis. In 1785, two years after the present city of Saint John was founded as Parr's Town, the British government granted the city the harbour waters from the entrance at Partridge island to a point on the Saint John river above the reversing falls. The development of shipping in the harbour was very rapid, the period between 1795 and 1870 showing an increase from 4,000 to 400,000 tons owned and registered in the port of Saint John. The year 1889 was of great importance, for it was in that year that the Canadian Pacific Railway completed and started to operate its rail connection between Saint John and Montreal. From that time on, the city, the railway company and the Federal government worked together in the development of the harbour. Then in 1927 the Federal government purchased the city's interests in the harbour and established it as a national harbour under the jurisdiction of a Harbour Commission.

Four years later, on June 22nd, 1931, the whole of the west side harbour facilities were destroyed by fire, down to about half tide level. Reconstruction of all the burned facilities, with the exception of berths 1, 2, 3 and 4, was started immediately, and the new wharves and sheds were opened for business in December of the same year. Because of the bad condition of the substructure of berths 1, 2, 3 and 4, it was decided to leave their reconstruction to some future time when sufficient funds should be available to demolish the old timber cribwork and build complete new structures.

Figure 1 shows the location of berths 1, 2, 3, 4. The ground now occupied by these berths was originally a tidal beach. Various small wharves were built and the ground gradually raised with fill. As ships became larger, deeper water was required, and new wharves were built farther out from the old shore line, until finally the cribs that have recently been demolished were built to accommodate ships up to 30 feet draught. As the old shore line was gradually pushed out, the old wharves were covered over with fill, so that today a pile can hardly be driven in this area without striking timber.

Some diamond drill borings and a number of wash borings were taken at the time of reconstruction of the other berths, and these were gradually added to during the next two years, so that a very complete record of foundation conditions was obtained. These show that the solid rock surface is about at elevation −55 at the west end of berth 4 and that it rises to elevation −35 in about 700 feet. It then falls away towards the intersection of berths 1 and 2, where it is at elevation −85. From that point it rises again to about elevation −50 at the south end of berth 1. In berth 4 and part of berth 3 the rock is covered with a layer of very hard compacted clay mixed with sand and gravel. This varies in depth up to about six feet. Over this is a deposit of stiff red clay sloping off from slightly above low water at the west end of berth 4 to nothing at the outer end of this berth. Very little hardpan is indicated at berth 1. Overlying these materials is silt of various depths and degrees of compaction.

The old structures were timber cribs founded on the more or less soft bottom of the harbour at about elevation −30. They were weighted down with rock ballast supported on ballast floors at various levels. The ground at the rear of the cribs was filled with burned off timber piles which had supported the transit sheds and railway trestles. Before new structures could be built all this old cribwork, timber piles, etc., would have to be demolished and disposed of.

The first move in the reconstruction of these berths was made when a contract was let in August 1934 to the Saint John Dry Dock and Shipbuilding Company Limited, for the demolition of the old cribwork and the dredging of the site, preparatory to construction operations. The contract provided that the work was to be done on a cost plus percentage basis. The contractor was to provide all the necessary plant at fixed rental rates and the Department of Marine was to loan the large dipper dredge *Churchill* to the contractor.

Work was started immediately, the first stage of the operations being the demolition and disposal of the crib-work from the top down to low water. The cribs were torn apart by locomotive cranes and floating derricks, and the timber was loaded onto deck scows. When the scows were fully loaded they were towed to the bulkhead wall south of berth 17, where they were unloaded by locomotive cranes. These cranes also piled the timber on a vacant area adjacent to the point of unloading. Most of this old reclaimed timber was cut into firewood by the city and county for distribution to persons on relief, and by individuals who cut it up and hauled it away for their own use.

The second stage of operations was begun upon the arrival of the dredge *Churchill*. This consisted of breaking up the cribwork below low water level, and dredging the site to the full width and depth required for the new structures.

This work was discontinued during the winter and, before operations were resumed in the spring of 1935, the contract was changed to provide for payment at a price per cubic yard for removal of all material, including timber. The dredge *Churchill* was withdrawn from the work by the Department of Marine and was replaced by the ladder dredge *Leconfield* owned by the contractor. The demolition was now handled with marine plant entirely, the remaining timber being practically all below low water level. The dredging and demolition have now been completed to the final grades which are elevation −35 in berth 1 and elevation −30 in berths 2, 3 and 4.

In giving consideration to what would be the most suitable type of substructure, the following types were investigated from the standpoint of both cost and suitability:

(1) Timber construction, cribs to be used where the rock surface was highest, and piles where it was low.
(2) One row of concrete cylinders sunk to rock along the face line with timber piles at the rear, supporting a concrete deck.
(3) Two rows of concrete cylinders with timber piles at the rear, supporting a concrete deck.
(4) Three rows of cylinders with timber piles under the rear wall only, supporting a concrete deck.

Type (3) was finally adopted as being very much more stable and permanent than (1) and (2) and costing very little more. Type (4) had many desirable features but would cost about half a million dollars more.

The layout of the face line of the berths was altered to provide a better approach to berth 4 and to straighten the alignment of berths 1 and 14 as much as possible. Berth 4 was lengthened to 600 feet, berths 2 and 3 were made into one berth 753 feet 4 inches long, and berth 1 became 769 feet 4 inches long. The total length of the new wharf structure is 2,122 feet 8 inches and the new bulkhead wall between berths 4 and 5 is 324 feet long.

Figure 2 shows a typical cross section of the type of construction adopted. A single bent is shown, and bents are 20 feet apart throughout the length of the structure. The two rows of precast concrete cylinder shells are sunk to rock level and extend up to elevation +15. After their foundation is reached they are filled with concrete. Lateral walls, 24 inches thick, tie the two rows of cylinders together at each bent. The front wall is continuous and ties the front row of cylinders together longitudinally. The two rows of concrete column footings are supported on timber piles, there being 13 piles under each footing. The columns are 3 feet 6 inches in diameter and are spread to 7 feet diameter at the top of the footings and 5 feet 6 inches diameter at the under side of the deck slab. The rear wall is continuous and is supported on the front of the timber relieving platform. Longitudinal and lateral con-

Fig. 1—Saint John Harbour.

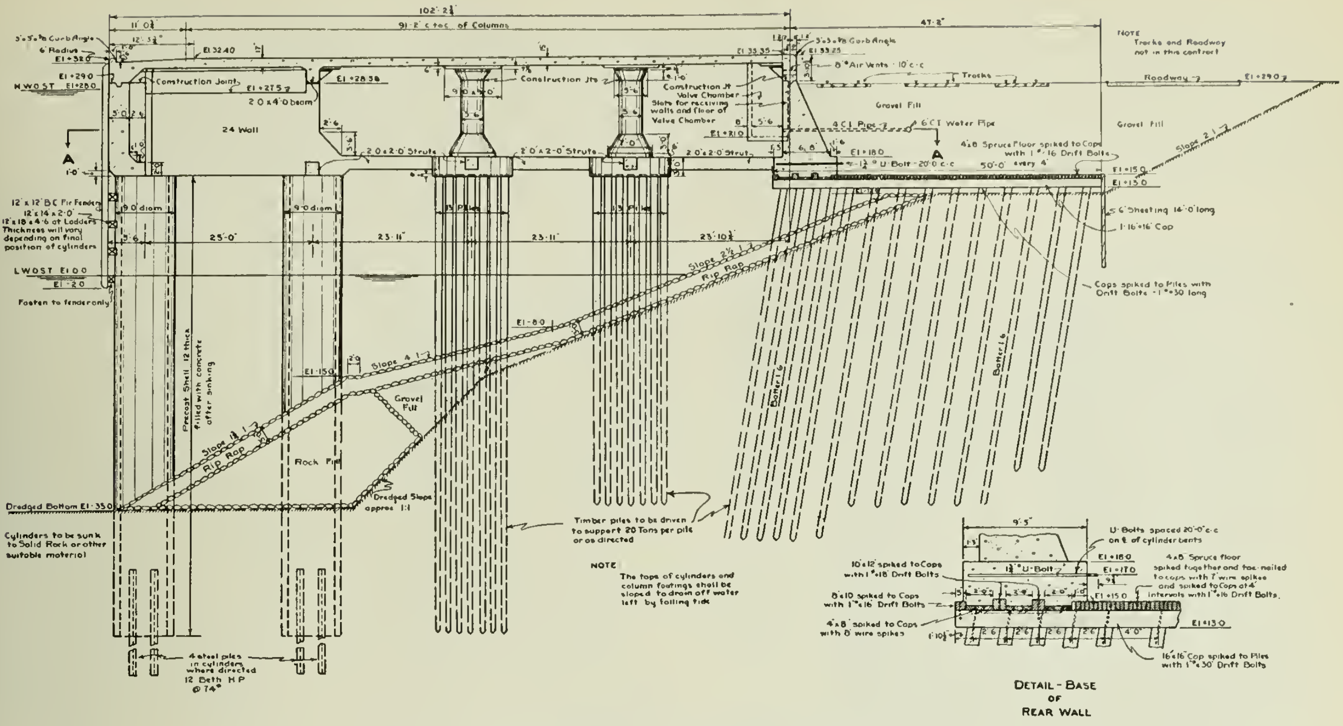


Fig. 2—Typical Section Main Structure.

crete struts, two feet square, tie the various units of the structure together at the level of the tops of the cylinders. The deck slab is supported by the walls and columns, and the major portion is designed as a two-way reinforced concrete flat slab. The timber relieving platform serves as a means of reducing the pressure on the main structure. This platform was not included in the original plans, the rear wall being carried directly on timber piles, but was added when ground movement developed during the driving of the rear wall piles in berth 4. Rock rip-rap, three feet thick, is placed on the dredged slopes as shown.

Figure 3 shows a perspective view of the completed structure with transit shed.

Figure 6 shows a cross section of the bulkhead wall between berths 4 and 5. This structure consists of a timber relieving platform at elevation +15 supporting a concrete retaining wall on the front. Steel anchor rods tie the base of the wall back to a continuous concrete anchor wall. No. 5 Larssen steel sheet piling is driven along the face of the platform to a depth of 20 feet below the bottom of the slip, and the tops of the piles project into the base of the retaining wall.

Figure 8 shows a cross section of the structure across the south end of berth 1. It was necessary at this point to provide a cut-off to retain the ground on which berth 14 transit shed stands. This structure consists of a relieving platform at elevation +15 extending under the end of No. 14 shed, with a concrete retaining wall along the north edge. This wall also forms the end wall of the new main structure.

The concrete in these structures is the most important material entering into their construction, particularly from the standpoint of future maintenance costs. The range of tide in the harbour is 28 feet, and during the winter the surfaces of structures within the tidal range are subject to alternate freezing and thawing. It is therefore essential, above all other things, to obtain a concrete as impervious to water as possible. To achieve this result it is necessary that the aggregates should be clean and sound and carefully graded and proportioned. A rich mixture, the proper amount of mixing water, and careful mixing and placing are also necessary. Careful control methods had been used during the construction of the Navy island berths and thus valuable experience had been obtained. Tests made at that time established the fact that the bay shore sand and gravel fully met all the requirements as to cleanness and soundness, but that care was necessary in the selection of the material in order to get proper grading. The method of measuring batches on the Navy island work was antiquated, but very gratifying results were obtained owing to careful inspection. These results are recorded in a paper by J. H. McKinney.*

There are two classes of concrete specified, No. 1 concrete containing 658 pounds of cement per cubic yard of concrete, and No. 2 concrete containing 470 pounds of cement. The No. 1 concrete is used throughout the work, except for the cylinder fill, which is No. 2. The grading

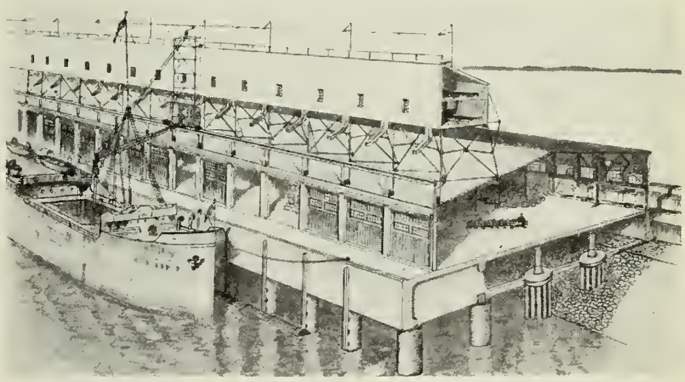


Fig. 3—Perspective View of Typical Berth.

of the coarse and fine aggregate is specified, but the proportioning is left to the engineer in the field. Experience has proved this to be more satisfactory than specifying definite proportions, on account of variations in grading. The fine

*"Field Control of Concrete," by J. H. McKinney, Engineering Journal, December 1933.

and coarse aggregate are supplied separately, run of beach gravel not being allowed. It has been found that the quantity of sand required is from 36 to 40 per cent of the total quantity of aggregate. An important feature of the specification is the requirement that the concrete be vibrated while placing. This, it is hoped, will produce a denser concrete than can be obtained by the ordinary methods of placing.

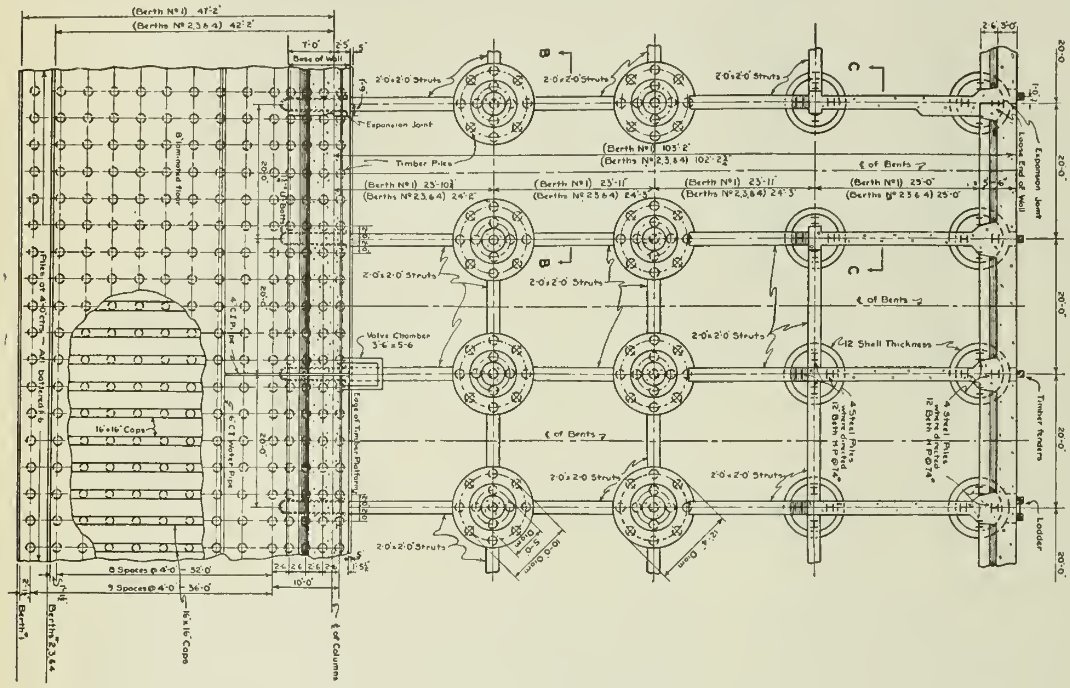


Fig. 4—Plan at Elevation +15, Main Structure.

With this preliminary outline of the work involved, reference will now be made to the actual construction operations. On June 20th, 1935, a contract was let by the Department of Marine at Ottawa to the Foundation Company of Canada, Limited, for the construction of the above mentioned structures, the work to be completed within two years. It should be noted here that no transit sheds are included in this contract. It is expected that funds will be available for the sheds in 1937. To construct the bulkhead wall between berths 4 and 5 it was necessary to close off a portion of Union street and to remove the railway tracks connecting with berths 5, 6 and 7. To construct the cut-off at berth 14 it was necessary to temporarily dismantle the end section of the existing shed 14. As it was essential that the roadway, tracks, and transit shed should be available for service during the busy winter shipping season, provision was made in the specification that these two sections of the work should be completed before December 1st. Therefore the work planned for the first season included the construction of the bulkhead and cut-off walls, and the casting, sinking and filling of a number of the cylinders.

The following special floating plant was brought on the work by the contractor:—

The *Foundation Scarboro* is the largest piece of floating equipment on the work. The hull is 100 feet by 42 feet with a moulded depth of 11 feet 6 inches. It is equipped with 85-foot shear legs overhanging the stern 40 feet, and having a capacity of 150 tons. The shear legs were built especially to handle the precast cylinders on this contract and the buoyancy of the hull was increased, to conform with the increased capacity of the shear legs, by tying two steel tanks to the sides near the stern. It is also equipped with a revolving crane having a capacity of 25 tons at a radius of 25 feet or 7 tons at 75 feet, and air compressors with a capacity of 1,600 cubic feet per minute low pressure or 1,050 cubic feet high pressure.

The *Foundation Masson* is a Diesel driven floating crane equipped with a revolving crane of 25 tons capacity.

The *Foundation Fafnir* is a floating concrete mixing plant. It is equipped with a tower hoist and chutes. The mixer is a 2-cubic-yard steam driven Smith tilting type mixer. Aggregate storage bins are loaded from scows by a small gas powered crawler crane placed amidships. The coarse aggregate is measured in a batch hopper and the sand in an inundator.

Other plant was also provided as follows:—

The *Foundation Sydney*, a floating derrick scow equipped with a 15-ton steam driven stiff leg derrick.

Two Diesel compressors.

A small crawler crane.

Arrangements were made by which the inner section of the drydock at Courtenay bay could be used for the casting of the cylinders. This was an ideal location, for more than three-quarters of the concrete could be placed without hoisting above the coping level of the dock. To remove the cylinders it was only necessary to flood the dock and to bring in the *Foundation Scarboro* to transfer them, one by one, to the fitting-out berth just outside the drydock.

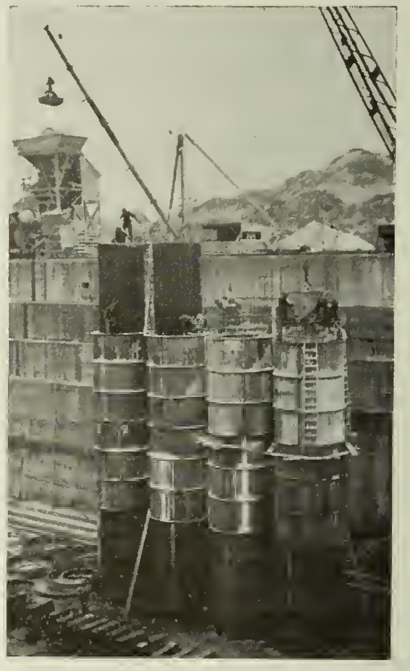


Fig. 5—Cylinder Casting.

A central mixing plant was set up on the south side of the inner dock. It is equipped with a ½-cubic-yard mixer set below aggregate bins. The coarse aggregate is measured in a batch hopper, and the sand in an inundator. The bins are loaded with a stiff leg derrick, and cement is delivered from a storage shed to the mixing floor by a belt conveyor. All this equipment is electric driven. The concrete is dumped into a one-cubic-yard bottom dump bucket standing on a flat car. This car is pushed to the site of placing by a locomotive crane, which then transfers the bucket to the cylinder being poured.

A screening plant was set up on the beach about three-quarters of a mile distant from the mixer. Oversized material from the screens is crushed and returned to the coarse aggregate bin. Transportation from the screening to the mixing plant is done by trucks. The quantity of coarse aggregate output from this plant is considerably less than the sand output, and it is therefore necessary to supply the deficiency from the bay shore on the opposite side of the harbour.

The operation of mixing and placing the concrete in the cylinders is fairly representative of the methods of placing and control throughout the whole work, and will therefore be outlined in some detail.

The following is the standard which was set up for the control of aggregate grading:—

Coarse Aggregate		Fine Aggregate	
Per cent passing 2″	100	Per cent passing ¼″	100
1½″	94	No. 4	95
1″	64	No. 8	85
¾″	41	No. 16	70
½″	27	No. 30	45
⅜″	10	No. 50	15.1
¼″	0	No. 100	1.5
Fineness modulus	7.55	Fineness modulus	2.88

As has been said before, the aggregates from the local beaches have always been found quite satisfactory from the standpoint of cleanness and strength, but the grading requires careful watching. It is sometimes necessary to add fines to the sand and to reduce the quantity of the smaller sizes in the gravel. It has been found that the use of a coarse sand, and a gravel carrying an excess passing the ⅜-inch screen, results in a harsh non-plastic, unworkable and porous concrete, which is most unsuitable for use in structures exposed to sea water and tidal conditions.

The cylinders are 9 feet outside diameter and are cast in lengths, varying in 5-foot intervals, from 55 to 70 feet. The walls are 12 inches thick and are heavily reinforced. A steel cutting edge is anchored into the bottom of each cylinder. The cutting edges are set up on the floor of the drydock and on top of each is set a section of steel forms 13 feet 6 inches high. The reinforcement is placed in position after the inner, but before the outer, form is set up. A flat wooden working platform is then placed on the top of the inner form. Four to six sets of forms are set

Fig. 7—Cylinder Setting.

up in a group and are all poured together, shifting from one to another in order to carry them up at a uniform rate. To place the concrete, the bottom-dump bucket is lowered down onto the working platform and dumped. Some of the concrete pours over into the forms but most of it has to be shovelled in by hand. One bucket load fills the forms practically one foot in height. Two vibrators are then immediately lowered into the forms and the concrete is vibrated at one-foot intervals around the circumference of the cylinder. The time required at each point is ten to fifteen seconds, or until the concrete becomes plastic. The concrete is sufficiently vibrated when it has levelled off and mortar begins to show on the surface. Over-vibration is bad, having the same effect as over-tamping or spading. The fines are all brought to the surface, which results in a porous concrete with a layer of mortar on the top of each lift. A vibrator weighs 82 pounds and as it is necessary to pull it up the full length of the forms to get over the form separators, two men are required to operate it. The vibrators used are the Jackson Vibro-Spade, operated by a one-horse-power submersible motor at 3,600 r.p.m. They are 4 inches in diameter and 16 inches long and have a rounded nose. The handles are rigid or flexible and the control switch is within easy reach.

During the pouring of the first few cylinders, various slumps, ranging from practically nothing to 2 inches, were tried in order to establish the consistency that would give the best results. A slump of 1½ inches was finally adopted as being the most satisfactory. The vibrating has one objectionable feature, that is the forming of air pockets on the outer face of the concrete. It seems to be impossible to

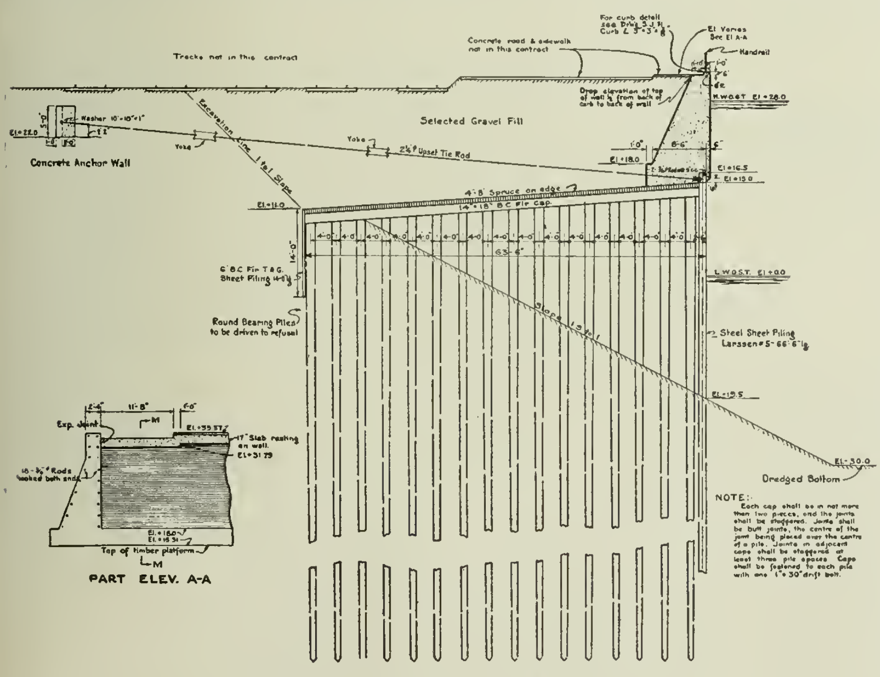


Fig. 6—Section of Bulkhead Wall.

eliminate this. These defects are not, however, considered to be a source of danger to the surface, for they are backed up with very dense concrete.

As soon as the top of the concrete is sufficiently set, at the end of a day's run, all laitance is removed, and the surface is carefully prepared for receiving the next lift. Just before starting the next run, the surface is wetted down and covered with a one-inch thick layer of mortar.

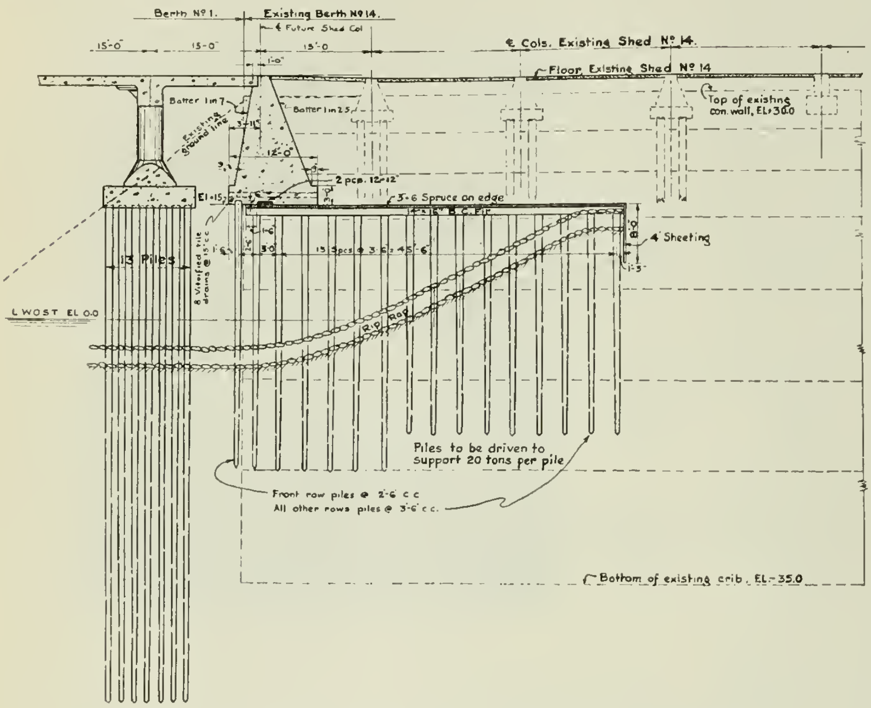


Fig. 8—Section of Cut-off at End of Existing Berth No. 14.

Curing of the outside surface is done by passing water through circular perforated pipes hung at the top of the lift and raised when the next lift is added. Whirling lawn sprays are used on the inside. Curing is continuous for seven days. The contractor is allowed to remove the cylinders from the drydock twenty days after the final lift has been placed.

The pouring is done in lifts of 13 feet 6 inches except the top lifts which are 5 or 10 feet, according to the length of cylinder required.

The first operation in connection with the construction of the bulkhead wall was the pile driving in the relieving platform. This was started with a pile driver on skids working off a pile trestle just above high water level. When the water was high, piles were set in position and driven as far as possible, then redriven to final bearing during the time that the water was below pile cut-off level. Other pile drivers were soon added, all hammers being either steam or air driven.

Shortly after the pile driving started, small cracks were observed in the ground surface about 100 feet back of the face line of the bulkhead wall, and close to the foundations of one of the grain gallery towers. This gallery is 120 feet from the face of the bulkhead and runs parallel to it. As the pile driving proceeded these cracks increased both in size and extent and other cracks developed just back of the gallery. It was also found that the grain gallery was shifting slightly forward, and that a number of the piles that had been driven for the relieving platform were shifting. In order to reduce the pressure on the slope and so stop this sliding, the ground surface was lowered about ten feet, back to a line slightly behind the gallery. This had the desired effect, although slight movement of the gallery and of piles on the slope was still observed. In the meantime some of the gallery foundations had shifted forward and settled several inches. In order to save the structure from serious racking the posts were jacked up and wedged above the tops of the foundation piers, and cables were run from the tops and bottoms of the bents to loaded coal cars placed on a siding behind the gallery. This was very effective and prevented further serious movement of the gallery, although some of the footings shifted considerably. The maximum movement of footings was about 12 inches forward and 12 inches down.

The construction of the platform deck followed close behind the pile driving. This consisted of cutting off the piles, placing the 14- by 18-inch timber caps and laying the 8-inch laminated floor. The driving of the steel sheet piling and the setting of the anchor rods was then started, and as soon as this had advanced far enough, the forms for the first section of the front retaining wall were erected. The forms were of wood and were built to the full height of the wall before pouring was started, and were made as watertight as practicable. The wall was divided into sections 30 feet in length, to provide for contraction. Pouring was started on the falling tide immediately after the water had fallen below the base of the wall. In this way the surface of the concrete was always kept above the water surface. Depositing was done in level layers about one-foot thick, great care being taken in the placing and vibrating to make sure that no segregation of aggregate occurred. The water content was kept to a minimum consistent with good workability. The concrete was mixed on the floating mixing plant and delivered through chutes to the forms.

The construction of the anchor wall followed along with the construction of the face wall. On account of the cracking of the ground in the area where it had been proposed to construct the anchor wall, the location was changed to a point 60 feet farther back, where there was no indication of any ground disturbance. The distance of the anchor wall from the face of the retaining wall is 160 feet.

When a stretch of anchor wall and front wall had been completed and sufficiently set, the anchor rods were tightened up and back filling was started. This had not proceeded very far when it was found that the face wall was slowly moving forward. Back filling was immediately stopped over the area at the rear of the relieving platform, but it was continued over the top of the platform. The wall still continued to move, so it was decided that some effective measure for stabilizing the whole structure would have to be adopted immediately. Accordingly the contractor was instructed to place a bank of gravel in front of the steel sheet piling. The Saint John Drydock Company dredge *Leconfield* started work at once in Courtenay bay and gravel was delivered at the bulkhead in 600 cubic yard hopper barges. The gravel was distributed along the full length of the structure and built up to low water level. Nearly 20,000 cubic yards were placed. Back-filling was then finally completed without further difficulty. This was followed by the relaying of the tracks that serve berths 5, 6 and 7, and the opening up of the section of Union street that had been closed. Surveys of the alignment of both the face wall and the anchor wall were continued for several weeks. These indicated that slight movement of both walls continued for a month or so, but this gradually slowed up and finally stopped. It should be mentioned that both the face wall and anchor wall moved the same amount, so that no failure of anchor rods occurred. The maximum movement of the walls was about one foot and took place at about the middle of the structure, tailing off to very slight movements at the two ends.

After all movements had finally ceased, the grain gallery was jacked back into its original position and new foundation piers were placed where the old ones had shifted too much out of line to be usable.

Before the contract is completed the two ends of the stabilizing gravel bank will be removed so that ships can be docked close up to the bulkhead line in berths 4 and 5. The heavy portion of the bank in front of the centre section of the bulkhead will remain.

The *Foundation Scarboro* and the *Foundation Masson* proved most useful in many ways on this part of the work, particularly in driving timber piles and steel sheet piling, and in handling the heavy timber caps for the relieving platform.

The construction of the cut-off at berth 14 did not present any difficulties, except that the pile driving was very hard and uneven on account of having to drive some of the piles through old cribwork. A stiff leg derrick was set up at this point, and this outfit did most of the excavation, and drove the piles with swinging leads. The *Masson* also assisted. The construction of the concrete retaining wall was handled in the same manner as the bulkhead wall.

The cylinder sinking is the least straightforward of the operations on this work, for, on account of the variable foundation conditions, each cylinder presents a problem in itself. Before this operation was started, pile and timber falsework was constructed. A separate enclosure, built to act as a guide to the cylinder while sinking, is provided for each cylinder. The falsework is carried forward as the cylinder sinking proceeds. A travelling derrick for excavating the cylinders is operated from the top of the falsework. Before a cylinder is placed in position, the site is cleaned out to make sure that there is no timber or other obstruction on the bottom. The cylinder to be sunk is then brought over by the *Foundation Scarboro* from the storage area at the drydock fitting out berth. It is hoisted in a vertical position by the *Scarboro's* shear legs until it is well clear of the bottom, and then the outfit is towed over to the point of sinking. The cylinder is then placed in its berth in the falsework, carefully located for position and slowly lowered on to the bottom. If the bottom is soft, it will sink several feet into the ground under its own weight. Excavating with clamshell inside the cylinder is then started by the travelling derrick. As the material is removed from around the cutting edge, the cylinder continues to sink, and if the material is soft all the way down to the rock, as is the case at berth 1, no extra weight is required to sink it to its final bearing, and no jetting is required except to clean up the rock surface preparatory to placing the concrete fill. When hard material is encountered, as at berth 4, and part of berth 3, it is necessary to place cast iron weights on the top of the cylinder and to jet below the cutting edge. In this area, divers worked in three shifts, jetting continuously, in order to loosen the material so that it could be clammed out. Additional weights up to 50 tons were used to break the friction on the sides of the cylinders. A number of boulders were also encountered in this area. When these were too large to lift out, they were broken by blasting. As the sinking proceeds, the cylinder locations are carefully checked, and any tendency of the cylinder to drift is controlled by jetting at the cutting edge and jacking at the top. Besides the travelling derricks, the *Scarboro* and *Masson* are used for sinking.

After a cylinder has been sunk to its foundation and checked for location, the bottom is examined by a diver, and when it has been reported clean, approval is given for filling. A cylindrical steel extension, reaching nearly to high tide level, is then placed on the top of the cylinder to act as a guide for the concrete bucket. The concrete for the fill is mixed on the *Fafnir* which chutes it to a hopper on the falsework. This hopper fills the bucket while it is held over the cylinder by the hoist. The bucket is one cubic yard capacity. It is filled level full and slowly lowered until it is under the surface of the water, in order to prevent wash, after which it is dropped more quickly. On reaching the bottom, the bucket is slowly raised so that as little disturbance as possible will be made. As a certain amount of cement is lost in an underwater operation, No. 1 concrete is placed at the base of the cylinders up to one foot above the cutting edge in order to make a good seal with the rock. The concrete is stopped off at elevation +7, or somewhat lower if the top of the cylinder is below that elevation. A considerable amount of laitance is formed on the top of the pour, the average being 8 to 12 inches. This is all carefully removed down to good sound concrete before the cylinder is extended up to its finished level. The concrete fill is not vibrated, this not being considered necessary or advisable when the concrete is placed under water.

When a cylinder has reached its foundation, its top is usually several feet below the finished elevation, which is elevation +15. To extend it to the correct level, a circular steel form is set up and filled during the low tide period. The concrete in the extension is vibrated.

The cylinder sinking was first started at the south end of berth 1, and twelve cylinders were sunk and filled with concrete before the end of last year. The weather was then becoming too stormy to continue work in such an

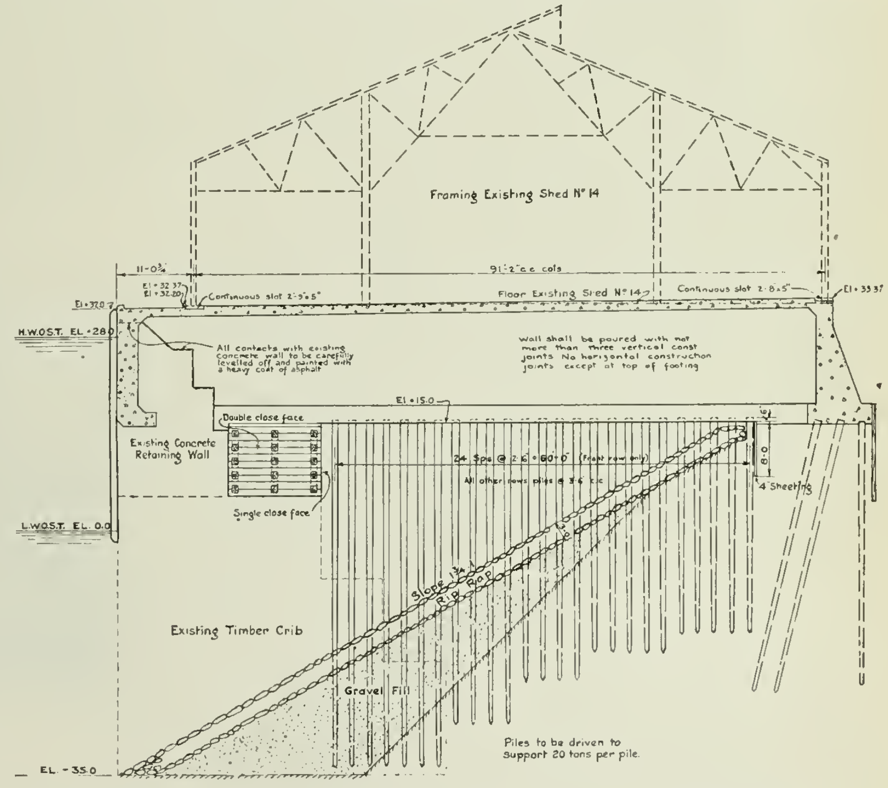


Fig. 9—Sectional Elevation Showing Connection with Existing Berth No. 14.

exposed position, so the operations were shifted to the west end of berth 4. A number of cylinders were sunk and filled at this point, this being the only work that was done during the winter. In March a pile driver was set up at the west end of berth 4 and work was started on driving the piles in the rear wall and column clusters. Before this operation had proceeded very far, cracks were observed in the ground at the rear, and a check up on the

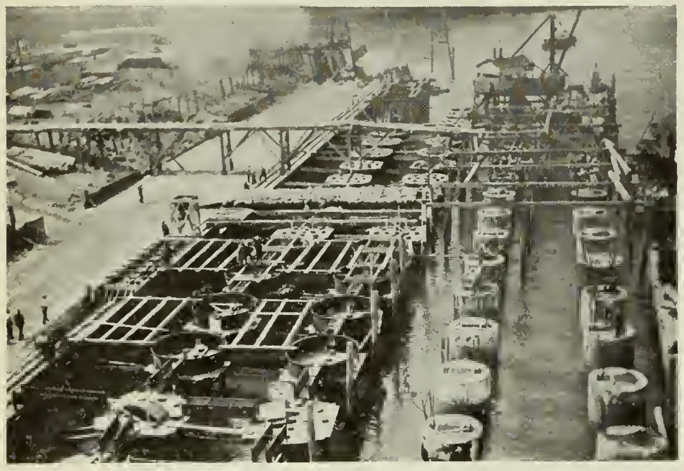


Fig. 10—Completed Foundations.

locations of the cylinders close to the pile driving operations showed that several of them had shifted. Pile driving was continued for another day, but when it was found that the cylinders were still shifting, the work was closed down until the whole situation could be studied and a means developed for protecting the work. A careful survey of the cylinders disclosed that they were tilting on their bases, but the bases were holding position. Slight movement continued for a couple of weeks and the cracks behind the rear wall increased in size, but no actual slide developed and everything finally came to rest again. The maximum movement of any cylinder was seventeen inches.

After careful study, it was finally decided to excavate the ground down to about elevation +12 to a line about 50 feet back of the rear wall, and to build a timber relieving platform on timber piles in this area. In order that the cylinders would not again be disturbed by pile driving, it was decided to keep the pile driving in advance of the cylinder sinking. It was also decided to flatten the slope and place more rock riprap than had first been planned. After the plans had been revised to include these changes, the work was resumed, the operations being again transferred to berth 1. Comparatively little excavation was necessary at this berth and work was started on pile driving almost immediately. Excavation at berths 2, 3 and 4 was much heavier. This work was sublet and the sub-contractor brought in a 3-cubic-yard dragline with a 100-foot boom. Material excavated from berths 2 and 3 was loaded into scows and dumped at sea, while at berth 4 it was loaded on trucks and disposed of at Navy island.

The piles in the relieving platforms require to be driven on a 1 to 6 batter, so it was necessary to rig up pile drivers with battered leads. The drivers are built on skids and are set up on falsework above high water level. As the cut-off level is about fifteen feet below this point, it was necessary to provide telescopic extensions to the leads to support the hammer when it passed below the base of the driver. Two drivers were rigged up in this manner, the leads being 60 feet long and the extensions 40 feet. Driving was extremely difficult and variable at berth 1, on account of old buried cribwork and slabwood. Otherwise this work has continued without interruption. The piles in the column clusters are driven with a revolving driver set up on falsework in a similar manner to the others. No. 9B McKiernan-Terry hammers are used. The piles range in length from 30 feet to 80 feet, which gives a fair indication of the variable nature of the ground.

The construction of the relieving platform deck follows closely behind the pile driving. The placing of rock riprap on the slopes also follows along behind the cylinder sinking and pile driving. The rock is quarried about three miles up the river and is delivered to the work in scows and trucks, where it is rehandled, when necessary, by floating and travelling cranes.

During the winter and early spring, a gravel screening plant and central concrete-mixing plant was set up close to berth B, about a half mile from the site of the work. The gravel is dredged at Courtenay bay and is delivered in scows and dumped in front of the bulkhead wall south of berth B. It is then excavated by a coal pocket type gantry, which stands on the bulkhead wall, and is separated over screens and delivered to sand and gravel bins. From these bins it is delivered by belt conveyors to stock piles close to the mixing plant. Gravel for filling behind the structures is handled in the same manner, except that the gantry loads it directly into trucks.

The mixer in the central mixing plant is two cubic yards capacity and is charged by weighing batcher equipment. The aggregate storage bins are loaded by a stiff leg derrick from the storage piles made by the screening plant. All equipment is motor driven. Sand is also supplied to this mixer from the Courtenay bay screening plant. The concrete is conveyed to the work in one cubic yard buckets on motor trucks.

The forms for the walls, columns and struts are of steel supported by steel beams resting on the tops of cylinders and wall and column footings. The slab forms are of wood supported by wood beams shored from the cylinders and footings. The concrete for this part of the work is supplied by the central mixing plant at berth B. The method of placing is similar to that used in casting the cylinders.

Permeability tests were made on four No. 1 concrete test cylinders 6 inches in diameter by 6 inches long. A

Fig. 11—Pile Driving.

hydrostatic pressure of 45 pounds per square inch was applied to one end of each cylinder over a continuous period of twenty-eight days and the maximum penetration of water through the surface was ¾ inch.

Compression test cylinders 6 inches in diameter by 12 inches long have been taken once a week during concrete operations, and the following very satisfactory results have been obtained:—

Average strength	7 days............	4,100 pounds per square inch
Average strength	28 days............	4,738 pounds per square inch
Highest strength	7 days............	4,945 pounds per square inch
Highest strength	28 days............	5,655 pounds per square inch

The total cost of the work, including demolition, dredging and construction will be about two and three-quarter million dollars.

The construction work is in charge of F. C. Jewett, A.M.E.I.C., representing the National Harbours Board. D. G. Ross, A.M.E.I.C., is resident engineer and J. H. McKinney, A.M.E.I.C., is concrete engineer. All plans for the work have been prepared by the Harbour Commission staff under the direction of the author, and approved by the engineers of the National Harbours Board. Alexander Gray, M.E.I.C., is port manager and chief engineer.

The Fundamentals of Air Conditioning

G. Lorne Wiggs, A.M.E.I.C.,
Consulting Engineer, Montreal, Que.

Paper presented at the Maritime General Professional Meeting of The Engineering Institute of Canada, Saint John, N.B., August 27th to 29th, 1936.

SUMMARY—The author defines and outlines the fundamentals of air conditioning and explains the thermodynamic properties of air vapour mixtures. He also gives a brief review of the types of air conditioning systems, their functions, and the purposes for which they are designed.

Air conditioning is one of the most widely discussed topics of the day. One can read something about it in almost any newspaper and magazine that is picked up. Even the man in the street, who will probably never be able to obtain the comfort and health conditions which it gives, is interested in it. But, because of the novelty of the subject to the general public, because of the subject being so little understood, and due to the many erroneous and conflicting claims of many manufacturers of equipment, considerable confusion and misconception of the term have arisen. It is, therefore, the purpose of this paper to define "air conditioning" and to describe how air conditioning is accomplished.

Air Conditioning Defined

The generally accepted definition of air conditioning is that given in "The Guide" of the American Society of Heating and Ventilating Engineers:

> "Air conditioning—The simultaneous control of all or at least the first three of those factors affecting both the physical and chemical conditions of the atmosphere within any structure. These factors include temperature, humidity, motion, distribution, dust, bacteria, odours, toxic gases, and ionization, most of which affect in greater or lesser degree human health or comfort."

This is a broad definition and is intended to cover all types of air conditioning installations and it is now generally recognized throughout Canada and the United States as the correct interpretation of the term. The glaring misuse of the term air conditioning and air conditioners in the United States, by the application of them to almost everything from a tin can to something approaching a pipe organ, has resulted in the National Better Business Bureau adopting this definition and recommending to publishers and advertisers that these terms be applied only to those systems which comply with it.

In other words true air conditioning should control temperature, by providing heating in the winter and cooling in the summer. It should control humidity, by adding moisture to the air in the winter and by removing moisture from the air in the summer. It should provide and control the air motion and air distribution throughout the year without the semblance of a draft or stagnation of the air at any point. It should cleanse the air so as to remove or minimize the dust and bacteria. It should supply the necessary amount of fresh air for the respiration of the occupants of the conditioned space. It is also known that air conditioning systems should control the ionic content, or electrical properties, of the air but in spite of the great amount of research carried out in this connection no method has as yet been found to do this.

In actual practice there are other considerations which enter into the engineering of air conditioning systems. These include the architectural and structural considerations and limitations, co-ordination with the other electrical and mechanical services in the building, the degree of quietness required, the provision for economic operation and proper maintenance, the provision for protection against breakdown and performance interruptions, the degree of refinement desired, the choice of equipment, and the financial considerations.

In order to properly understand air conditioning and to appreciate the functions of the various pieces of equipment used, it is necessary to be familiar with the physical and thermodynamic properties of the medium that is conditioned; that is to say, the air. Consequently before proceeding further, a few notes about the properties of air are given to enable the subject of air conditioning to be better understood.

Properties of Air

Air is a mechanical mixture of gases, the principal ones being oxygen, which supports life and combustion; nitrogen, an inert gas which acts as a diluent of the oxygen in the atmosphere; carbon dioxide, another inert gas which is the product of animal respiration and of the combustion of fuels; and water vapour, which is a gaseous form of water. The amount of water vapour in the air varies greatly, depending on a number of conditions, which are themselves variables. The relative properties of oxygen, nitrogen, carbon dioxide, etc., are either subject to such small variations or are so small that they need not be considered separately. Instead, they may be treated collectively as a gas mixture of constant composition, which is called "dry-air." In air conditioning then, air is considered to be comprised of "dry-air" and of water vapour or humidity.

As a matter of fact the water vapour in the atmosphere varies from about two and one-half per cent by volume in exceedingly humid summer weather down to about one-fifth of one per cent in winter. While the water vapour is a small constituent of air, the control of the amount of water vapour in the air in any air conditioned space is one of the most important considerations in the design of the air conditioning system for that space.

Before leaving the discussion about humidity or water vapour in the air, attention should be drawn to the fact that the humidity in the air is not in the form of water, but is in the state of steam, which is generally superheated. A great many people make the mistake of thinking that because water is heavier than air, that when moisture is added to the air, the air becomes heavier and descends. If, as it should be, the moisture is considered to be steam, and steam is known to be lighter than air, it will be readily appreciated that when water vapour is added to the air, the mixture will become lighter, and, therefore, ascends.

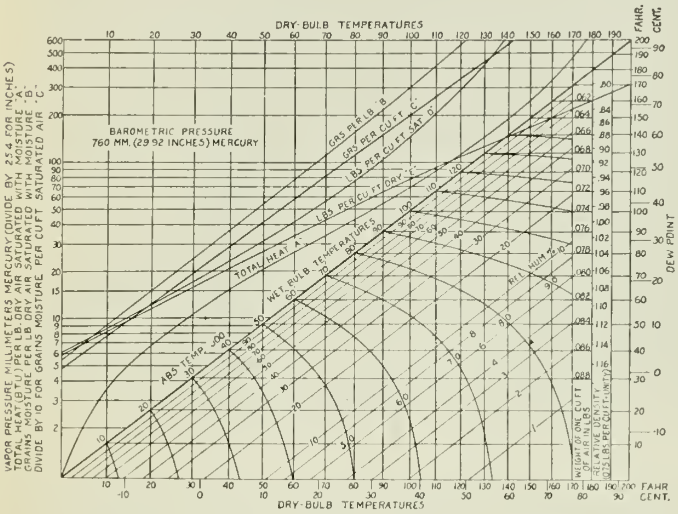


Fig. 1—The Bulkeley Psychrometric Chart.*

The quantity of water vapour that the air will hold depends upon the temperature of the air and on the barometric pressure, which in practice is assumed to be constant. When air at a given temperature contains all the water vapour it is capable of holding at that temperature, it is said to be "saturated."

While in ordinary heating and ventilating calculations the quantities of air are generally expressed in cubic feet, in most air conditioning calculations the quantities are usually expressed in terms of pounds. The weight of dry air, per cubic foot, varies with the temperature of the air and with the barometric pressure. In practice the barometric pressure is assumed to be constant and the weight of dry air is considered to vary only with its temperature. For convenience, the amount of water vapour in the air is usually stated in grains per pound of dry air.

The temperature corresponding to saturation, or 100 per cent relative humidity, for a given moisture content, is known as the "dew-point temperature." The ratio of the actual density of water vapour in the air at any given temperature, to the density of saturation vapour at that temperature, is called "the relative humidity" of the air.

The temperature of the air is obtained by means of an ordinary thermometer, giving what is known as "the dry-bulb temperature." The amount of water vapour in the air, or the relative humidity, is usually determined by means of another thermometer, known as a "wet-bulb thermometer," exactly similar to an ordinary thermometer except that the bulb is covered with muslin, silk or other fine material, which is wetted or dipped in pure clean water before a reading is taken. When a "wet-bulb thermometer" is placed in a stream of air, or rapidly whirled through the air, the wet-bulb thermometer usually gives a lower reading than a dry-bulb thermometer under the same air conditions.

At saturation or 100 per cent relative humidity, the dry-bulb temperature, the wet-bulb temperature, and the dew-point temperature are all the same. In air conditioning work it is standard practice to use what is known as "a sling psychrometer" to obtain the dry-bulb and wet-bulb temperature readings. This instrument consists of a dry-bulb thermometer and a wet-bulb thermometer mounted on a frame, which is attached to a handle in such a manner that the thermometers may be whirled rapidly around. Provided that the proper technique is followed, the sling psychrometer gives the most accurate psychrometric determinations. From these two thermometer readings the dew-point temperature of the air, the relative humidity, the quantity of water vapour in the air, and the volume of the air per pound, may be obtained.

Thermodynamic Properties of Air Vapour Mixtures

Since all air conditioning problems are basically those involving the exchange and conversion of heat, it is necessary to know something of the thermodynamic properties of air vapour mixtures. Air, like all other substances at ordinary temperatures, contains heat. In dry air the heat is sensible heat only, but the heat contained in air vapour mixtures is made up of both latent and sensible heat. The total quantity of heat in any mixture of dry air and water vapour is the sum of sensible heat of the air, the latent heat of the water vapour, and the sensible heat of the water vapour. Consequently the total heat of any air vapour mixture depends not only on the temperature of the air, but on the quantity of water vapour in the air. It also varies slightly with the barometric pressure, but in practice this is usually neglected. It has been proved that the total heat of the air is the same for all conditions of the mixture that have the same wet-bulb temperature.

Assuming the barometric pressure to be constant, there are then three primary variables in all air conditioning problems, which are the dry-bulb temperature, the wet-bulb temperature and the weight of water-vapour mixed with each pound of dry-air. From these the relative humidity, the dew-point temperature, the total heat of the mixture and the volume of the mixture can be calculated. In practice, however, it is usual to obtain these values from tables or from charts known as "psychrometric charts." There are many forms of psychrometric charts, but the Bulkeley psychrometric chart, shown in Fig. 1, is the most commonly accepted.

Dust

Before leaving the discussion of the properties of air, there is one other thing which must be considered, which, while not a true constituent of air, is found in all air to some degree. It is the dust which is suspended in the air. Common dust consists of animal, mineral or vegetable matter picked up by the movement of the atmosphere or wind. This dust remains suspended in the atmosphere with very little movement of the air. The removal of the dust is one of the basic considerations in air conditioning. Its importance can be appreciated by the fact that bacteria do not float self-suspended in air, but they collect and travel upon dust particles, many thousands being carried upon a single particle. The elimination of dust then can be expected to reduce many diseases and so improve our health. For example, it has now been proved that most hay fever and asthma sufferers experience great relief after spending a few hours in an air conditioned room, in which the air has been effectively filtered or cleaned and is consequently free of pollen.

*Copyright, A.S.H.V.E. Reproduced by permission.

Physiological Effect of Air Conditions

Since the object of comfort air conditioning is to provide air conditions for the maximum comfort and health of the occupants of the conditioned space, the physiological effect of various air conditions on the human body is of the utmost importance.

For some years now the American Society of Heating and Ventilating Engineers and numerous medical and public health organizations have been studying the effects of temperature, humidity, barometric pressure, air motion, dust, odours, etc., on the human body and on comfort and health. As a result the physiological effects of various degrees of temperature, humidity, etc., on the human body has been determined by innumerable tests and observations, and consequently the conditions most favourable to human comfort and health have been accurately fixed.

It has also been found that temperature, humidity and air movement exert a profound influence on human comfort and health. Under normal conditions, the human body is maintained at a temperature of about 98.6 degrees F. by means of a delicate heat regulating mechanism. This body temperature is the resultant of two factors: (1) the heat produced by the combustion of the food eaten and (2) the heat loss from the body by radiation, convection, and evaporation. Although the body is capable of adapting itself to considerable variations of heat loss, its ability to maintain heat equilibrium is limited. It is known that a moderate amount of variation in air temperature is beneficial not only to comfort and to health, but also to the performance of physical and mental work. On the other hand extreme changes appear to be harmful. However, one's feeling of warmth and comfort is dependent not only on the temperature of the air, but on the humidity and air motion. By means of numerous and elaborate experiments the research laboratories of the American Society of Heating and Ventilating Engineers have determined the relationship between human comfort and the temperature and humidity of air at the usual air motion encountered in air conditioned buildings. This relationship is shown graphically on the A.S.H.V.E. Comfort Chart, which is illustrated in Fig. 2. It will be noted that the air conditions required for optimum comfort in winter are distinctly different from those necessary in summer. For instance, at 50 per cent relative humidity a temperature of 70 degrees F. gives the greatest comfort in winter, while in summer, at the same relative humidity, the temperature has to be maintained at 76 degrees F. for the same degree of comfort. Another thing about the A.S.H.V.E. Comfort Chart is the fact that the summer comfort zone is applicable only to homes, offices and so forth, where the occupants are exposed to the conditioned air for three hours or more.

In artificially cooled theatres, department stores, restaurants and other public buildings where the exposure is less than three hours, the Comfort Chart does not apply. In such buildings the differential between the outdoor and indoor air conditions becomes the deciding factor in regard to the temperature and humidity to be maintained in the buildings. Furthermore, this differential is not a fixed quantity but varies with the outdoor temperature.

One other thing to note about the Comfort Chart is that it applies to conditioned spaces in which the air motion varies between 15 and 25 feet per minute. There are comfort charts for other air velocities, but in air conditioning, particularly in comfort cooling, it has been found that the air motion should be about 25 feet per minute and should not exceed 50 feet per minute. It should be remembered that it is now generally recognized that air motion ranks only second in importance to temperature. Closely associated with air motion is the air distribution. The air should not only have the required motion but it should be distributed and circulated in the conditioned space with reasonable uniformity.

Effect of Climate and Weather Conditions

The next sub-division of air conditioning to be considered is that of the climate and weather conditions of the locality in which air conditioning is being considered. By the word "weather" is meant the daily variations of temperature, humidity, barometric pressure, wind velocity and direction, rain or snow, and sunshine or cloudiness. The variations of these over longer periods of time are what is known as "climate." The weather varies from day to day, while the climate changes with the passing of the years or of centuries. The climate of the locality determines the outside temperature and humidity to be used in the air conditioning calculations for that locality and so governs the capacity of the air conditioning system required in any building in that locality, while the weather variations influence the flexibility required and the operating costs. Due to the climate in Canada, air conditioning systems here must provide heat and humidification in winter and they should furnish cooling and dehumidification in summer. The temperature of the air outside in winter limits the humidity that can be maintained in buildings in Canada, without frost forming on the windows. For this reason buildings in eastern Canada not equipped with double windows cannot have the optimum conditions of humidity maintained during a considerable portion of the winter.

Due to the stimulating climate in Canada and to the frequent and severe storm changes here, Canadians are generally vigorous, and full of vitality, and resistance to disease is here about as great as in any other part of North America. The stimulating climate, however, results in a

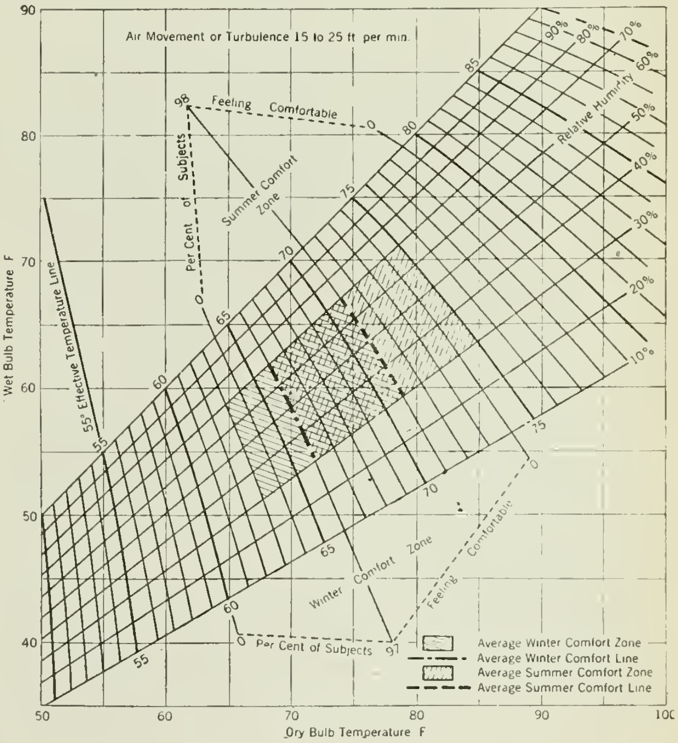


Fig. 2—A.S.H.V.E. Comfort Chart.*

high rate of certain diseases while the frequent storm changes bring on "colds," sinus trouble and pneumonia.

Nothing can be done to control or change the climate or the weather variations outdoors, but, since eight to sixteen hours of our days are spent indoors, the air in our buildings can be artificially maintained at the optimum conditions and so offset, in part at least, the deleterious

*Copyright, A.S.H.V.E. From A.S.H.V.E. Transactions, vol. 38, 1932. Reproduced by permission.

effects of the severe climate in Canada and the wide variations of weather conditions encountered here and so raise our level of health. In fact, it is probable that in the near future our hospitals and sanitaria will make use of air conditioning systems as a direct aid in securing recovery from illness and in reducing the time of convalescence.

Types of Air Conditioning Systems

Because the air conditioning required in summer is quite different from that necessary in winter and because

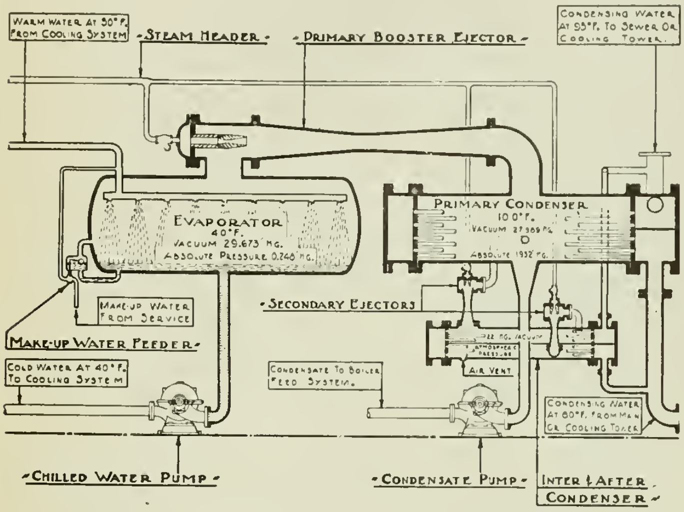


Fig. 3—Arrangement of Steam Ejector Cooler.

the work which air conditioning systems are required to perform is also different in summer to that in winter, systems may be designed for summer operation only, for winter operation only, or for operation throughout the entire year.

Systems designed for summer operation are known as "summer air conditioning systems" or as "comfort cooling systems." These systems must provide for and control the cooling of the conditioned space, dehumidify the air, remove the dust, furnish the necessary air distribution and air motion, and furnish the required amount of fresh air.

Systems designed for winter operation are called "winter air conditioning systems" or "conditioned air heating systems." They must provide for and control the heating of the conditioned space, humidify the air, remove the dust and give the necessary air distribution and air motion, and provide the required amount of fresh air.

The systems which are designed for operation throughout the entire year are generally known as "year round air conditioning systems." They must combine the functions of summer and winter air conditioning. In general, summer air conditioning systems require the circulation of considerably more air than winter air conditioning systems. As a result summer air conditioning systems may generally be used for winter air conditioning too, with very little extra expense or difficulty. But winter air conditioning systems usually cannot be used for summer cooling, because they are then generally too small and the duct layout and air distribution may not be satisfactory for cooling purposes.

Air conditioning systems may also be classified according to the purpose for which they are designed to function: (1) for human comfort and health and (2) for industrial processes.

The fundamental principles of air conditioning for human comfort and health have been outlined in the proceeding discussion. Air conditioning for industrial processes plays an important part in many industries, but the subject is so greatly involved and so broad in its many applications that any detailed explanation of the subject is beyond the scope of this paper.

Industrial Air Conditioning

In air conditioning for industrial processes the fundamental principles are basically the same as for human comfort, but in place of controlling the air conditions to provide for the comfort and health of the occupants, these systems are designed to improve the manufacture or processing of certain materials. It is well known that such materials as foodstuffs, textiles, paper, wood, leather, tobacco, etc., are hygroscopic materials and that the temperature and humidity of the air have a marked influence upon the weight, strength, appearance and quality of the products. In addition, industrial air conditioning is used to control the rate of chemical reactions, to control the physical properties of the material being processed and to control the drying of certain materials. In general in industrial air conditioning the conditions to be maintained are governed almost entirely by the requirements of the products to be processed or conditioned. In that case, any attention given to the comfort of the occupants is secondary. In some cases, the conditioning or processing is carried on in special enclosures in which there are no occupants.

Having defined air conditioning and described the fundamental theory of the same, and also having described the various types of air conditioning systems, it is now in order to consider how the various functions of air conditioning are performed in practice.

Heating

In air conditioning work the heating of the air in the conditioned space may be provided either by heating equipment in the air conditioning unit only or by a combination of radiators in all or part of the conditioned space and some heating equipment in the air conditioning unit. The heating equipment in the air conditioning unit may be direct-fired or heating coils, utilizing steam or hot water. Since the various methods of heating are so well known it is unnecessary to go into the details of them in this paper.

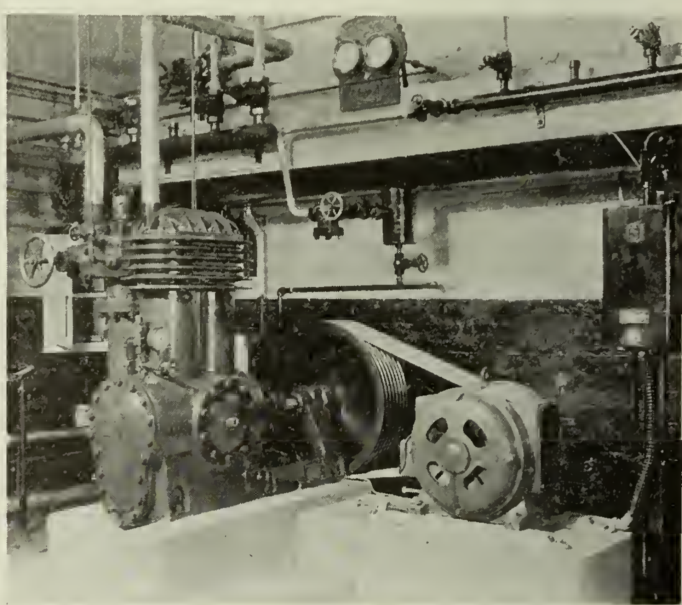


Fig. 4—Freon Refrigeration Installation of 30-ton Capacity.

Cooling

Cooling, in air conditioning work, is accomplished either by spray type air washers, using cold water, or by cooling coils in which cold water or a refrigerant is circulated. Because of the high cost of water from city mains and because in most cities the water in the mains is at too high a temperature, city water is not generally used, except in such cities as Toronto, where due to its proximity to Lake Ontario, the water in the city mains is cold enough to be satisfactory for cooling. The necessary cold water in many cases can be obtained from deep wells, which in eastern Canada usually deliver water between 48 degrees F. and 52 degrees F. Cold water may, in some cases, be obtained by the use of ice. Where ice can be purchased at a reasonable price, this method of procuring cold water is not only simple and satisfactory, but in many cases it will prove to be the most economical. Cold water may also be obtained from steam ejector systems. A typical steam ejector system is shown in Fig. 3. With such a

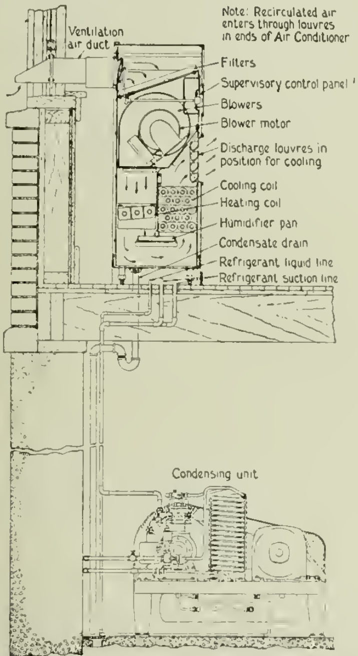


Fig. 5—Typical Unit Installation.

system it is possible to cool water in the evaporator to as low as 33 degrees F. The steam ejector systems require large amounts of steam and of water but where the cooling load is relatively large the steam ejector system is a satisfactory and economical means of obtaining the necessary cold water for cooling. In addition it has the advantage of being simple, of having no reciprocating parts and very few moving parts.

Where cold water is not available and where steam ejector systems cannot be used, it is necessary to use some form of refrigeration system. The refrigeration system most extensively used in air conditioning is the mechanical refrigeration system, using dichlorodifluoromethane (Freon 12) as a refrigerant.

Freon is a comparatively new refrigerant. It is colourless, practically odourless, non-toxic, non-irritating, non-inflammable and non-corrosive. It is, therefore, almost an ideal refrigerant for use in air conditioning. A large freon refrigerating plant is shown in Fig. 4.

Humidification

Humidification in winter air conditioning may be provided either by finely atomized water sprays, by the use of wetted fabrics or screens through which the air flows or by the use of pans arranged so that the heated air causes evaporation of the water contained in them. Air conditioning units containing air washers utilize the air washer for humidification as well as for washing the air. In this case the amount of humidity is usually regulated by controlling the temperature of the spray water.

Dehumidification

Dehumidification, in summer air-conditioning, is generally accomplished by either one of two ways: (1) by cooling the air below the dew-point and so causing a part of the moisture contained in it to precipitate out, or (2) by removing part of the moisture by adsorption. In the first method the equipment that does the cooling, does the dehumidification at the same time. It is simply a problem of cooling the air to the right temperature so that the required amount of moisture is removed. In some cases, the use of this method requires that the air be reheated slightly after being cooled and dehumidified. Where independent control of the temperature and humidity is required, reheating the air is essential.

Dehumidification by the use of adsorption, while not at present used to any great degree in comfort air conditioning is of interest and offers definite possibilities in Canada. In industrial air conditioning requiring very low humidities the system of moisture removal by adsorption is to be preferred to dehumidification by cooling. Where adsorption systems are used, refrigeration is either not required or the size of the refrigeration equipment is smaller than where cooling and dehumidification is carried out by refrigeration only.

The term adsorption pertains to the action of a substance in condensing vapour or a gas and holding the condensate on its surface without any change in the chemical or physical structure of the substance and with the release of sensible heat. The substance used in adsorption systems include solids, such as silica gel and activated alumina, and liquids, such as solutions of calcium chloride and lithium chloride.

Air Motion and Distribution

To produce proper air motion and air distribution in any air conditioned space, the design and location of the air inlet and outlet openings must be given careful consideration. It is comparatively simple to design and install equipment to provide the required air temperature and humidity, but it requires considerable knowledge and experience to provide the correct air distribution and air

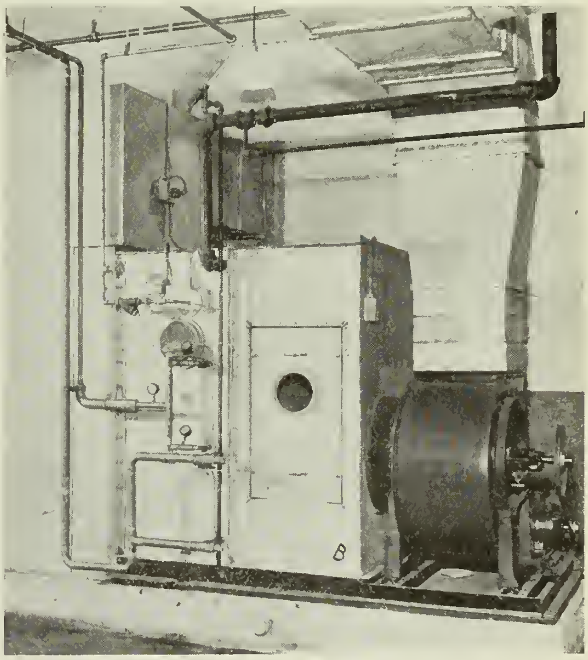


Fig. 6—Central Air Conditioning Installation for Year Round Air Conditioning.

motion, particularly in comfort cooling. A cooling system may not be satisfactory, though all other factors are correct, if proper air distribution and air motion is not provided. Thus air motion and air distribution become prime factors in correct air conditioning design. While in winter air conditioning it may be satisfactory to locate the air supply inlets or grilles in or near the floor, in comfort cooling the air inlet grilles must be located in or near the ceiling. In fact, high inlets are preferable for both summer and winter air conditioning.

Air Cleaning

The dust and bacteria in the air are removed or reduced to prescribed limits by cleaning the air by means of air washers, or by viscous or dry filters.

Formerly all air cleaning was done by air washers but because of the cost and limitations of the air washer as a cleaning device, the viscous and dry air filters have been developed and are now more generally used. In the viscous filters the air is cleaned by adhesive impingement, while

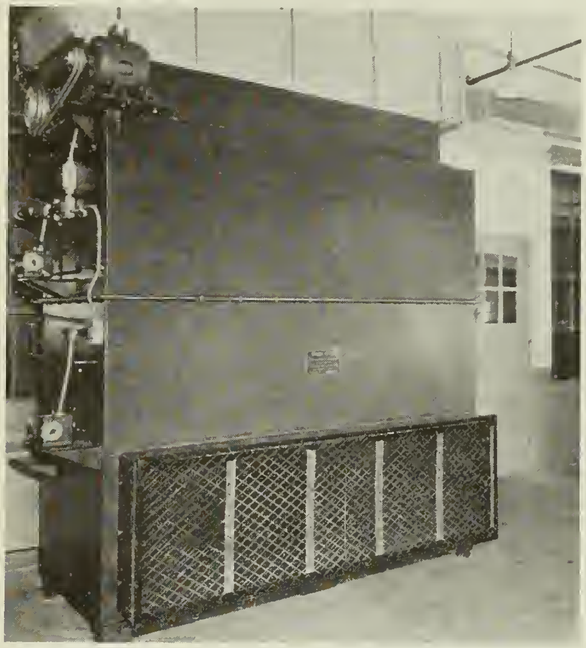


Fig. 7—Central Air Conditioning Installation in a Pharmaceutical Plant.

in the dry air filters the air is cleansed by being filtered through cellulose or cloth screens.

The quantity of air to be circulated through an air conditioned space must be sufficient to maintain the required standards of air temperature, humidity and air motion and distribution. All the air circulated need not be fresh or outside air. It is now well established that, except in restaurants which permit smoking, 10 cubic feet per minute of fresh air per person is sufficient to provide for the respiration of the occupants and to remove body odours. The correct air motion and air distribution is obtained by the proper selection, sizing and location of the air inlet and outlet grilles and by the careful and accurate design of the ductwork. The air then is actually circulated by one or more fans.

Automatic Control

To be entitled to be called air conditioning, the process must include the simultaneous control of temperature, humidity, and air motion. It is, therefore, of prime importance that the system should be properly controlled. While it may be feasible to control air conditioning systems manually, it is practically impossible, so that automatic control should be used on all air conditioning systems. Automatic controls may be electrically operated or operated by compressed air and may be quick acting or gradual acting. Generally gradual-acting controls are to be preferred.

Types of Equipment

Having described the functions of air conditioning and given some of the details of the individual pieces of equipment used in air conditioning, the next step to be considered is the manner in which the various air conditioning units are assembled.

Air conditioning systems are made up in many ways but they all fall into two general types: (1) central air conditioning systems and (2) unit air conditioning systems. Actually there is no sharp line of demarcation between the two types.

"Central air conditioning systems" are those in which the heating and/or cooling coils, filters, fans, and other related equipment are assembled in a suitable location with supply and return ducts to the conditioned space.

"Unit air conditioning systems" are those systems in which factory-made and encased units are used in the conditioned space. These units are shipped substantially complete or fabricated and shipped in sections, so that the only field work that is necessary is to assemble together the sections and to connect them to the steam, water, drain, and electrical services. A typical unit installation is shown in Fig. 5.

"Central systems" are generally designed for year round operation. The units then contain heaters and humidifiers, cooling and dehumidifying equipment, filters, fans and

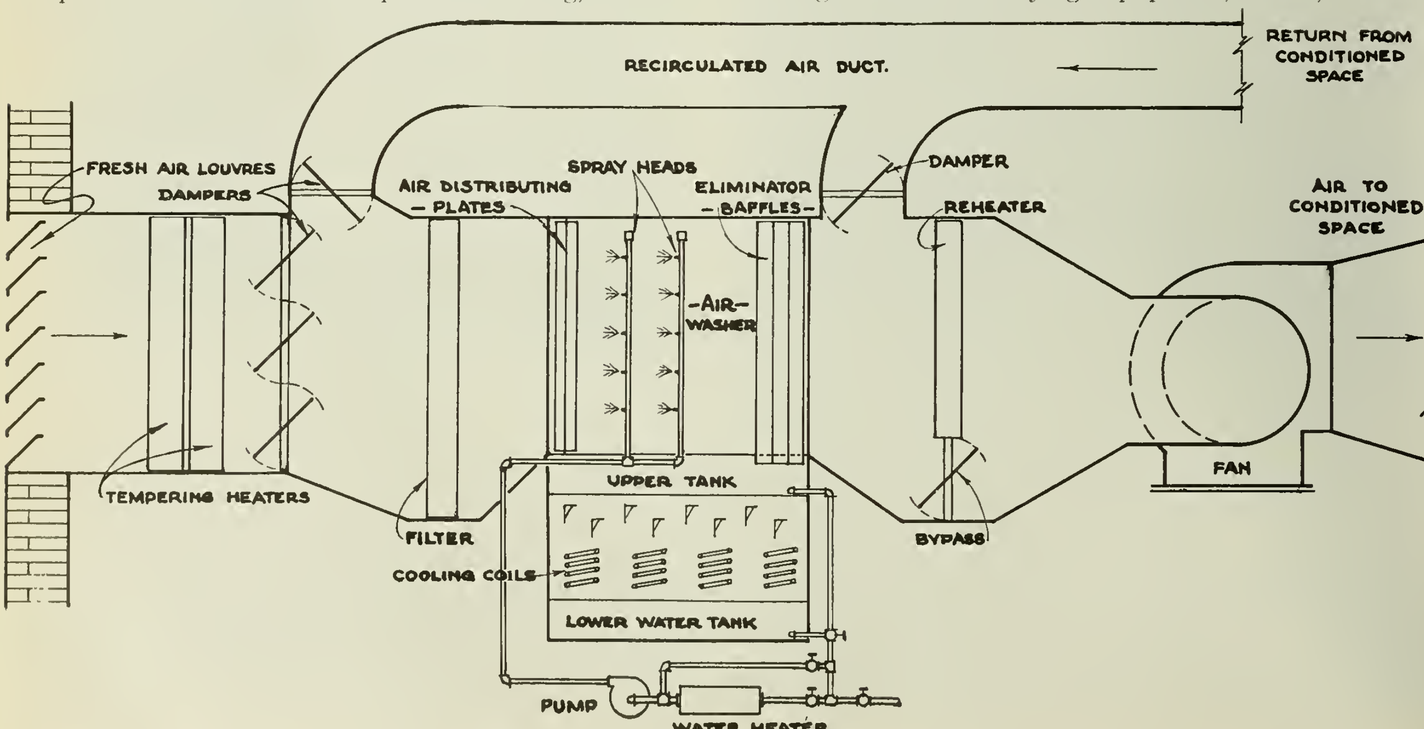


Fig. 8—Section Through Typical Central Air Conditioning Unit, using an Air Washer, for Year Round Air Conditioning.

motor and suitable controls. The type of the equipment and its arrangement varies considerably, depending principally on the method of air cooling employed.

A central air conditioning unit, equipped with filters, steam heating coils, humidifying sprays, direct expansion cooling and dehumidifying coils and a single fan, for year 'round comfort air conditioning of a group of offices, is shown in Fig. 6. A central air conditioning unit, for year 'round industrial air conditioning in a pharmaceutical plant, is shown in Fig. 7. This unit is arranged for independent control of the temperature and humidity and is consequently equipped with cooling coils and reheating coils.

A section of a large central air conditioning unit, for year 'round air conditioning and utilizing an air washer for humidification and for cooling and dehumidification, is shown in Fig. 8.

At the present time the trend in residence construction is to provide winter air conditioning systems in place of hot water or steam heating systems. In such systems the heating may be done by means of direct-fired units (warm air furnaces) equipped with the necessary filters, humidifiers, fans and control, but in the larger and better homes the so-called "split systems" are being installed. In the split system, a hot water or steam boiler is used and the bath-room, kitchen, garage, etc., are heated by direct radiation and not supplied with conditioned air. The living room, dining room, library and bed-rooms are heated by conditioned air and may or may not be equipped with radiators. A typical installation is shown in Fig. 9.

Cost of Air Conditioning Installations

To make such a paper as this complete, some idea of the cost of air conditioning systems should be given, but due to the many variables entering into the design of air conditioning systems and due to the great progress and rapid development of the industry it is impossible to give cost figures that will be of much value.

It may, however, be said that the direct-fired winter air conditioning systems can be installed in new residences for about the same cost as good hot water heating systems, having thermostatic control. In a new residence, having a cubage of say 60,000 cubic feet, a high grade split system can be installed for about $500 more than an equally good hot water heating system.

At the present time, most of the air conditioning systems being installed in Canadian homes are for winter air conditioning only. Eventually most air conditioning systems will probably be designed for year 'round conditioning.

The office air conditioning system, of which the unit was shown in Fig. 5, provides year 'round comfort air conditioning, conditioning 3,600 cubic feet of air per minute, for an office about 60 feet by 80 feet having large single-glass industrial steel sash windows and providing for an office staff of fifty people, installed in an existing office, cost between $4,000 and $5,000 complete with refrigeration equipment having a capacity of 10 tons.

A restaurant air conditioning system, recently installed in a Montreal restaurant, conditioning 7,000 cubic feet of air per minute, to provide year 'round comfort air conditioning for an average of two hundred and fifty patrons, cost between $7,000 and $8,000 complete with refrigeration equipment having a capacity of 20 tons.

In all air conditioning work, to secure a low initial cost as well as a low operating cost, careful consideration should be given to the construction of the structure to be air conditioned. Wherever possible, double windows, well weatherstripped should be used. Windows should be kept closed and preferably locked, because only in this way can the operating costs be kept down to reasonable limits, particularly in comfort cooling. People not accustomed to air conditioning generally believe that this will result in many complaints. But it is the author's experience that where the air conditioning systems have been carefully designed, well installed and adjusted that once the occupants have experienced the benefits of air conditioning that they will neither demand open windows nor complain about them being kept closed. For cooling systems, all windows exposed to the direct sun should be equipped with awnings. In new buildings the walls should be well insulated, because a well insulated wall will not only reduce the heat transmission through the wall, but it will also retard the flow of solar heat, so that the heat flowing into the conditioned space will not then coincide with the maximum load on the cooling system and so will reduce the size of the equipment.

Fig. 9—Year Round Residential Air Conditioning Installation.

While the cost of year 'round air conditioning systems is undoubtedly high at present, it should be remembered that while the principles of air conditioning are now definitely established, that the present development is towards greater production, lower equipment costs, and lower installation costs. It is to be expected then that as time goes on, air conditioning systems will be reduced in cost. But fundamentally air conditioning is a problem of good engineering, requiring a thorough knowledge of the principles and practice of air conditioning and a sound knowledge and extensive experience with air motion and distribution. Unless good engineering is used, air conditioning systems are liable to prove to be a disappointment and a waste of money. But when air conditioning systems are properly engineered, well installed and carefully adjusted they will enhance comfort, aid health and prove a satisfactory investment.

Winter air conditioning systems are being demanded in the better class of homes being built today and are being installed in many of the speculative houses as well. New restaurants are now going in for year 'round air conditioning systems, while some of the existing restaurants are also installing such systems. The two Canadian railways are busy building air conditioned cars. Even the large hotels in Canada are now considering it, because travellers, now used to air conditioned trains, desire the same comfort at the hotels. Furthermore, since the hotels are usually located near railway stations or train tracks or in the centres of heavy street-car and vehicular traffic, the hotel guests desire air conditioned bed-rooms, because in such rooms, the windows being closed, train and street noises are kept out or minimized. Large theatres are now installing comfort cooling systems and the larger stores are installing air conditioning systems throughout or in various departments. Even though the climate in Canada is such that no great amount of cooling is required, air conditioning will undoubtedly play an important place in Canada's future.

Highway Paving in the Province of Nova Scotia

R. W. McColough,
Chief Engineer, Department of Highways, Nova Scotia, Halifax, N.S.

Paper presented before a meeting of the Halifax Branch of The Engineering Institute of Canada, April 16th, 1936.

The present programme of trunk road work in the province of Nova Scotia is popularly called a paving or hard surfacing programme. While a paved road is the final result the paving itself is perhaps the least of the problems. In a province such as Nova Scotia the first thing to be accomplished is the construction of a stable subgrade on which to place the paving which may with some qualification be termed a wearing surface only.

While a few miles of highways were paved prior to 1934 that year saw the commencement of the present paving programme, which has as its objective the paving of about 800 miles of trunk highway and some of the more heavily travelled sections of other highways, particularly those sections passing through compacted villages and the paving of incorporated town approaches under agreement with the towns. Only a small mileage was completed in 1934, the work being largely of an experimental nature so that the work really started in earnest in 1935.

Engineering Staff

The paving programme has made necessary a large increase in the engineering staff.

The permanent engineering organization consists of a chief engineer, assistant chief engineer, office engineer and assistants, right-of-way engineer, five division engineers and four county engineers. To take care of the additional work involved the engineering organization was expanded from this nucleus. The division and county engineers exercise supervision over all work in their counties or divisions, all resident engineers reporting directly to them both in grading and paving contracts.

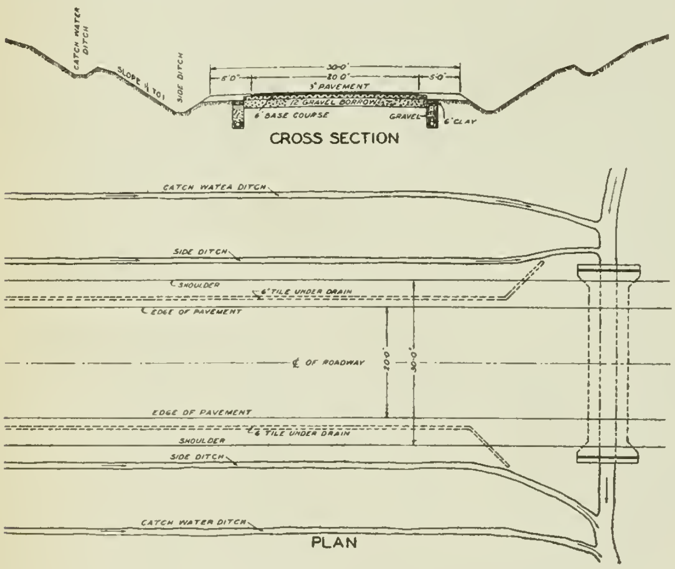


Fig. 1 —Diagram of Typical Underdrainage.

The resident engineer's staff consists of one or two instrumentmen, rodmen, chainmen, and inspectors as required. The additional engineering staff totalled two hundred and fifty-six including all ranks.

Pavement inspection is being carried out by an inspection company. Their organization in the province comes directly under their consulting engineer, and consists of two supervisors for the province and one plant inspector and one road inspector on each project.

Construction of Subgrade

Before a paving can be placed a subgrade must be constructed which will not only carry the load required at all seasons of the year, but will have such width, grades and alignment as will be adequate for the traffic it must carry during the life of the pavement.

The stabilization of the subgrade to a degree sufficient to carry the load required should be particularly emphasized. To construct a cheap or short life paving on a subgrade which will carry the load might be considered an error. Such an error, however, is not nearly so serious as the construction of an expensive and it may be assumed a good pavement on a subgrade which will not carry the load. In the first instance, repairs, or even resurfacing, may be effected without great difficulty; but in the second instance, before the subgrade can be strengthened, the pavement must be destroyed and rebuilt. Therefore if costs are to be cut let it be done in the pavement and not in the subgrade. A stable subgrade is a prerequisite to a pavement.

Before deciding on width, grades and alignment consideration must be given to the present traffic and the traffic the highway will carry during the life of the pavement.

The traffic to be served by any road is the primary factor in determining standards, and again these standards will be modified by the difficulty of construction, and the same standards as to alignment, grade and cross-section cannot be maintained for Nova Scotia as would be laid down for a level country.

In this province a subgrade width of 30 feet and pavement width of 20 feet will answer the requirements for many years and during the life of the pavements now being constructed.

Neither a maximum grade nor a maximum degree of curvature has been laid down but the highways are being built to grades and alignment that can be economically constructed. Speaking generally, the present alignment and grades are being retained excepting that where the gradients are too broken, or prevent safe vision, they are being improved, and where broken back curves exist, or there is an excess of curvature, the highway is being diverted, provided this can be done at reasonable cost.

The grading work has been carried out both by contract and day labour.

The grading work in 1935 involved the movement of 1,300,000 cubic yards of common excavation; 147,000 cubic yards of solid rock; 1,300,000 cubic yards of borrow; 35,000 cubic yards of excavation for structures; 575,000 cubic yards of gravel and base course—a total of 3,357,000 cubic yards of material.

Thirty-four power shovels and one hundred and fifty tractors and graders were employed on the work.

The resident engineer is required to stake out the work giving both grades and alignment and the grading contractor is required to do grading in accordance therewith. The contractor is also required to apply a gravel or crushed rock surfacing, the main purpose of which is to carry the traffic until the section is paved.

It is essential that a stabilized subgrade be constructed before the paving is placed, and as may be realized this must be done at the minimum cost. In all sections of the continent this is a problem but in Nova Scotia with its soil and climatic conditions it is the most important.

Engineers all over North America have given this phase of highway construction serious study for some years, and in this province it has been given particular attention for it may be said that it is the first essential of highway construction, more particularly where paving is to follow.

While much has been written on the subject and many schemes have been proposed, it is the intention to rely chiefly on underdrainage and stone or gravel base to produce the required stability. (See Fig. 1.)

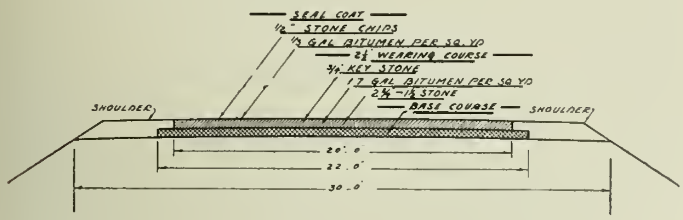


Fig. 2—Section of Typical Penetration Method.

The grading contractor is required at the time of grading to put in such underdrainage as it is believed will be required. It is not essential that one hundred per cent of this work be carried out at the time the grading is done as there will still be an opportunity to place additional drainage before the paving is laid and there is generally considerable underdrainage included in the paving contract.

All sections of highway which were graded in 1935 and are to be paved in 1936 were inspected daily by experienced engineers when the frost was coming out of the ground and a careful record was made during this period of the condition of almost each foot of the roadway. Therefore it should be possible to know just what further underdrainage and additional base course is required.

Last year a minimum thickness of 4 inches of gravel base was placed and in many sections twice this depth. However, despite the fact that there were no failures in the 1935 paving, this year the base course is being increased to a minimum of 6 inches. When the thickness of base course exceeds 4 inches it must be laid and rolled in two or more courses, this in order to secure maximum compaction.

Pavements

The pavements at present being constructed in Nova Scotia properly belong in the low cost classification. The term low cost, however, is really a relative one, and whether or not a pavement is classed as low cost is determined largely by the existing conditions in the area in which it is to serve, particularly those conditions relative to traffic density and previous construction costs, and it will be appreciated that a low cost pavement in one locality which has a certain density of traffic and population may be a high cost pavement for some other locality where different conditions prevail.

Bituminous materials for road building purposes fall commercially into two main classifications, namely, those produced from petroleum known as "asphaltic" products and those produced by gas-making and coal-coking processes known as "tar material." Both the tars and asphalts are complex and varying hydrocarbons, and both are residuals left after the lighter fractions are distilled off.

In the 1935 work both tar and asphalt were used, the tar being a coal tar product manufactured at Sydney and the asphalt being manufactured by the Imperial Oil Company at Dartmouth from South American crude.

Principal Types of Low Cost Roads

There are three principal types of low cost roads:—

1. Surface application of bitumen to a roadway already compacted by traffic with a cover coat of sand or stone chips (Fig 2).
2. Road mix, either dense graded aggregate type, or coarse aggregate type generally called retread.
3. Premix or plant mix.

There is a fourth class of pavement, penetration bituminous macadam, which is on the border line between low and high cost pavements.

All of the pavements just mentioned have been laid in Nova Scotia.

Those of the first class (1) surface applications, generally speaking can only be classed as temporary. A small mileage was surface treated in 1935 and about 50 miles will probably be surface treated this year. This work will be carried out on sections where it is not definitely known that the grade has completely settled, and it is the intention to lay a gravel or broken stone base course, give it an application of priming bitumen and then a bituminous seal coat followed by a cover coat of sand or stone chips.

Surface treatment has its place. However, the borrowing of moneys for such work is not justified unless it forms one stage in a construction programme.

The second class (2), road mix, has a place in any low cost road construction programme and this class of work has been successfully carried out in Nova Scotia. One of the difficulties, however, is that the work is held up completely during wet weather.

The third class (3), premix or plant mix, is the type of pavement used principally during 1935. One hundred and thirty-seven miles of this type were laid in 1935. Fifteen miles of the fourth class, penetration bituminous macadam, were also laid and 1.4 miles of road mix, a total of 153.5 miles in 1935.

The 1936 programme will probably consist of 178 miles of plant mix, 19 miles of penetration bituminous macadam, 4.0 miles of road mix, coarse aggregate type or retread, and 49 miles of surface treatment, a total of 250 miles. The selection of type is generally determined by the aggregates available in the locality in which the pavement is to be constructed.

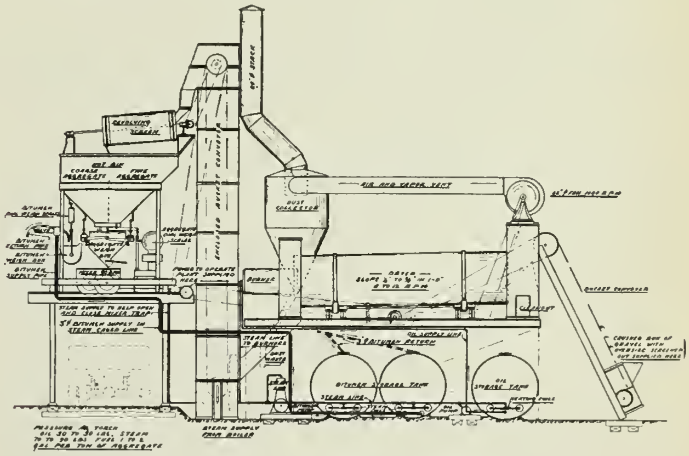


Fig. 3—Diagram of Bituminous Paving Plant.

Plant Mix

The base course is fine graded to the lines and grades laid down by the engineer. It is then primed with a bituminous primer. Primers are bituminous materials of such low viscosity that they will penetrate into the subgrade and yet having a base such that after the volatile has evaporated the residue will have sufficient strength to act as a binder, helping to consolidate the subgrade and thereby providing a satisfactory base for the pavement.

Mineral Aggregates

Mineral aggregates are usually obtained by crushing pit gravel. Some pits contain the required proportion of coarse and fine aggregates and when this is the case all material required can be obtained from the same pit. In other cases, however, it is necessary to add either coarse or fine aggregates.

Fig. 4—Bituminous Paving Plant at Gold River.

The portion of the aggregates retained on a one-quarter-inch round screen which is termed coarse aggregate is required to contain fifty per cent of crushed particles and to have a percentage of wear of not over ten.

All aggregates must pass a screen having one-inch circular openings and must be well graded from coarse to fine, meeting a screen test within the following range:—

Passing 1-inch round opening 100 per cent
Passing ½-inch round opening 60-80 per cent
Passing ¼-inch round opening 40-55 per cent
Passing 10-mesh screen 20-30 per cent
Passing 100-mesh screen 5-10 per cent
Passing 200-mesh screen 0- 5 per cent

The limits specified for the various sizes are fairly wide and in most sections of the province gravel pits are available containing material which when crushed will come within this grading.

The mixing plants employed on the work have a capacity up to forty and fifty tons per hour and therefore of necessity require quite large crushing units to produce the mineral aggregates (Fig. 3).

The mineral aggregate after passing the one-inch screen of the crushing plant is dried in a revolving cylinder drier being heated to a temperature of about 225 degrees F.

From the drier the material is conveyed to a screen located over the hot aggregate bins, which separates the aggregates and places them in two separate bins—one containing the aggregates passing a one-inch round opening and retained on a one-quarter-inch round opening, and the other containing aggregates passing a one-quarter-inch round opening, or into "coarse" and "fine" aggregates.

These bins are located directly over the pugmill mixer which in the smaller plants has a capacity of 1,000 pounds and in the larger 2,000 pounds—with one or two 3,000 pounds.

A definite amount of coarse aggregate and a definite amount of fine aggregate are then weighed into the mixer, usually about fifty per cent of each, but in accordance with the specifications not less than forty or more than fifty-five per cent of fine aggregate, this tolerance being allowed so as to, as far as possible, obtain all the aggregate from one pit. However if the pit cannot supply the material within the range allowed by the specifications it is necessary to bring in either coarse or fine aggregate to make up the deficiency in the pit, or the same object could be attained by wasting the surplus.

The mineral aggregates having been weighed into the mixer, the bitumen is added and mixing continued for at least forty-five seconds and until all the particles of the aggregate are well coated and the whole mass is a uniform colour.

The asphalt selected for use in Nova Scotia has an 85 degrees F. softening point. First, because it is sufficiently hard so that pushing or rippling will not occur during the summer months and, secondly, it is soft enough so that it does not become brittle during the winter season and the paving is thus able to stand the inevitable "heaving" without damage.

From four to four and one-half per cent of bitumen by weight is used, the amount required in each case depending on the aggregate used. An aggregate containing a high percentage of fine material requires more bituminous material than aggregates which have a low percentage of such material. Again, the percentage of bitumen required is governed by the character of the stone particles as some stone will absorb considerably more bitumen than others.

While there are several tests to determine the amount of bitumen to use perhaps the best is the visual test. Where a high percentage of fines are present in the mix more care must be exercised than if they are lacking for if an excess of bitumen is used pushing or rippling will result, whereas with coarse aggregates the flushing of the bitumen to the surface will probably be the only damage and this is not very serious.

The mixed material is transported from the mixer to the roadway by truck, in some cases the haul being as long as 17 miles. The temperature at which the mix shall arrive on the roadway is not specified. It usually arrives there, however, at a temperature around 200 degrees F. This type of pavement is sometimes called hot mix cold laid.

Fig. 5—Laying Bituminous Paving near McKinleys Corner, Lower Onslow.

On arrival at the roadway the mixed material is dumped from the trucks into spreader boxes, or a self propelled finishing machine, and spread on the fine graded and primed subgrade at a rate of approximately 300 pounds per square yard. After spreading, the material is bladed with a pneumatic tired patrol grader. If a finishing machine has been used blading is not necessary and the pavement is rolled immediately behind the machine. It is preferred that the contractor lay a considerable length of mixed material before blading. In warm weather blading may be deferred for an hour or more without danger of setting up. The longer the section bladed the better the riding qualities of the finished pavement.

When the blading is completed rolling is carried on provided the mix has sufficiently set up to bear the weight of the roller. Rolling is continued for several days until there is no displacement of the surface under the roller. The specifications provide that there shall be one gas or Diesel roller on the work for each 200 tons of paving laid per day of eight hours, and three steam rollers are deemed to be the equivalent of two gas or Diesel rollers.

The average cost per ton for mixed material paid contractors in 1935 was $2.33 not including bitumen. All bitumen was furnished free to the contractor by the department at the railway station designated by him.

Penetration Bituminous Macadam

During 1935 the department constructed 15 miles of bituminous macadam by the penetration method.

This type of paving received official recognition in 1912 and the New England section of the United States, especially Massachusetts, has long been a stronghold of this type. Outside of New England, however, comparatively little penetration macadam has been built.

The state of Massachusetts has a large mileage of this type which is very smooth even at high speeds. It is, however, perhaps the most difficult of all pavement to construct, and much more care is required during construction, if good riding qualities are to be obtained, than is the case with pavements which are bladed during construction. A supply of hard stone is a prerequisite, the stone taking the wear to a much greater extent than in other types.

This pavement, as it is now being constructed in the state of Massachusetts, can hardly be called a low cost surface if the entire depth of the work made up of one foot of gravel base, four inches of broken stone base and two and one-half or three inches of bituminous penetration is considered. The bituminous penetration wearing course taken alone, however, can perhaps be placed in the low cost class.

The method of construction used in Nova Scotia follows very nearly that used in Massachusetts. To the existing gravel road is added such an amount of gravel or stone base as is deemed necessary. On this base, after it has been graded and rolled, a base course, usually four inches of loose crushed stone, is spread with spreader boxes. This course is then shaped to the required cross-section and profile by raking and hand placing and is then rolled. The base stone must have a percentage of wear of not over four, all must pass a three-inch ring and not over thirty per cent pass a one and one-half-inch ring.

After being rolled the voids in the base course are filled with stone dust or sand, no surplus being allowed above the top of the stone. The finished base course is checked with a ten-foot straight edge and a template and no variation over one-half inch in ten feet is allowed. As a measure of economy, of course, the penetration bituminous wearing course could be laid on a well constructed gravel base.

Bituminous Penetration Wearing Course

In 1935 the wearing course was three inches thick, when completed this year it will be reduced to two and one-half inches. All stone for the wearing course is required to have a percentage of wear of not over three, all is required to pass a two and three-quarter-inch ring and excepting keystone and chips retained on a one and one-half-inch ring, so that the coarse aggregate in the wearing course consists of one and one-half to two and three-quarter-inch stone. The keystone is three-quarter inch and chips one-half inch. The bituminous material, if asphalt, is required to have a softening point of 110 minimum and a penetration of 85 to 100. If tar, a melting point between 100 and 115 degrees F.

Fig. 6—Irish Cove-Portage, East Bay, Route No. 4.

The coarse stone for the wearing course is spread on the prepared base by means of spreader boxes, then brought to the required grade and cross-section by hand raking and placing. It is then rolled sufficiently to bond it but not enough to destroy the keying qualities of the stone. The contractor is required to have one roller on the work for each ten cubic yards of stone delivered per hour.

This course is then penetrated with 1.7 gallons of bitumen per square yard at a pressure of 40 to 60 pounds per square inch and if asphalt at a temperature of 300 to 350 degrees F., if tar 200 to 275 degrees F.

As soon as the surface cools sufficiently so that the bitumen will not be picked up by the roller wheels which are wetted or oiled, it is again rolled. The keystone is then broadcasted on the surface, broomed and rolled in.

Next the seal coat at the rate of ⅓ gallon per square yard is applied and immediately covered with stone chips, the rolling being continued to completion.

While this type of surface is difficult to construct so as to give as good riding qualities as the bladed surfaces, it has the advantage of being non-skid and is very durable.

The type of pavement constructed in the various sections of the province depends almost entirely on the aggregates which are available in the particular locality. That is where sufficient hard ledge rock is available penetration macadam is used, and where suitable gravel pits exist premix is used. It is seldom that both types of aggregates are available in the same locality.

In conclusion it may be pointed out that in this province with a fair distribution of aggregates suitable for paving, the construction of a wearing surface is not a difficult problem and it can be dealt with by using several different types, any one of which will be satisfactory. The difficult and important item, however, is the construction of a subgrade which will carry the traffic required.

While an inspection of last year's paving work shows there are no failures excepting a certain amount of cracking which might be expected in any pavement under similar conditions, this year more money is being spent on base stabilization per mile than in 1935.

The Stabilization, Realignment and Surfacing of New Brunswick Roads

D. R. Smith,
Resident Road Engineer, Department of Public Works, Province of New Brunswick.

Abstract of an address delivered at the Maritime Professional Meeting of The Engineering Institute at Saint John, N.B. August, 28th, 1936.

Based on a paper by W. J. Lawson, presented before the Canadian Goods Roads Association, September, 1936.

The province of New Brunswick has a total of 1,500 miles of main trunk roads, which it is proposed to pave under the present programme. The asphalt pavement design has been based upon the use of local aggregates, and in the bulk of the work gravel will be used as the use of crushed stone would be too costly. Fortunately suitable gravel is available in most sections of the province.

The total population of the province is only about 400,000 and the total road mileage about 12,000. Recent highway construction work in the province has been hampered by lack of funds and by the necessity of keeping highway development in line with the traffic it has to carry.

The Highway Division of the Department of Public Works of New Brunswick has been organized as such on a real working basis only since 1919. The roads of that day were narrow, and very little gravel had been used on them. From 1919 until the beginning of the present paving operations an extensive programme of reconstruction and surfacing had been followed year after year. Thus, nearly all of the main roads are now in fair shape.

On the more heavily travelled sections of the main trunk highways it is the policy to use a densely graded gravel aggregate bituminous base course. On the less travelled sections a cheaper type of surface will be used, such as a bituminous carpet coat. After taking into consideration the existing traffic and the increase anticipated in future years it was felt that a base course of a thickness of three inches was the minimum for the more heavily travelled portions of the system, having regard to existing subgrade conditions. A pavement width of twenty feet was adopted as standard.

It is recognized that probably the most important item in the programme is the stabilization of the subgrade previous to putting any wearing surface on it. This is done by means of a system of tile underdrains in addition to side ditches outside the roadbed proper. The improvement of subgrades has been an essential part of the work, being carried out departmentally during 1934 and 1935.

The present extensive programme of road work is concerned primarily with the 1,500 miles of trunk roads, all of which are to be converted from gravel surfaces to asphalt pavements, the present structure being generally from 3 inches to 6 inches of local gravel, with little in the way of subgrade stabilization. The present programme was authorized in 1930, the total sum allotted being ten million dollars. Work did not get under way until 1934 when seven contracts for 66 miles of road were awarded; in 1935, eight contracts for 70 miles were awarded; and in 1936, fourteen contracts covering over 400 miles have already been awarded.

In view of the large amount of grading, contracts included subgrade work, contract periods being generally two years to enable grading to be done one year, and surfacing after a year's interval. Careful location of culverts, etc., and the provision of a continuous drainage system are the essentials of the subgrade work.

Preparatory Work

During 1934 and 1935 practically all of the preparatory work, embracing the installation of tile underdrains, the addition of gravel sub-base, and the renewing of culverts, structures, etc., was undertaken by the Department's own forces at day's work.

With the beginning of the present paving programme it became necessary to stabilize the road foundations. In doing this, the points for tile installation have been determined by spring surveys of frost conditions, extending over a two- or three-year period.

After grading the subgrade, a gravel sub-base of a thickness of four inches consolidated is laid on the freshly graded subgrade and consolidated by traffic.

As soon as the subgrade is considered fit for paving, the necessary fine grading is done by the contractor, the gravel sub-base is primed and traffic is allowed on it for at least a week, when paving operations may start. New culverts and structures, of course, are put in during the grading operations.

During 1934 and 1935 upheavals and depressions developed in the pavement over a few of the culverts. These have had to be relaid in several cases. Complete gravel backfill is being used around all culvert pipes.

Design of Pavement

Pavement construction is exclusively of asphalt, using local gravels as aggregate, carefully graded. A base course of 3 inches of bituminized gravel was standard in 1934 and 1935, well rolled and then topped with a 1-inch asphalt sheet wearing surface, all hot mixed, a one-day interval being allowed between rolling of the base course, and finishing. In 1936, practice was modified to a 4-inch base course, to be primed with asphalt, using ¼ to ½ Imperial gallon to the square yard. This year, the use of a liquefier has been permitted, to enable a central batch plant to be used and the mixed material transported to different sites by rail.

All plants used in manufacturing paving mixtures are of the batch type, of a size approved by the engineer, and are provided with separate chambers for heating and mixing the constituents. The following considerations led to the use of a plant-mixed surface seal course instead of liquid asphalt seal coat. The sand used in the plant-mixed surface seal is the same as is used with the coarse aggregate to make the base course. The material is simply drawn from the required bin when needed and the proper proportion of asphalt cement added. It is then taken out and placed on the road.

Further, in using a liquid seal the cover coat used should be composed of very hard, sound chips in order to get the best results. This material is not very plentiful in the province and would greatly increase the cost if it were used. It is also believed that the life of the plant-mixed seal coat is considerably longer than that of the liquid seal, thus effecting an appreciable saving in maintenance cost.

Construction

During 1934 and 1935 the use of hand work was allowed in spreading the paving mixtures, but it was found that the use of the spreader box with hand rakers did not give as good results as the spreading machine, for segregation of material in the pavement surface resulted from the use of hand work. This year the specifications call for the use of self-propelled spreading and finishing machines, or an approved spreading machine towed by a truck.

The placing of the pavement mixtures is as continuous as possible. Where traffic is not diverted from the section under construction the pavement is laid in two strips, each one-half the full width of the pavement, the two strips being carried forward in alternate stretches.

After spreading, the base course is given a preliminary rolling, giving a light initial compaction just previous to spreading the surface course.

The surface seal course is spread as soon as possible after the base course has been given this preliminary rolling. The amount is at the rate of from thirty to forty pounds per square yard, spread by means of shovelers broadcasting over the base. The rolling is then continued with a power-driven, three-wheel roller weighing not less than ten tons. Traffic is not allowed over the base course or the seal course until it has had a preliminary rolling.

Side forms have always been used with all types of bituminous concrete pavement and they are again specified for this year's work.

In this year's operations at least part of the shoulder material is being rolled with the final rolling or consolidation of the pavement. This entails the contractor's removing his forms and placing at least part of his shoulder material previous to the final rolling. The final rolling is continued from day to day until there is no displacement of the surface.

The surface of the finished pavement has to be smooth and true to the established crown and grade, presenting a surface of uniform texture with no evidence of segregation or insufficiently sealed areas. Its average thickness must be from three and one-tenth to three and one-quarter inches and the minimum permitted is two and seven-eighths inches. The surface must be free from depressions exceeding one-quarter of an inch, as measured with a ten-foot straight edge paralleling the centre line of the roadway.

Payment is made to the contractor on a tonnage basis for both the base and seal courses and he is obliged to provide and install an approved truck scale at a location convenient to the asphalt plant. The Department provides a weighing checker for this material.

Field Organization

Each contract is in charge of a resident engineer who has one or more instrumentmen and the necessary assistants to take care of the laying out of the work. The checkers are supplied by the Department and are under the control of the resident engineer. Each job has two inspectors supplied by the inspection company; a road inspector, who is responsible for the laying of the pavement mixtures; and a plant inspector, who is in charge of the plant operations.

In addition to the plant and road inspectors, the inspection company supplies one or more supervisors who travel constantly between the jobs, advising and correcting where necessary.

The resident engineers and inspection staff are under the supervision of one or more inspecting engineers, reporting directly to the chief highway engineer or the assistant chief highway engineer.

Costs

The approximate average cost per mile of pavement, including preparatory work, was as follows:

Using a one-inch sheet asphalt wearing surface 1934-35	$19,000
In 1935, when using the plant-mixed surface seal course	17,000
For the 1936-37 bituminous concrete paving programme, the estimated cost per mile complete is	17,500

This somewhat higher cost is due to the heavy grading included in the 1936-37 programme.

During 1934 and 1935 the contracts varied in length from seven to twelve miles; for 1936 and 1937 they are from twenty-five to thirty-five miles.

As soon as possible it is hoped to have the sources of all aggregates determined for all future jobs, so that before tendering the contractor may be in a position to know definitely just where the satisfactory aggregates are to be obtained. This information would tend to lower unit prices considerably.

On the whole, the pavement laid during 1934 and 1935 has come through to the present time in a very satisfactory condition. There has been a certain amount of cracking which is being taken care of by the maintenance crews.

One of the main reasons for adopting the soft type of asphalt this year was that its use would minimize the amount of cracking which has taken place in the pavement when using the harder type. New Brunswick's soil and climatic conditions are such that some small amount of frost action on the foundation of the road seems unavoidable, no matter how carefully the preparatory work is done. It is believed that the use of the softer type of asphalt will result in a more flexible pavement which will lessen this trouble by giving somewhat under the action of frost.

THE
ENGINEERING JOURNAL
THE JOURNAL OF
THE ENGINEERING INSTITUTE
OF CANADA

VOLUME XIX OCTOBER 1936 No. 10

Aeronautical Research and Progress

There is always risk in attempting to predict the future of any branch of scientific progress. The hazard is particularly great in the case of a subject like aeronautics, which is of such recent and rapid growth, solves its problems by having recourse to practically every branch of physical and engineering knowledge, and even leads its practitioners into fields of enquiry where the resources of present day mathematics are of little avail.

In some respects the aeroplane resembles the sailing ship, in that both structures are subject to the uncontrolled action of moving air and water. This circumstance causes one of the chief difficulties in aeroplane design, since the nature and amount of the forces acting upon the structure are to some extent indeterminate. But the sailing ship reached its highest development by a slow process of trial and error, extending over centuries; the aeroplane has become an effective means of transport within a single lifetime, thanks to the fullest possible utilization of the benefits of scientific research.

Fortunately aeronautical science can now command experimental and mathematical resources far greater than those available in its earlier stages, but even now new types of problems are continually arising and new ways of dealing with them have to be explored. These explorations may carry the experimenter into regions almost unknown, and this is one reason why the probable lines of advance are so difficult of prediction.

Progress has been remarkable during the last six years, particularly as regards speed. The military aircraft of 1930 with a top speed of 150 miles per hour was considered to be putting up a good performance. The world's high-speed record is now over 400 miles per hour. Commercial aircraft fly regularly at speeds of 150 miles per hour and upwards, and passengers can cross North America from coast to coast in fifteen hours.

It is interesting to enquire how far this rapid development may continue. An illuminating survey of the present situation as regards the technical problems of aeronautics was given recently by Mr. E. F. Relf in the forty-second James Forrest lecture which he delivered before the Institution of Civil Engineers on May 5th last. As Superintendent of the Aerodynamics Department of the National Physical Laboratory, he is an authority on aeronautical investigation, and is specially qualified to speak on the problems which are now being attacked. He speculates as to the direction in which further progress is possible and indicates the lines of research which will be needed to solve the difficulties which are now appearing.

Some of the problems he names lead to unexpected results. For example, the question arises as to what is a really smooth surface from the aircraft designer's point of view. In the new compressed-air wind tunnels tests can now be made at very high Reynolds numbers, representing conditions corresponding to those of a full size aeroplane at high speed. It has been shown that the roughness of a surface covered with dust particles averaging 1/1000 of an inch in diameter has no perceptible effect on drag at low speeds, but at the speeds corresponding to the highest expected performance of present day machines may increase the drag by some 70 per cent. With a different kind of roughness, like that of a surface dotted with small rivet heads, there is an entirely different result, the drag increasing up to a certain point and then diminishing, so that at the upper limit it is not much more than that of a smooth wing. A physical explanation of these facts involves the study of air flow in the very thin laminar sub-layer close to the wing skin. The discovery of a surface which will be aerodynamically smooth at all speeds would result in marked economy at high speeds.

As regards interference, by which aircraft designers mean the effect of putting together two or more component parts in different combinations, dependence is placed on wind-tunnel experiments. For example, a given body and a given wing, both of good design aerodynamically, will give quite different results when combined as a high-wing or as a low-wing monoplane, or when combined with or without sufficient fairing at the junctions. This subject has been a fruitful field for enquiry, in fact the avoidance of interference is essential for a clean design, and the production of an easily driven machine.

Much has been done and much remains to be achieved in respect to engine cooling and the air resistance caused by the necessary cooling equipment. Special cowling, retractable radiators, surface radiators in the wings, steam cooling and other devices can now be tried in the large wind tunnels now available, in which a fuselage complete with engine and airscrew can be tested under actual running conditions. As a result of such tests it seems possible that in a 300 miles per hour machine the stream of cooling air may actually be so guided that some slight propulsive effect may result from its rise in temperature while passing through the radiator. This result, while not yet a matter of regular practice, may be compared with the price now usually paid for engine cooling, a drag corresponding to some 6 to 10 per cent of the brake horse power.

The development of new materials and their application to aeroplane structures, together with designs which attempt to make every possible piece of material contribute to the strength of the structure, have done much to improve aircraft performance and speed. It must be remembered that strength calculations in aeroplane structures are difficult. The system has many redundancies and is liable to failure by elastic instability, due to such causes as wing and tail flutter.

The past six years has been especially a period of increase in aerodynamic efficiency, although there has also been marked improvement in aero-engine performance and reliability. Further progress, Mr. Relf believes, will be continuous, but is not likely to be spectacular unless there is some fundamental discovery in physical or metallurgical science which will open a new avenue of research, as for example a means of storing or producing power lighter than the internal combustion engine, some entirely new synthetic material of construction, or some unexpected way of dealing with turbulence in the boundary layer.

For other reasons it seems unlikely that the speed of flight can be very greatly increased. First, as the speed of sound is approached, say at 740 miles per hour (a speed only 75 per cent greater than the present speed record), the drag increases very rapidly, due to the compressibility of the air. Further, as speed through the air increases, the temperature of the air layer in contact with the flying body rises considerably, the rise being of the order of 100 degrees F. at 600 miles per hour, and varying as the square of the speed. This condition will cause difficulty in cooling the engine, and, as Mr. Relf remarks, in cooling the passengers also. The alternative is high altitude flying in regions of low air density, a course which confronts the designer with another and quite different set of difficulties.

Thus it seems probable that during the next few years at any rate, aeronautical progress will be along the lines of economy and safety of operation, increased load carrying capacity and longer range of flight, rather than in the direction of greatly increased speed.

Committee on Consolidation

Report for September 1936

The twenty-second meeting of the Committee on Consolidation was convened at 9.45 a.m., on Friday, September 18th, 1936, and continued throughout the day, adjourning at 9.45 p.m.

This meeting took the form of a joint meeting with the Council of The Institute, under the chairmanship of the President, Dr. E. A. Cleveland, and there were present:—

As members of Council: Past-Presidents O. O. Lefebvre, and F. P. Shearwood; Vice-President P. L. Pratley; Councillors: H. Cimon, A. B. Crealock, L. F. Goodwin, F. S. B. Heward, F. Newell, E. A. Ryan, J. A. Vance and the Treasurer, J. B. Challies.

As members of the Committee on Consolidation: Dr. O. O. Lefebvre, J. B. Challies, A. B. Crealock, G. J. Desbarats, R. E. Jamieson, C. C. Kirby, Robert F. Legget and Gordon McL. Pitts, Chairman.

This meeting was called for the purpose of considering revisions to the By-laws of The Institute as proposed by the Committee on Consolidation.

In connection with the above proposals communications were received from the following, and were given detailed consideration by the meeting:—

R. L. Dobbin, M.E.I.C., Vice-President.

C. G. R. Armstrong, A.M.E.I.C., Councillor, Border Cities.

Stewart Young, M.E.I.C., Councillor, Saskatchewan.

H. S. Johnston, M.E.I.C., Councillor, Halifax.

D. A. R. McCannel, M.E.I.C., Chairman, Joint Committee on Consolidation in Saskatchewan.

C. C. Kirby, M.E.I.C., Chairman of the Dominion Council of Professional Engineers.

A. J. Taunton, M.E.I.C., Chairman of the Manitoba Joint Committee on Consolidation.

E. A. Wheatley, M.E.I.C., Registrar of the Association of Professional Engineers of British Columbia.

The joint meeting referred certain clauses for the further study of the Committee on Consolidation and a plenary meeting of the Council of The Institute to be held on October 16th and 17th.

The twenty-third meeting of the Committee on Consolidation was convened at 11.30 a.m., on Saturday, September 19th, 1936. There were present Messrs. Lefebvre, Crealock, Desbarats, Jamieson, Kirby, Legget and Pitts.

This meeting considered the matters referred to it by the joint meeting of September 18th, and approved the final form of the proposed revisions to the By-laws to be submitted to the plenary meeting of Council by the Committee.

The proposals of the Committee on Consolidation have been submitted to Council over the signatures of twenty or more members of The Institute in accordance with the provisions of Section 75 of the By-laws governing "Amendments" thereto.

The Professional Meeting of The Engineering Institute of Canada held in co-operation with the Association of Professional Engineers of the Province of New Brunswick at Saint John, N.B., on August 27th, 28th and 29th, was attended by several members of the Committee on Consolidation and was pronounced a most interesting and enjoyable occasion, and one which reflects much credit on those responsible for its programme.

Mr. R. F. Legget, Secretary of the Committee on Consolidation, presented some phases of this movement to the convention, and a detailed discussion of certain proposals of the Committee was carried out with representatives of the Branches and Professional Association from Nova Scotia.

From the above it will be seen that the further activities of the Committee on Consolidation await consideration of its proposals by the plenary meeting of Council on October 16th and 17th.

GORDON McL. PITTS,
Chairman.

Meeting of Council

A meeting of the Council of The Institute was held at the Admiral Beatty Hotel, Saint John, N.B., on Friday, August 28th, 1936, at six thirty p.m., with President E. A. Cleveland, M.E.I.C., in the chair, and six other members of Council present.

A progress report was received from Mr. Busfield with regard to the arrangements for the Semicentennial Celebrations.

A copy of the draft proposals for the revisions of The Institute by-laws, as approved by the Committee on Consolidation, was submitted, and arrangements were made for a joint conference between Council and the Committee on Consolidation to be held on September 18th, 1936. It was also decided that a Plenary Meeting of Council should be held on October 16th and 17th, 1936, to consider these proposals when in their final form.

John Murphy, M.E.I.C., was appointed The Institute's official representative at the dinner of the American Society of Mechanical Engineers to be held in Niagara Falls, N.Y., on September 17th, 1936.

An invitation was presented from the American Society of Civil Engineers to The Institute to hold a joint meeting with that body in Boston during the Fall of 1937, detailed arrangements to be settled later. This invitation was accepted, with appreciation of the Society's suggestion.

Three resignations were accepted; one reinstatement was effected; three members were placed on the Life Membership List; and two special cases were considered.

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

Elections		*Transfers*	
Members	3	Assoc. Member to Member	2
Assoc. Members	3	Junior to Assoc. Member	4
Juniors	1	Student to Assoc. Member	2
Affiliates	1	Student to Junior	1
Students admitted	4		

The Council rose at ten forty-five p.m.

SEMICENTENNIAL
1887 1937
THE ENGINEERING INSTITUTE OF CANADA FOUNDED 1887
JUNE 15-18 1937

Semicentennial Committee

A. COUSINEAU, A.M.E.I.C.
R. L. DOBBIN, M.E.I.C.
J. M. FAIRBAIRN, A.M.E.I.C.
R. H. FINDLAY, M.E.I.C.
F. S. B. HEWARD, A.M.E.I.C.
J. L. BUSFIELD, M.E.I.C., Chairman

Meetings

Plans for the celebration of the Institute's fiftieth birthday in June, 1937, are well advanced. Invitations have been sent to seventy engineering societies throughout the world to notify their members that they will be welcome at our meeting. The immediate response has been very gratifying; many societies have indicated that they will be officially represented, and there is every indication that the Semicentennial will be a truly international gathering.

The principal functions will be held in Montreal at the Windsor Hotel on June 15th, 16th and 17th, following which the meeting will adjourn to Ottawa at the Chateau Laurier.

Historical Reviews

A special Semicentennial number of The Engineering Journal will be published. This issue will contain a series of papers by eminent authors reviewing engineering activities in Canada for the past fifty years, under such specific headings as waterpowers, railways, waterways, industries, irrigation, harbours and bridges, as given in detail on the opposite page.

Papers on Canadian Engineering

Technical papers for presentation and discussion at the meetings are not being forgotten. For example, in the mechanical engineering field it is expected that there will be a symposium of papers dealing with the combustion of low-grade Canadian coals. Latest developments in trans-Atlantic aviation, modern motive power in Canada, and other subjects,—Canadian in colour but of international interest,—will be presented.

Other plans which are at present in embryo will be announced from time to time on this page.

How Members Can Help

The success of the meeting will depend on the interest and co-operation of the Institute membership. The committee in charge of the arrangements asks for your personal support. For instance, if you are associated with engineering firms outside of Canada, why not suggest that a visit to Canada by your principals at the time of the Semicentennial will be opportune? But above all, make your own plans to attend and don't forget that the ladies will be welcome.

Special Semicentennial Number of the Journal

Containing a series of papers presenting a notable record of Canadian engineering activities during the period

1887-1937

Contents

The Maritime Professional Meeting, 1936

In undertaking to sponsor a professional meeting in Saint John this year, the Maritime Branches of The Institute were no doubt influenced by the approaching completion of the extensive harbour works at Saint John which are described elsewhere in this issue of The Journal. Their enterprise and initiative were fully justified by the results. The Saint John Branch probably recalled the very successful professional meeting held at White Point Beach in Nova Scotia in 1933, and, as on that occasion, secured the support and co-operation of the Association of Professional Engineers of the province in which the meeting was planned. Like the White Point Beach meeting, the Saint John gathering was a practical example of that co-operation between The Institute and the Professional Associations which has been sought for by Canadian engineers during recent years.

The time selected for the Saint John meeting, towards the end of summer, made attendance easy for those who travelled by motor, and favourable weather conditions fortunately prevailed. The attendance was gratifying, the total registration being well over one hundred, and it was pleasant to note the unusually large proportion of visiting ladies who were able to be present.

After the necessary formalities of registration on the first day, the official proceedings commenced on the afternoon of Thursday, August 27th, with a professional session, as a preliminary to which J. R. Freeman, M.E.I.C., Chairman of the Saint John Branch, opened the meeting by introducing the Mayor of Saint John, D. L. MacLaren, Esq., who in conveying the city's welcome to The Institute members pointed out that it is the engineer who has made modern city life possible by the provision of light, power, water, and other amenities on which civilization is based. Mayor MacLaren therefore considered it most appropriate that in choosing the place for the meeting, the oldest incorporated city in Canada should have been selected. His friendly speech was warmly received, and suitably acknowledged by President E. A. Cleveland.

The chair was then taken by C. S. Bennett, A.M.E.I.C., chairman of the Halifax Branch, and an address on the "Stabilization, Realignment and Surfacing of New Brunswick Roads" was delivered by D. R. Smith, resident road engineer, Department of Public Works, Province of New Brunswick. Mr. Smith's address, of which an abstract appears on another page, was based on a paper on the same subject which was to be presented by Mr. D. R. Lawton at the Good Roads Convention held at Charlottetown on September 2nd, and contained interesting technical data on the extensive two-year programme of highway work which is now being carried out in New Brunswick, in which some 1,500 miles of trunk road are being converted from gravel surface to asphalt pavement.

As in the neighbouring province of Nova Scotia, a comprehensive modernization programme has thus been undertaken, and existing highways are being brought into conformity with present day requirements in a manner which reflects great credit on the Highways Departments of both provinces, and involves surprisingly little interference with road traffic. Mr. Smith's paper gave rise to an active discussion, dealing with such points as the relative costs of different types of bitumen paving, the layout necessary for clear vision on curves and hills and the economic aspects of the demand for roads which will be safe at high speeds. During the discussion, attention was also drawn to the difficulties likely to arise in the case of main highways near centres of population, due to their obstruction by parking and other hindrances resulting from the occupation of abutting property by people who move out from the cities to settle along such main arteries.

At the dinner in the evening, the President of The Institute, Dr. E. A. Cleveland, M.E.I.C., was in the chair, and took the opportunity of reminding the members and ladies present that although living in British Columbia, he is a native son of New Brunswick. The Premier of the Province, the Hon. A. A. Dysart, was unfortunately prevented from being present, but was ably represented by the Hon. W. D. Roberts, Minister of Health and Labour, who had made a record motor trip from Fredericton to attend the dinner, and extended a cordial welcome to the members of The Institute visiting the Province of New Brunswick. In moving a vote of thanks to Dr. Roberts, Mr. Bennett suggested that gratitude should also be expressed to the New Brunswick Department of Highways, whose facilities had enabled Dr. Roberts to attain such a high speed during his journey.

The very brief programme of speeches at the dinner was followed by a dance and bridge in the Georgian ballroom, and these proved very popular features of the evening's entertainment.

The serious work of the meeting was resumed on Friday morning with two technical papers, both of which appear elsewhere in this issue of The Journal.

In the first of these, G. Lorne Wiggs, A.M.E.I.C., gave a clear exposition of the meaning and scope of air conditioning, and in the discussion which followed Messrs. F. P. Shearwood, M.E.I.C., H. W. McKiel, M.E.I.C., and C. H. Wright, M.E.I.C., took part. Professor McKiel added an interesting description of his experimental work on various aspects of air conditioning applied to his own dwelling house, an investigation which is being continued and will no doubt provide further data on this phase of the question.

The paper by V. S. Chesnut, A.M.E.I.C., was an excellent preliminary to the visit in the afternoon, as it dealt with the extensive reconstruction work at Berths 1, 2, 3 and 4 in Saint John harbour, which is being carried out by the Harbour Commissioners.

Maritime General Professional Meeting, 1936.

At lunch members were guests of the Foundation Company, the contractors to whom this reconstruction work has been entrusted, and were welcomed by F. G. Rutley, A.M.E.I.C., the vice-president of the company. Immediately after lunch some eighty members proceeded to the harbour works, where they were received by representatives of the Harbour Commission and the contractors, and spent a most instructive afternoon in inspecting the works. These are now approaching completion, and the trip therefore afforded an excellent opportunity to study the results of the engineers' plans and designs, and the successful construction methods of the contractors.

During the visit Mr. Chesnut's paper was amplified by verbal descriptions given at each part of the work, which is notable in that for the first time in eastern Canada the cylinder and surface-slab type of wharf construction is being used. The 28-foot tide and the severe winter conditions make this two million dollar reconstruction project an exceptionally interesting one.

While this excursion was in progress, the ladies were taken in charge by the ladies committee, and entertained at tea at the Westfield Golf Club, one of the most scenic points on the beautiful Saint John river.

Later, members and guests gathered for a smoker in the ballroom of the Admiral Beatty hotel, listened to an inimitable speech by the Hon. Michael Dwyer, A.M.E.I.C., who did not confine his remarks to mining topics. They renewed old acquaintanceships in the intervals of an interesting programme of motion pictures, shown under the supervision of A. R. Crookshank, M.E.I.C., and dealing with many aspects of transportation, construction and communication.

On Saturday, August 29th, the closing event of the gathering was a visit to Eastport, Maine, where, through the kindness of the officers of the United States Corps of Engineers in charge of the works, over a hundred members and ladies inspected the Passamaquoddy Tidal Project. This scheme, on which some six million dollars have been spent, deals only with waters within the United States, although consideration has been given to possible future international development. Its design involves many difficult technical problems and heavy construction work, and provides for an ultimate production of some four hundred to six hundred million kilowatt hours per year, depending on the final layout adopted. It has been financed under the United States Public Works Administration as a relief measure and the work has been designed and carried out by the U.S. Army Engineers.

Some thirty cars made the 70-mile journey. The motorists were most hospitably received and given the fullest possible opportunity to inspect the development. The return journey to Saint John was made under unfavourable weather conditions, which, however, failed to dampen the enthusiasm of the party or dim the very pleasant memories of the Maritime Professional Meeting of 1936, which, everyone agreed, had been one of the most successful on record.

The officers and members of the Saint John Branch have undoubtedly earned the many congratulations which they received on the success of the meeting.

OBITUARIES

Robert Alexander Ross, M.E.I.C.

The morning of September 23rd, 1936, closed the career of a distinguished member of The Institute, when death came to Past-President R. A. Ross, at his home in Montreal.

Dr. Ross' long activity as an electrical engineer commenced in the closing years of the nineteenth century when the technical advance of his branch of the profession had hardly begun. His early experience was in the era of the carbon lamp and direct current generator, his later work in that of the high voltage transformer and thermionic valve. Thus he was enabled to take part in the remarkable developments of the past fifty years which have so greatly enlarged the scope of electrical engineering.

Robert Alexander Ross, M.E.I.C.

He was born at Woodstock, Ontario, on August 29th, 1865, and was educated at the University of Toronto, graduating from the School of Practical Science in 1890.

Following graduation he was with the Canadian General Electric Company at Sherbrooke, Que., and Peterborough, Ont., until 1893, when he was appointed chief electrical and mechanical engineer of the Royal Electric Company, Montreal. In 1896 Mr. Ross was granted the professional degree of E.E. by the University of Toronto. At that time he began his consulting engineering practice in Montreal, during which he was responsible for the design of many important electrical and power installations, including the West Kootenay Power and Light plant at Bonnington Falls, B.C., the Huronian Company's plant and that of the Canadian Copper Company at Copper Cliff, Ont., the West India Electric Company, Jamaica, and many others.

He has acted at various times as consultant to most of the larger cities and municipalities throughout the Dominion and has carried out work in China, India, Straits Settlements, Russia, Finland, Scotland, Australia and the United States.

An interesting feature of Dr. Ross' professional career was his long connection with the City of Westmount as their consulting engineer. His original commission from the city led to the installation of their well known municipal power plant and refuse destructor. This plant was built in 1905 and its success was largely due to his progressive ideas, while its operation as a municipal undertaking did much to bring about successive reductions in electrical rates in the Island of Montreal.

In 1916 at the time of its establishment, he was appointed a member of the Honorary Advisory Council for Scientific and Industrial Research, and later held the office of chairman of that body for some years. He was also chairman of the Lignite Utilization Board (1918-1924).

From 1918 until 1921 Mr. Ross served as a member of the Administrative Commission of Montreal, a body formed by the provincial government to save the city from financial chaos. In 1921 he received the honorary degree of Doctor of Science from the University of Toronto.

In 1923 Dr. Ross was appointed a member of a Royal Commission instituted by the provincial government of Ontario to investigate and report upon the affairs of the Hydro-Electric Power Commission of Ontario, and in 1932 was a member of the Board of Engineers who carried out an important investigation into power rates in the city of Quebec and reported to the city council thereon.

Dr. Ross was one of the senior members of The Engineering Institute of Canada, having joined the Canadian Society of Civil Engineers as a Member on May 6th, 1897. He took a leading part in The Institute's activities, for he served as a member of Council for eight years, was a vice-president from 1914 to 1916, and filled the presidential chair of The Institute in 1920. In 1934 he received the highest distinction which The Institute can bestow, in the award of the Sir John Kennedy Medal for outstanding merit in the profession of engineering.

He was elected a Fellow of the American Institute of Electrical Engineers in 1912.

Broad in his outlook, Dr. Ross early realized that for an engineer worthy of the name, competence as a designer, knowledge of scientific principles and familiarity with technical detail must be joined with administrative capacity and ability to deal with men and affairs. His success as a consultant, and his value as a public servant proved the soundness of this view.

In addition to his purely engineering work he was always ready, even at considerable personal sacrifice, to render to his country or to the public any service for which he felt himself fitted. During his long connection with The Institute he devoted much of his time to its affairs, regarding which he was a valued counselor. His pithy comments and dry humour always enlivened any discussion in which he took part.

His Presidential address to the members of The Engineering Institute, delivered in March, 1921, dealt largely with the organization and future of the engineering profession, a subject near his heart, and one on which he held very definite views. Deeply concerned with the young engineer and his future, he was one of the band of senior engineers who were interested in the development and establishment in Canada of the Ritual of the Calling of an Engineer.

His many friends within and without The Institute have to deplore the loss of a man of sterling integrity and high principles, whose ability, independence of character and professional competence gave him a place among Canadian engineers which it will indeed be difficult to fill.

Joseph Harrison Wallace, M.E.I.C.

Deep regret is expressed in placing on record the death at Hamilton, Ohio, on July 7th, 1936, of Joseph Harrison Wallace, M.E.I.C., a prominent paper-mill engineer.

Mr. Wallace was born at Worcester, Mass., on November 10th, 1869, and graduated from Worcester Polytechnic Institute, obtaining the degree of B.S. in 1892 and that of C.E. in 1899. Following graduation he was for several years with the United States Lighthouse Service on the coast of Maine, developing fog signals. In 1894 Mr. Wallace became connected with the firm of A. B. Tower and Company as draughtsman and engineer, and in 1895 he was resident engineer for the firm with the Marshall Paper Company, Turners Falls, Mass., in charge of design and construction of a steam and water power plant for the manufacture of copying tissues. In 1896-1897 Mr. Wallace was resident engineer with the New England Talc Company at Pittsfield, Vt., in charge of surveys, plans and estimates for the development of talc mines. In 1897 he became a partner in the firm of Tower and Wallace, mill and hydraulic engineers, New York, N.Y., and four years later entered private practice as a mill engineer and hydraulic engineer under the firm name of J. H. Wallace and Company. In the course of his very active career he built many important paper mills such as that of the Spanish River Pulp and Paper Company at Webbwood, Ontario, the Petawawa Lumber Pulp and Paper Company at Petawawa, Ontario, the Wall Paper Manufacturers Limited mill at Greenhithe, England, the Kalamazoo Paper Company mill, and the Oxford-Miami Paper Company mill at Carrollton, Ohio. To take care of his European enterprises, he established an office in London in 1904.

One of Mr. Wallace's greatest interests became the utilization of southern woods. He designed, built and operated for three years the Southern Paper Company's plant at Moss Point, Miss. This started the successful manufacture of Kraft paper from Southern pine in the United States.

During the war, Mr. Wallace and his laboratories and organization worked on problems relating to explosives for the government, and he was in charge of a large construction area at Nitro, Va.

From 1925 to 1930 Mr. Wallace was engaged in paper mill operation and sales of paper. Later in 1931, he joined the Black-Clawson Company and was associated with that company and the affiliated Shartle Brothers, in the manufacture and sale of their line of paper mill machinery, which connection he retained until the time of his death.

Mr. Wallace was a member of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the Technical Association of the Pulp and Paper Industry, and a number of other societies and organizations.

He became an Associate Member of The Institute (then the Canadian Society of Civil Engineers) on November 21st, 1901, and a full Member on April 10th, 1902.

PERSONALS

Max Levin, S.E.I.C., who graduated from the University of Manitoba with the degree of B.Sc. in 1930, and from the University of Toronto with that of M.A.Sc. in 1933, is now on the engineering staff of the Yukon Consolidated Gold Corporation, at Dawson, Y.T.

A. G. Barrett, A.M.E.I.C., is now mechanical and structural engineer with the Yukon Consolidated Gold Corporation Limited, at Dawson, Y.T. Mr. Barrett graduated from Queen's University in 1921 with the degree of B.Sc., and following graduation was for a time with the Department of Public Highways of Ontario. In 1924 he was with the Quebec Development Company as instrumentman, and in the same year joined the staff of the Canadian Johns-Manville Company at Asbestos, Que., as instrumentman and on office work. In 1926 he became assistant chief engineer, and in 1929 chief engineer of the same company.

David Shepherd, A.M.E.I.C., a member of the Toronto firm of Campbell and Shepherd, consulting engineers, has been named as housing expert adviser to the National Employment Commission. Mr. Shepherd was a member of the Better Housing Committee formed by Lieut. Governor Bruce of Ontario, and he served as government inspecting engineer on the Confederation building in Ottawa. Mr. Shepherd is a graduate of Edinburgh University, and has lived in Canada since 1912.

S. J. Hungerford, M.E.I.C.

S. J. Hungerford, M.E.I.C., has been appointed chairman of the new]Board of [Directors of the Canadian National Railways.

Born at Bedford, Que., in 1872, Mr. Hungerford's first railway work was as machinist apprentice with the Southeastern Railway and Canadian Pacific Railway at Farnham, Que. Between 1891 and 1910 positions held with the Canadian Pacific Railway included master mechanic of the Western division, with headquarters at Calgary, Alta., and superintendent of the large locomotive and other shops at Winnipeg. In 1910 Mr. Hungerford accepted the position of superintendent of rolling stock of the Canadian Northern Railway, with headquarters, first at Winnipeg, and later at Toronto. Following the organization of the Canadian National Railways, Mr. Hungerford was appointed, in November 1917, general manager of the eastern lines, and in the following year became vice-president and general manager. In 1923 he assumed the office of vice-president in charge of operation and maintenance, and in 1934 was appointed president by the Board of Trustees named to administer the railway affairs.

Harold W. Harkness, M.E.I.C., formerly associate professor of physics at Acadia University, Wolfville, N.S., is now on the staff of the Memorial University College, St. John's, Newfoundland. Mr. Harkness graduated from Queen's University in 1915 with the degree of B.Sc. and in 1929 received the degree of M.Sc., and in 1930 that of Ph.D. from McGill University. He also engaged on graduate study and research at the University of Chicago and the University of Toronto. In 1918 Mr. Harkness went to China, and was assistant supervisor of building construction at Cheeloo University, Tsinan, Shangtung. In 1918-1919 he was also instructor in engineering and applied physics at the same university and in 1919-1921 associate professor. In 1922-1927 Mr. Harkness was district representative at Tientsin for the Eastern Engineering Works, and was also consultant for the Tsinan Power Company. Returning to Canada in 1927 he became research assistant at McGill University, and in 1930 he was for a time research physicist with Price Brothers and Company Limited. In the same year Mr. Harkness was appointed to the position from which he has now resigned.

Professor H. J. MacLeod, M.E.I.C., has accepted the position of Head of the Department of Mechanical and Electrical Engineering in the University of British Columbia.

Professor MacLeod graduated from McGill University in 1914 with the degree of B.Sc. and received the degree of M.Sc. from the University of Alberta in 1916, and that of M.A.Ph.D. from Harvard University in 1921. From 1914 until 1916 he was lecturer in electrical engineering at the University of Alberta, and from April 1916 until August 1919 he was overseas with the Canadian Expeditionary Forces. From September 1919 until June 1921 Professor MacLeod was engaged on research work on power losses in dielectrics at Harvard University, and following this was associate professor of electrical engineering at the University of Alberta until January 1924 when he was appointed head of the department of electrical engineering, which office he has held until the present time.

B. A. Berger, Jr.E.I.C., is now tool engineer with the General Motors Corporation of Canada at Oshawa, Ontario. Mr. Berger graduated from McGill University in 1930 with the degree of B.Sc., and since 1932 has been designing draughtsman with the Ford Motor Company of Canada, Limited, at Windsor, Ontario.

D. H. McDougall, LL.D., M.E.I.C., head of the McDougall Engineering Company of Nova Scotia and Montreal, is one of the members of the recently appointed Board of Directors of the Canadian National Railways.

Mr. McDougall was president of the Nova Scotia Steel and Coal Company Limited, New Glasgow, N.S., and is now liquidator and adviser to the receivers. He was vice-president and general manager of the Dominion Steel Corporation for several years after the war. Since 1923 he has been in consulting work which has taken him all over Canada and to the United States. Mr. McDougall is a director of the McIntyre Porcupine Mine, of the Atlantic Sugar Company, the Castle-Tretheway Mines, the English

D. H. McDougall, M.E.I.C.

Electric Company, the Eastern Car Company and a number of other organizations. He had several years direct railway experience as the assistant resident engineer of the New York Central and Hudson River Railway, and with the Sydney and Louisburg and Cumberland Railway, part of the Nova Scotia Steel operations.

W. G. Murrin, M.E.I.C., president of the British Columbia Electric Railway Company, Vancouver, B.C., was recently elected a director of the Bank of Montreal. Mr. Murrin, who is a graduate of the Royal Naval School, Greenwich, England, and the Finsbury Technical College, London, England, was with the City of London Electric Light Company from 1893 until 1899, when he joined the staff of the Stockton and Middlesboro Electric Tramway Company. From 1901 until 1913 Mr. Murrin was works manager and electrical engineer with the London United Tramway Company. In 1913 he came to this country and became mechanical superintendent with the B.C. Electric Railway. He was subsequently general superintendent, assistant general manager and vice-president of the company of which he is now president. In addition to this office, Mr. Murrin is also president of the British Columbia Power Corporation Limited, the British Columbia Electric Power and Gas Company Limited, and the Growers Wine Company Limited, and he is a director of a number of other companies.

Dr. A. Frigon, M.E.I.C.

Dr. A. Frigon, M.E.I.C., has been appointed assistant general manager of the Canadian Radio Broadcasting Corporation, of which Mr. Gladstone Murray is to be general manager. Dr. Frigon, whose office will be in Montreal, will deal particularly with the French section of the work, and will also act as technical adviser to the Corporation.

Elections and Transfers

At the meeting of Council held on August 28th, 1936, the following elections and transfers were effected:

Members

DOLMAGE, Victor, Ph.D., (M.I.T.), consltg. geologist, 1318 Marine Bldg., Vancouver, B.C.

MacLEOD, George Grant Webber, B.Sc., (Queen's Univ.), mgr., Lands and Mines Dept., Algoma Central and Hudson's Bay Rly.; Sault Ste. Marie, Ont.

TAYLOR, Edward George Towle, president and gen. mgr., Taylor Engineering and Construction Co., 14 King St. E., Toronto, Ont.

Associate Members

BIEDERMANN, Othmar, E. E., (Bienne Technicum), mgr., Oerlikon-Canada Limited, 1514 University Tower, Montreal, Que.

CHURCH, Charles Edward, (Dublin Tech. School), patent attorney, 21 Main St. E., Hamilton, Ont.

SWAN, Nicholas Stanley Scobie, struct'l. steel design, Ontario Paper Co., Thorold, Ont.

Junior

FORBES, Donald Alexander, B.E., (Univ. of Sask.), asst. engr., Consolidated Paper Corpn., Port Alfred, Que.

Affiliate

YOUNG, James William, (Prov. Inst. Technology, Calgary), asst. city chemist, Calgary, chemist, Glenmore Water Supply, chemist, sewage disposal plant, Calgary, Alta.

Transferred from the class of Associate Member to that of Member

COWLEY, Frank Penrose Vaughan, (Grad., R.M.C.), asst. engr., City of Vancouver, B.C.

LEGER, Oswald Ernest, (McGill Univ.), asst. to the president, Hamilton Bridge Co. Ltd., Hamilton, Ont.

Transferred from the class of Junior to that of Associate Member

ADDIE, Donald Kyle, B.Sc., (McGill Univ.), asst. mgr., Point St. Charles plant, Dominion Glass Co. Ltd., Montreal, Que.

DOVE, Allan Burgess, B.Sc., (Queen's Univ.), asst. West Mill supt., and chem. engr., Canada Works, Steel Company of Canada Ltd., Hamilton, Ont.

HAYES, Roland Earle, B.Sc., (McGill Univ.), mgr., engrg. dept., The General Supply Co. of Canada Ltd., Ottawa, Ont.

LUCAS, John William, B.Sc., (Univ. of Alta.), tester of bldg. materials, Testing Laboratories, Dept. of Public Works Canada, Ottawa, Ont.

Transferred from the class of Student to that of Associate Member

GODWIN, Harold Brandon, Flight-Lieut., R.C.A.F., B.Sc., (McGill Univ.), Trenton, Ont.

PARKER, Clarence Collins, M.A.Sc., (Univ. of Toronto), bridge designer, Dept. of Northern Development, Toronto, Ont.

Transferred from the class of Student to that of Junior

FRASER, Campbell, B.Sc., (Queen's Univ.), bridge inspector, Dept. of Highways Ontario, Port Hope, Ont.

Students Admitted

EVANS, Leslie Murray, (N.S. Tech. Coll.), 97 North St., Halifax, N.S.

FINDLAY, Frank Peyton, B.Sc., (Univ. of Man), 987 McMillan Ave., Winnipeg, Man.

GUIHAN, William Bonaventure, engrg. asst., Canadian Celanese Ltd., Drummondville, Que.

TAYLOR, Frederick William, B.A.Sc., (Univ. of Toronto), 1198 Woodbine Ave., Toronto, Ont.

Joint Meeting with the A.S.M.E. at Niagara Falls

It is seldom that members of The Engineering Institute of Canada have the opportunity of taking part officially in as interesting a meeting as that of the American Society of Mechanical Engineers which took place recently at Niagara Falls. This meeting, which was held from the 17th to the 19th of September, was arranged as to subject matter and time so as to permit the attendance of those taking the tours which followed the World Power Conference, all five of which visited the Falls at some time during the meeting. The locality chosen was particularly fortunate in that Niagara Falls is known the world over for both its scenic beauty and the engineering and industrial achievements which the development of this great natural resource has made possible.

The Institute, on the invitation of the Council of the American Society of Mechanical Engineers, participated jointly in the meeting, over sixty of our members being present. All were appreciative of the courtesy extended to The Institute by the A.S.M.E. and took full advantage of the attractive technical and social features of the gathering.

Throughout the programme emphasis was placed on current practice in power, a number of internationally known engineers presenting papers as follows: "Current Practice and Trends in American Power Plants" by A. G. Christie of Johns Hopkins University; "Superposition" by E. H. Krieg, of the American Gas and Electric Company; "Trend of Design for 500 to 800 pound Pressure Steam Electric Plants" by J. A. Powell, of the E. M. Gilbert Engineering Corporation; "German Boiler and Turbine Practice" by Dr. Otto Schoene of the University of Berlin; a Discussion of British Boiler and Turbine Practice; "Operating Experiences of 400 pound Pressure Sugar Refining Steam Plant" by Dan Gutleben of the Pennsylvania Sugar Company; "Operating Conditions at Huntley Station" by H. M. Cushing of the Buffalo Niagara East Power

Company; "Design and Operating Problems when Using Gas and Oil Fired Boilers for Standby Steam Electric Stations" by V. F. Estcourt, Pacific Gas and Electric Company.

Hydro-electric plants both in Canada and the United States and hydraulic research work were adequately reviewed. Dr. T. H. Hogg, M.E.I.C., of the Hydro-Electric Power Commission of Ontario delivered a paper on "Canadian Hydro-electric Practice"; Leslie J. Hooper of the Worcester Polytechnic Institute presented one on "American Hydraulic Laboratory Practice"; F. H. Falkner of the U.S. Corps of Engineers, Vicksburg, Miss., Director U.S. Waterways Experiment Station, gave a paper on "Hydraulic Laboratory Projects of the Corps of Engineers, U.S. Army"; and A. C. Clogher, chief hydraulic engineer, Electric Bond and Share Company, spoke on "Hydro-electric Practice in the United States." Professor R. W. Angus, M.E.I.C., of the University of Toronto, acted as chairman for the hydraulic laboratory session.

Subjects other than power were also discussed and included transportation, under which category the two following papers were presented: "Performance of Diesel-Electric Locomotives in the Buffalo Area" by J. C. Thirwall, of the General Electric Company and "The Mechanics of the Car Retarder" by N. C. L. Brown, of the General Railway Signal Company.

The wood industries received attention as follows: "Discussion of Material Waste Reduction in Woodworking Plants" by F. R. Hassler, consulting engineer;" Grinding and Maintenance of Cemented Carbide Fitted Saws and Woodworking Knives" by C. M. Thompson, H. Disston and Sons, Inc.; "Factors to be Considered in Substituting one Wood for Another" by R. P. A. Johnson, Forest Products Laboratory; "Use of Synthetic Resins in Modern Varnishes for Wood Protection" by R. J. Moore, Bakelite Corporation.

Two papers were presented on processing: "Drum and Contact Drying" by Guy Harcourt, Buffalo Machine and Foundry Company and "Discussion of Drying Developments" by A. Weisselberg, consulting engineer, New York.

In addition two papers were presented on "Latest Developments in Aircraft Power Plant Accessories" by S. H. Webster, Eclipse Aviation Corporation, and "Piston Ring Friction in High Speed Engines" by Louis Illmer, consulting engineer, Cortland, N.Y.

The dinner on Thursday evening was attended by nearly six hundred engineers, including many delegates to the World Power Conference. The international aspect of the gathering was particularly noticeable as the greater proportion of these delegates were from countries other than the United States and Canada. The toastmaster was Mr. William L. Batt, President of the American Society of Mechanical Engineers, and the visitors were welcomed by Dr. Norman R. Gibson, vice-president and chief engineer, the Niagara Falls Power Company. The guests of honour were Dr. Heinrich Schult, President, Verein Deutscher Ingenieure, John Murphy, M.E.I.C., representing The Engineering Institute of Canada, Dr. Conrad Matschoss, Secretary of the Verein Deutscher Ingenieure, and fifty-year medallist of the American Society of Mechanical Engineers. The principal speaker was Dr. William F. Durand, Chairman of the Third World Power Conference, and Past-President of the American Society of Mechanical Engineers, who spoke on the World Power Conference in Washington which had just concluded.

Throughout the three-day meeting considerable emphasis was laid on plant inspection trips. Some of the more important of the eleven visits arranged were to: the Schoellkoepf station of the Niagara Falls Power Company, the Huntley steam power plant, the Curtiss Aeroplane and Motor Corporation, and the Bethlehem Steel Corporation's new Lackawanna strip mill plant. About one hundred and fifty participated in the latter trip.

CORRESPONDENCE

The Editor,
The Engineering Journal.

Dear Sir,

Construction Materials in Canada

In the August issue of The Engineering Journal you published a most interesting letter from Mr. T. A. McElhanney A.M.E.I.C., Superintendent of the Forest Products Laboratories of Canada, at Ottawa, in which are presented some comments on a paragraph of a paper of mine on Steel Sheet Piling, previously published in the Journal. I regret that repeated absences from Montreal have prevented me from writing previously with regard to this letter, but I trust that even at this late date you will extend to me the courtesy of replying through the columns of our official organ. I ask this in view of my appreciation of Mr. McElhanney's interesting comments, and in the hope that I may be able to answer, at least to some extent, some of his suggestions. The points at issue are but parts of a much broader general question which might well be discussed at further length in the forum presented by the Journal, the pages of which offer our only opportunity for considered technical discussion on Canadian engineering matters.

Mr. McElhanney suggests that I have made statements "which conceivably might leave an entirely erroneous impression of the situation with respect to sources of timber for piles in Canada"... and which might "create an erroneous idea of the forestry situation in Canada." May I first assure you, Sir, that no statements of mine have ever had that intention. I regret therefore that my reference to the National Research Council's Associate Committee on Forestry, based on reports in the public press which I took to be reasonably accurate, displayed an incorrect emphasis. As to factual evidence regarding the present state of Canada's forests, I naturally accept all that Mr. McElhanney says, asking leave merely to point out that I did not refer to timber piles, timber cribwork construction being in my mind when comparing timber with steel for wharf construction.

May I suggest that the erroneous impressions may possibly have arisen due to one or both of two factors: (*a*) the abstraction of one paragraph from its context; and (*b*) the condensation of the original paper, as read, which you had to make in order to reduce it to a suitable length for publication. The first quarter of the original paper was a general discussion of the use of timber, reinforced concrete, and steel in modern construction, with special reference to the economic aspect of this general question, and it was in reference to this discussion that the paragraph quoted was specifically directed. This is made clear by the following quotation from the original paper, italics indicating words left out in the printed version:—

> "It is the writer's firm belief that there is no real competition between these two materials of construction, *each having its part to play in future civil engineering work in Canada*... In such conservation work the judicious use of steel piling for permanent structures can be of real assistance *and when, in addition, such applications can be shown to be truly economic a partial answer at least will have been demonstrated to the broad question with which this paper opened.*"

The broad question to which reference is here made is whether comparable attention is paid in civil engineering work to the selection of construction materials as is given to design calculations. In the discussion of this question it was suggested that, provided a material will have when in place the properties assumed in design, its selection should normally be based on a study of comparative annual costs (i.e. maintenance, interest and sinking fund charges) for all materials available. Such are the "economics of its use" to which reference is made in the paper. In pointing out that reasonably sized square timber could not now be readily obtained in the east of Canada, the implication was that as the special local factor which the availability of such local timber introduces is not now effective, construction materials for the works considered having in any case to be brought from distant sources, the economics of wharf construction and reconstruction work should be studied on this fundamental basis. If this be done, steel piling will inevitably take its place in such civil engineering work. Unfortunately, and especially in the eyes of the public, the first cost of a structure is often alone considered. It was in the hope that informed discussion on this vital matter on a correct basis might possibly be promoted that the views in question were set forth.

Although for some years past I have had the privilege of doing my engineering work for an organization concerned solely with steel sheet piling, and therefore can not suggest that I am able to view these questions without bias, I do hope that through you Mr. McElhanney will accept my assurance that, so far as was possible, my paper was prepared strictly from a general engineering standpoint. And as some confirmation of my genuine interest in, and appreciation of the correct place of timber in civil engineering work, perhaps I may be permitted to recall some remarks I made on this very point when exhibiting two interesting samples of timber now in my possession, cut from the timber bearing piles which carried Waterloo Bridge for well over one hundred years across the River Thames, during the course of an address on this same general subject which I was privileged to give in March last, to the Ottawa Branch of The Institute, and to which Mr. McElhanney did me the honour of listening.

I am, Sir,
Yours faithfully,
Robert F. Legget, A.M.E.I.C.

1106 Castle Building,
Montreal.

THE EDITOR,
THE ENGINEERING JOURNAL.

DEAR SIR,

I am sending you herewith two photographs of curious bridges which I came across this summer on the Upper Matane river on the Lower St. Lawrence. They may be of interest to readers of The Journal.

The first (Fig. 1) is a simple span bridge supported on corbeled abutments similar to Tibetan construction, north of the Himalayas.

Fig. 1

Fig. 2

Fig. 3

This structure is a curiosity in that it has really no lower chord, but merely two inclined posts butting into longitudinal timbers more or less securely fastened to the guard over the abutments. The floor consists of two longitudinal logs with cross-logs secured between them. There is no hardware on the structure except old rusty wire rope, which has been used in the manner of hay wire twisted, as necessary, in order to tighten up. There are no diagonals, and altogether the structure may be characterized as being "fearfully and wonderfully made." The total disregard for theory has, as usual, produced results, and the structure is "badly bent"—and closed to traffic. Probably the "engineer" did without the famous blue print.

The second bridge (Fig. 2) consists of what looks like a bridge without a top chord, but in reality this structure is not without merit. The abutments are corbeled as in the previous structure, and there is a true central span. The centre of this span is also supported on two cantilever spans, which rationalize the construction, and seeing that it has no rods nor hardware other than spikes and is carrying ordinary horse-drawn carts, it certainly may be called interesting. The details of construction are clear from the photograph.

In addition to the foregoing, I send another picture from the west (Fig. 3), which is certainly a curiosity. It is located behind a section house on the Kettle Valley Railway in B.C. Here the section foreman has apparently tried his hand at bridge building without the aid of a "blue print," and I understand it has been in service some time.

Yours very sincerely,

P. B. MOTLEY, M.E.I.C.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

New Zealand Society of Civil Engineers: Proceedings, 1935-36.

North-East Coast Institution of Engineers and Shipbuilders: Transactions, 1935-36.

Reports, etc.

Engineers' Council for Professional Development: 3rd Annual Report, 1935.

Queen's University: Calendar of Faculty of Applied Science, 1936-37.

United States Bureau of Mines: Minerals Yearbook, 1936.

Institution of Municipal and County Engineers: Handbook 1936-37.

Dominion Water Power and Hydrometric Bureau: Water Resources Paper No. 71, Arctic and Western Hudson Bay Drainage.

Labour Organization in Canada: 25th Annual Report, 1935.

Trustees of the Public Library of the City of Boston: Annual Reports for the years 1932, 33, 34 and 35.

Technical Books, etc.

Reinforced Concrete, by Robert A. Coughey (*D. Van Nostrand Inc., New York*).

A National Reference Book on Canadian Men and Women, 5th ed. 1936. (*Canadian Newspaper Service Reg'd., Toronto and Montreal*).

BULLETINS

Transformers.—The English Electric Company of Canada Ltd. have issued an 8-page bulletin containing data on their Type F distribution transformer. These are manufactured to be used for 25 and 60 cycles and cover a large range.

Air Compressors.—Two 4-page pamphlets received from the Worthington Pump and Machinery Corporation, Harrison, N.J., give information on their Types VS and VA-2 air compressors for use in garages, repair shops and service stations.

Nickel Alloy Steels.—A 16-page booklet received from the International Nickel Company Inc., New York, N.Y., contains information on the properties and applications of heat treated wrought nickel alloy steels in sections up to about 6 inches in diameter or thickness.

Structural Steel for Buildings

A new standard specification for the design, fabrication and erection of structural steel for buildings has been issued by the American Institute of Steel Construction, in the form of a 30-page booklet. In this new specification revisions have been incorporated in accordance with the recommendations of a Committee on Specifications of which F. T. Llewellyn, research engineer of the United States Steel Corporation, is chairman.

The specification provides for allowable unit stresses which accord in general with a basic stress of 20,000 instead of 18,000 pounds per square inch in tension.

To the industry, the Institute is making a free distribution of the new specification but duplicate copies may be had only upon payment of the cost of production. Those desiring copies in quantity may obtain same in lots of 10 to 50 at 15 cents each, in lots of 50 to 100 at 10 cents each, and in lots of over 100 at 8 cents each.

BRANCH NEWS

Halifax Branch

R. R. Murray, A.M.E.I.C., Secretary-Treasurer.
C. Scrymgeour, A.M.E.I.C., Branch News Editor.

The members of the Halifax Branch of The Engineering Institute of Canada met at a special dinner meeting on September 1st, 1936, for the purpose of welcoming to Halifax Dr. Ernest A. Cleveland, M.E.I.C., President of The Institute.

The large attendance at this meeting showed the considerable interest which was taken by the local members in Dr. Cleveland's visit, and C. S. Bennett, A.M.E.I.C., chairman for the Halifax Branch, welcomed the visiting guest to the meeting and introduced him to the respective members present.

In introducing Dr. Cleveland to the members of The Institute, the chairman made mention of the recent professional meeting held at Saint John, New Brunswick, and of the very cordial welcome which had been given to the members of the Halifax Branch by the members of the Saint John Branch.

Dr. Cleveland in addressing the meeting asked that complete co-operation be given to The Engineering Institute at this present time when various changes in the status of the organization were being discussed, as he felt that this year would prove to be one of the most important years The Engineering Institute of Canada would have since its inauguration.

In moving a vote of thanks to Dr. Cleveland for his very eloquent and able address, Harold S. Johnston, M.E.I.C., assured the President of The Institute that the Halifax Branch would co-operate to the fullest extent in any proposals which The Institute brought forward for its proposed re-organization.

Niagara Peninsula Branch

P. A. Dewey, A.M.E.I.C., Secretary-Treasurer.
C. G. Moon, A.M.E.I.C., Branch News Editor.

The first seasonal meeting of the Niagara Peninsula Branch was held at St. Catharines with about forty-five members and guests in attendance. At 3.30 in the afternoon of September 11th, some of this party met to visit the Guarantee Silk and Dye Works and were initiated into the secrets connected with the preparation of fabrics.

Mr. A. S. Townsend, who conducted the group through the plant, explained all the processes. Before dyeing, the silk is first thoroughly washed to remove the natural gums and other impurities, and then is taken to the weighting vats, where the weight lost in washing is made up. Dyeing is carried out by several different processes, varying with different types of natural and artificial silks. One interesting feature noted here was that by using two different silks in the cloth, e.g. acetate and viscose, the material could be dyed two colours by using dyes which would affect only one of the silks After dyeing, the silk is finished, which consists of stretching to remove any creases, and adding a suitable filler. An interesting inspection took place after the tour, at which those present found it exceedingly difficult to differentiate between the various natural and artificial silks.

Dinner was held at the Welland House, with Chairman Geo. H. Wood, A.M.E.I.C., presiding. A vote of thanks for the courtesy extended by the Dye Works was presented by W. D. Bracken, A.M.E.I.C., and responded to by Mr. A. S. Townsend.

Councillor E. P. Murphy, A.M.E.I.C., introduced Mr. Geo. R. Wyer of the Canadian Fairbanks-Morse, who explained the operation of the Diesel engine, and, with the aid of slides and motion pictures, showed the progress which had been made on this continent in this form of prime movers. For the benefit of Vice-President E. G. Cameron, M.E.I.C., who may read this note, it may be said that the functioning of the cameras was perfect.

Mr. Wyer's paper was followed with great interest, and a lively discussion ensued. H. M. Campbell, A.M.E.I.C., proposed the vote of thanks.

Ottawa Branch

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

Trends in Aviation Lighting

Dr. F. C. Breckenridge, of the National Bureau of Standards in Washington, spoke before the Ottawa Branch at a noon luncheon at the Chateau Laurier on September 4th, 1936. His subject was "Trends in Aviation Lighting." In the absence of E. Viens, M.E.I.C., chairman of the Branch, Dr. R. W. Boyle, M.E.I.C., presided, and in addition head table guests included: Major General A. G. L. McNaughton, M.E.I.C., J. A. Wilson, M.E.I.C., Air Commodore G. M. Croil, A.M.E.I.C., G. J. Desbarats, C.M.G., M.E.I.C., C. P. Edwards, A.M.E.I.C., Group Commander E. W. Stedman, M.E.I.C., A. D. McLean, and Squadron Leader A. Ferrier, A.M.E.I.C.

Dr. Breckenridge, in his address, first of all traced the history of aviation lighting from its early days of the Great War down to the present day. He divided this history into the following: the Great War period of 1914-1918 when the exigencies of military operations required that aircraft be sent into the air at night; the post-war or transition period when aviation was gradually taken over by commercial interests; the experimental period of 1924-1926 when most of the present types of aviation lighting in use today were begun; and a period of expansion with new airways being constructed, equipment standardized and details improved. With regard to the last-mentioned, the speaker stated that indications point to the fact that this period is merging into another transition period which is having its effect upon aviation lighting development. It is concerned, among other things, with a more comprehensive co-ordination of radio and visual aids to aerial navigation, to more proper methods of handling increased aerial traffic, to lower costs in beacons and allied equipment, and to a pronounced simplification in such equipment.

Regarding a popular impression that radio aids to aerial navigation are doing away with visual aids, he was of the opinion that such was a long way from being the case. "Radio must be considered as an indispensable but not an infallible aid to aerial navigation," he commented. To his mind the use of radio was changing the requirements of luminous aids but was not replacing them. Radio was not a universal aid to navigation at the present time and only a small percentage of aircraft was equipped with it. Such equipment was heavy and in the cases of the smaller aircraft particularly, economies in weight had to be considered. It was not comprehensive in its application, though it was quite useful in guiding aircraft in small runways, in giving an idea of altitude, and in other ways. Engineers had yet to develop suitable radio aids to prevent collision between aircraft in the air, he stated.

Institute Affairs

The Ottawa Branch was host to a considerable number of out-of-town members and others at their noon luncheon on Wednesday, September 16th, 1936, at the Chateau Laurier, at which Dr. E. A. Cleveland, M.E.I.C., of Vancouver, B.C., President of The Institute, was the speaker. These included delegates to the recent world power conference held at Washington who were on tour after the conference visiting major power projects in eastern Canada. A considerable number of Montreal members were also present.

Dr. Cleveland spoke upon "Institute Affairs." In his address he outlined the history of The Institute since its formation as the Canadian Society of Civil Engineers nearly fifty years ago and spoke about present trends in the profession. A considerable portion of the address was taken up with efforts that had been made recently toward consolidating The Institute with the various provincial professional engineering associations so as to bring about a Dominion-wide organization the members of which would have legal standing under the various provincial acts.

The work of the Committee on Consolidation was also referred to and the probable future course of action as a result of this work was indicated.

In the absence of E. Viens, M.E.I.C., chairman of the Ottawa Branch, Dr. R. W. Boyle, M.E.I.C., presided, and in addition head table guests included: G. J. Desbarats, C.M.G., honorary member of The Institute; Dr. Charles Camsell, M.E.I.C., of Ottawa, and Dr. O. O. Lefebvre, M.E.I.C., of Montreal, past presidents of The Institute; Alan Hay, A.M.E.I.C., Group Captain E. W. Stedman, M.E.I.C., and C. M. Pitts, A.M.E.I.C., of Ottawa, and Dean Frigon, M.E.I.C., of Montreal, members of the Council; B. J. Roberts and Col. A. E. Dubuc, M.E.I.C., recently appointed members of the National Harbours Board; A. C. T. Sheppard, first vice-president of the Canadian Institute of Surveying; J. C. Beauchamp, first vice-president of the Professional Institute of Civil Servants; J. A. MacIssac, president of the Civil Service Association of Canada; J. M. Wardle, M.E.I.C., deputy minister of the Department of the Interior; and N. B. MacRostie, A.M.E.I.C., member of the executive of the local Branch of The Institute.

Winnipeg Branch

J. F. Cunningham, A.M.E.I.C., Secretary-Treasurer.
H. L. Briggs, A.M.E.I.C., Branch News Editor.

Farewell Dinner to Prof. J. N. Finlayson, M.Sc., M.E.I.C.

On August 23rd, 1936, the Winnipeg branch, in conjunction with the Association of Professional Engineers of the Province of Manitoba and the Engineers Alumni Association of the University of Manitoba, held a farewell dinner at the Fort Garry hotel in honour of J. N. Finlayson, Professor of Civil Engineering of the University of Manitoba, on the occasion of his departure to become Dean of the Faculty of Applied Science, University of British Columbia.

The high esteem in which Professor Finlayson is held by all who know him was voiced by H. A. Bergman, K.C., vice-chairman of the Board of Governors, University of Manitoba, in speaking on "The Parting Guest"; E. P. Fetherstonhaugh, M.C., M.E.I.C., in speaking on "J.N.F. as an Associate"; George Collins in speaking on "Our professor—B.C.'s Dean"; and George E. Cole, M.E.I.C., in speaking on "J.N.F.—A Man of Parts." On behalf of the Alumni Association, Professor Finlayson was presented with a case of pipes, and on behalf of the Winnipeg Branch of The Engineering Institute of Canada and the Association of Professional Engineers of the Province of Manitoba, with a library chair with plate suitably engraved. In acknowledging the honour accorded him, Professor Finlayson drew attention to the unusually fine spirit which exists between professional engineers in the province, and the University of Manitoba.

A. L. Cavanagh, A.M.E.I.C., president of the Association of Professional Engineers of the Province of Manitoba, was chairman of the evening.

List of New and Revised British Standard Specifications

(Issued during July, 1936)

B.S.S. No.

81—1936. *Instrument Transformers.* (Revision.)
Brings specification into line with modern practice, includes additional classes of current transformer two of which are particularly suited to laboratory and high class test-room work.

171—1936. *Electrical Performance of Transformers for Power and Lighting.* (Revision.)
Various changes and improvements have been made to keep pace with progress in transformer design, the most important of which relate to reference ambient temperature, temperature-rise, overloads, terminal markings and vector diagrams, high-voltage tests and standard fitments.

686—1936—*Methods for the Analysis of Coal Ash and Coke Ash.*
Standard methods for the full routine analysis of coal ash and coke ash in addition to a method of reporting the analysis.

687—1936. *Methods for the Ultimate Analysis of Coal and Coke.*
Standard methods for determination of carbon and hydrogen, nitrogen, sulphur, phosphorus, arsenic and chlorine, while methods are included in appendices for the determination of carbon dioxide and of "sulphate" and "pyritic" sulphur in coal.

689—1936. *Railway Mechanical Signalling Apparatus. (Signal Posts, Semaphore Signals, Fittings and Connections, and Point Connections and Fittings.)*
Deals with the quality of material for railway mechanical signalling apparatus and point connections and fittings. Detailed drawings of the various fittings do not appear in the specification, but will be issued separately as and when they are completed.

690—1936. *Asbestos-Cement Slates and Unreinforced Flat Sheets and Corrugated Sheets.*
Provides for the dimensions (size, thickness and tolerance) of asbestos cement slates, flat sheets and corrugated sheets together with a transverse test to ensure sound workmanship. Method of making the transverse test, and general recommendations with regard to the use of corrugated sheets on roofs.

692—1936. *Meteorological Thermometers (Maximum, Minimum and Ordinary) Sheathed Type.*
Covers thermometers suitable for mounting in a Stevenson screen of the pattern employed by the Meteorological Office, Air Ministry.

693—1936. *Oxy-Acetylene Welding as Applied to Steel Structure.*
Quality of the parent metal and of the weld metal, the method of making joints and the stresses to be permitted. Tests on both welded joints and parent metal, together with other information relating to methods of welding and notes on design, are given in appendices.

697—1936. *Rubber Gloves for Electrical Purposes.*
Specifies physical, mechanical and electrical tests for rubber gloves intended for electrical purposes in circumstances involving the possibility of direct contact with equipment of which the voltage does not exceed 3,300 volts to earth.

698—1936. (issued:— 7-9-36) *Papers (Unvarnished) for Electrical Purposes, excluding Asbestos Papers and those used in the Manufacture of Cables.*
Describes methods of test acceptable both to maker and user, and gives limits for various properties, leaving it to the purchaser to select the paper he requires for a particular purpose.

704—1936. *Y-Alloy Casting (Heat-Treated) for General Engineering Purposes.*
The above three specifications correspond generally to the British Standard Aircraft Specifications L.33 2, L.24 and L.35 respectively, differing principally in that the aluminium used in the alloy may be of 98 per cent purity. Provision is also made for a porosity test to be carried out.

Copies of the new specifications may be obtained from the Publications Department, British Standards Institution, 28 Victoria Street, London, S.W.1, and from the Canadian Engineering Standards Association, 79 Sussex Street, Ottawa.

Telephones in Czechoslovakia

Considerable progress has been made during the past two years in extending the network of telephones in Czechoslovakia, the total length of lines being now 1,100,000 km., compared with 800,000 km. in 1933. There are now 6,722 stations in existence, an increase of 20 per cent over the 1933 figure, while the number of subscribers is 143,000. At the present rate of increase it is anticipated that by the end of the current year the number will be 150,000, this being equivalent to one telephone per 100 head of population.—*Engineering.*

Bakelized-Cloth Replace Metal Bearings for Rolling Mills

The provision and maintenance of bearings in rolling mills offers particular difficulty. The bearing pressures are usually high and the conditions generally unfavourable, and maintenance and replacements are apt to be difficult and expensive, both on account of the cost of spares and the time lost. White metal bearings have been found quite inadequate for the heaviest services, and, although bronze bearings are generally used, the wear is rapid, the neck of the shaft also soon becoming rough and grooved. Much thought and effort have been given to the problem of eliminating these defects, and it has been found that a bearing material consisting of fibrous material, such as paper or cloth, bonded with bakelite, is superior for this service to any metal. No oil is used, but the bearing is fed continuously with a stream of water. The water serves a two-fold purpose, acting as a lubricant and a more important function, keeping the bearing cool. The latter is of special importance, due to the fact that the heat-conductivity of the bakelized material is very much less than that of metal.

A leading part in this development has been taken by Messrs. The Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester, whose attention was called to the problem in connection with rolling-mill electrification. A thorough investigation was made by the firm into the behaviour of different varieties and forms of bakelized material for this service.

Each bearing consists of a sleeve section and a thrust washer, clamped by retaining plates into a chock of similar form to that used with metal bearings. The bearing sections are manufactured from special strong fabric, treated with synthetic varnish and moulded by a time, heat and pressure process. It may be mentioned that materials having a paper base instead of fabric were tried, but it was found that these were weaker, less resistant, and had some tendency to split. The cloth is ordinarily used in layers laid concentrically in the mould, but successful results have also been obtained by a method of using clipped pieces of fabric compressed in special moulds. With either method of fabric assembly, the bearings are usually moulded to correct shape and not subsequently machined, but in this respect also some exceptions have been made, and with suitable preparation, machined bearing surfaces have proved quite satisfactory. The approximate characteristics of the material are: Density, 0.045 pound to 0.05 pound per cubic inch; coefficient of expansion, 0.0004 per inch per degree F.; Brinell hardness number, 25 to 40; compressive strength, 30,000 pounds to 50,000 pounds per square inch; water absorption, 1 per cent to 3 per cent; and maximum allowable temperature, 300 degrees F. The density value has little significance in comparison with metal bearings. The coefficient of expansion is about double that of metal, but this characteristic is mainly of importance in connection with casting the metal into the shell, a process not involved with bakelite. The Brinell hardness number lies between the values for white metal and bronze. At very high bearing pressures, the life of the bakelized bearings is many times that of bronze.

The slight absorption of water appears to be advantageous in reducing friction. Apart from the uses already mentioned, the water employed serves to wash away any particles of dust or abrasive matter. All bakelized bearings require grease to lubricate them when starting up, and for running speeds up to about 200 feet per minute. The general method is to apply grease to the neck as the mill is coming to rest, this treatment also preventing the formation of rust on the roll neck when standing. Suitable grease remains on the surface for a long time and is scarcely affected by the water. For higher rubbing speeds, water lubrication alone is adequate for loads up to about 1,500 pounds per square inch, but for heavier loads, grease must be used at all speeds, and for loads above 4,000 pounds per square inch, a special cooling medium may also have to be used.

One or two examples of the results obtained with the bearings for mills supplied by the company may be of interest in conclusion. On a 3-high, 18-inch mill, bakelized bearings have reduced the power required by 30 per cent and have up to date rolled 50,000 tons of material, against 8,000 tons for the best metal bearings; that is, they have had already more than six times the life of metal, and the wear of the fabric material is only 1/16 inch, so that the bearings should roll many more thousand tons. On a 12-inch strip mill, where the whole series of stands has been fitted with bakelized bearings, the saving of power is 50 per cent and the life of the bearings, compared with that of brass, has increased from five to forty shifts. On a 10-inch wire mill the installation of bakelized bearings has increased the bearing life to over eight times that of bronze.—*Engineering.*

Twelfth National Exposition of Power and Mechanical Engineering

The Twelfth National Exposition of Power and Mechanical Engineering will be held at the Grand Central Palace, New York, on November 30th to December 5th, 1936. Displays designed to give the visitor the maximum information in the shortest possible time will present new developments in the field of power generation and mechanical-engineering equipment. The Exposition is, as heretofore, under the management of the International Exposition Company, Grand Central Palace, New York.

Preliminary Notice

of Applications for Admission and for Transfer

September 26th, 1936

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

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

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

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

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

The Council will consider the applications herein described in November, 1936.

R. J. DURLEY, Secretary.

*The professional requirements are as follows:—

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

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

Every candidate who has not graduated from a school of engineering recognized by the Council shall be required to pass an examination before a board of examiners appointed by the Council. The candidate shall he examined on the theory and practice of engineering, with special reference to the branch ofengineering 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 year.

A Junior shall he at least twenty-one years of age, and shall have heen 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 equiva ent standard.

A Student beshallat 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 hy the Council.

He shall either be pursuing a course of instruction in a school of engineering recognized hy 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 hut whose pursuits, scientific attainments or practical experience qualify him to co-operate with engineers in the advancement of professional knowledge.

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

FOR ADMISSION

DERY—JACQUES LOUIS, of 509 Stuart Ave., Outremont, Que., Born at Montreal, June 7th, 1911; Educ., Grad., R.M.C., 1934; 1928-29, survey helper, rodman; Dept. Public Works, Quebec; 1934 to date, junior engr., Dept. Public Works Canada, dftsman., engr. in charge of survey, etc.

References: J. A. L. Dansereau, J. H. Landry, J. F. Plow, L. V. Denis, L. F. Grant, G. G. M. Carr-Harris.

NARIMAN—RUSTUM KAIKHUSHRO, of Secunderahad, India, Born at Surat, India, May 25th, 1877; Educ., 1894-99, College of Science, Poona, and The Royal Indian Engineering College, Cooper's Hill, England. A.C.H. (Hons.), 1899; Member, Inst. C.E. (Great Britain), 1916. Memher, Am. Soc. C.E., 1933. Founder Member, Inst. of Engrs. (India). F.R.G.S.; 1900-04, in charge of remodelling and constructing channels; 1905-07, maintenance, Chenah, Indus, Multan Canals, and river training works; 1908, tour of inspection, Egypt, Italy, Great Britain, Holland, studying hydraulic and irrigation problems; 1909, River Indus training works; 1910-13, Sutlej River training works; 1914, studying hydraulic and irrigation problems in Ceylon, Burma, Baluchistan; 1914-19, remodelling Sirsa Canal and designing Otu Lake enlargement and allied works; 1921-22, in charge of Chenab Canal works; 1923-25, visiting works in Austria, Great Britain, Persia, Russia, etc.; 1929, delegate to World Engineering Congress, Tokyo; 1931-34, professor of construction engineering, Osmania University; 1932, special visit to Netherlands, and Dutch East Indies; 1933, delegate to First World Congress on Large Dams, Scandinavia; 1935, delegate to the Inst. of Engrs. (Australia), Melbourne Centenary Celebrations; at present, consltg. engr., Sapper Lines, Secunderabad, India.

References: J. A. L. Waddell, R. Modjeski, Sir Alex. Gibb, F. T. Kaelin, F. A. Gaby, J. M. R. Fairbairn.

PICARD—STANISLAS A., of Quebec, Que., Born at Quebec, Nov. 25th, 1902; Educ., B.A.Sc., Chem. Engr., Ecole Polytechnique, Montreal, 1927; 1927-34, with the Leamington Tobacco Sales Corpn. Ltd., Leamington, Ont., from 1932 as vice-president and officer-in-charge; 1934 to date, chemist engr., with Rock City Tobacco Co. Ltd., Quebec, Que.

References: H. Cimon, A. B. Normandin, J. Joyal, J. U. Archamhault, L. Gagnon, J. L. Bizier, T. M. Dechene.

FOR TRANSFER FROM THE CLASS OF JUNIOR

DAVIS—GEORGE ROLAND, of Belleville, Ont., Born at Smiths Falls, Ont., June 12th, 1903; Educ., B.Sc., Queen's Univ., 1927; With the Hydro-Electric Power Commn. of Ontario as follows: 1927-30, meter and relay engr. on Eastern Ontario system; 1930-33, meter and relay engr. for Rideau, St. Lawrence, Ottawa and Madawaska districts of E.O.S.; 1934 to date, operating dept., engr. in charge of metering and relaying on Eastern Ontario system. (*St. 1927, Jr. 1930.*)

References: G. B. Smith, R. L. Dobbin, J. J. Traill, J. A. Acherli, J. W. Falkner.

GATHERCOLE—JOHN W., of Kenogami, Que., Born at Hamilton, Ont., Mar. 10th, 1903; Educ., B.Sc., Queen's Univ., 1927; Summer work—1924-25-26, Bell Telephone Co., H. J. Heinz Co., Canadian Crocker Wheeler; 1927, meter course; 1928, sales and service engr., Bailey Meter Co.; 1928-29, meter mtce. and boiler plant engr., Brompton Pulp and Paper Co.; 1929-35, meter mtce. and steam plant engr., Canada and Dominion Sugar Co.; 1935 to date, steam plant engr., Price Bros. & Co. Ltd., Kenogami, Que. (*St. 1927, Jr. 1931.*)

References: E. P. Wilson, K. G. Cameron, J. Shanly, C. R. Bown.

GILMOUR—WILLIAM ALEXANDER TURNER, of Hamilton, Ont., Born at Hamilton, April 11th, 1903; Educ., B.Sc. (Mech.), 1925, B.Sc. (Elec.), 1926, McGill Univ.; 1924 (summer), inspr., County of Wentworth roadwork; 1925 (summer), rodman, Fort Francis to Kenora road; 1926 to date, general engrg., covering design, listing and sales of pumping machinery of all kinds, and at present chief engr., The Smart-Turner Mach. Co. Ltd., Hamilton, Ont. (*St. 1924, Jr. 1930.*)

References: W. L. McFaul, W. D. Black, J. B. Carswell, F. I. Ker, E. M. Proctor.

FOR TRANSFER FROM THE CLASS OF STUDENT

BENNY—WALTER ROBERT, of Smiths Falls, Ont., Born at White River, Ont., Jan. 3rd, 1909; Educ., B.Eng., McGill Univ., 1932; Summers 1927, rodman, rly. location, C.P.R., 1928, student asst., control traverses, Geol. Survey of Canada; 1928-29 (6 mos.), office asst., plotting, Topog'l. Survey of Canada; 1929 (summer), transitman, rly. mtce., C.P.R.; 1929-30, instr'man., power transmission line location and constrn., Shawinigan Engineering Co.; 1930-1931 (summers), instr'man., T. & N.O. Rly.; 1934-35, dftsman., aerodrome constrn., Dept. National Defence; at present, transitman, rly. mtce., C.P.R., Smiths Falls, Ont. (*St. 1928.*)

References: E. Brown, J. H. Forbes, S. B. Clement, N. B. MacRostie.

DICKSON—WILLIAM LESLIE, of Newcastle Creek, N.B., Born at Stellarton, N.S., June 7th, 1908; Educ., B.Sc. (E.E.) N.S. Tech. Coll., 1929; 1927-28 (summers), Nova Scotia Advisory Board on Fuels; 1929-30, Can. Gen. Elec. test course; 1930-31, induction motor design office, Can. Gen. Elec. Co.; With the N.B. Electric Power Commission, 1931 on constrn., and 1932 to date, operating tests on coal, feedwater analysis, and efficiency tests for a steam electric plant. (*St. 1930.*)

References: F. R. Faulkner, G. A. Vandervoort, E. J. Owens, T. H. Dickson, V. S. Foster.

DUFF—DUNCAN CLEMENS VERR, of Barranca-Bermegha, Colombia, S.A., Born at Stellarton, N.S., Aug. 30th, 1909; Educ., B.Sc. (C.E.), N.S. Tech. Coll., 1933; 1925-28, electric hoist operation, Acadia Mines; 1928 (5 mos.), refrigeration equipment, Pictou Co. Dairy; 1929 (6 mos.), railroad car constrn., Eastern Car, Trenton; 1930 (3 mos.), rly. location surveying, Guysboro, N.S.; 1933 (6 mos.), equipment installn., Dept. of Mines, Halifax; 1933-34, process, asphalt research, engrg. office, Imperial Oil Limited, Dartmouth, N.S.; 1934-1935, technical service divn., road constrn., Imperial Oil Ltd.; 1935 to date, with the Tropical Oil Company, Barranca-Bermegha, asst. to chief engr. on new unit constrn. (6 mos.), and at present, supervisory operator on processing and refining equipment. (*St. 1933.*)

References: R. L. Dunsmore, F. R. Faulkner, S. Ball, H. Fellows, F. C. Tempest.

ESMOND—DOUGLAS C., of 3592 University St., Montreal, Que., Born at Winnipeg, Man., Jan. 26th, 1909; Educ., B.Eng. (E.E.), McGill Univ., 1933; 1930 (summer), dftsman., Canadian Steel Corporation; 1929(summer), asst. operating engr., Walkerside Dairy Ltd., Windsor, Ont.; 1935-36, junior engr., design and testing of radio power and audio transformers under supervision, Canadian Marconi Co., Montreal, Que. (*St. 1934.*)

References: E. Brown, C. V. Christie, R. DeL. French, R. W. Dobridge.

LAPLANTE—ARTHUR, of 39 Moncton Ave., Quebec, Que., Born at St. Hyacinthe, Que., July 21st, 1908; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1933; 1930, asst. engr., for Armand Bourbeau, C.E., Contractor-Engineer; 1931-32, superviser engr., Highway Dept., Prov. of Quebec; 1933-34, asst. teacher,

Ecole Polytechnique, Montreal; 1933-35, engr. for E. R. Truchon, contractor; 1935 to date, engr., Highway Dept., Prov. of Quebec. (*St. 1933.*)
References: A. B. Normandin, A. Frigon, A. Mailhiot, H. Cimon, A. Paradis, A. Gratton, J. A. Lalonde, J. O. Martineau.

McMORDIE—ROBERT CAMPBELL, of Niagara Falls, Ont., Born at Toronto, Ont., Jan. 24th, 1908; Educ., B.A.Sc., Univ. of Toronto, 1930; Summers—1927, rodman, C.N.R.; 1928, Toronto water from viaduct constrn.; struct'l. dftsman., H.E.P.C. of Ontario; 1930-33, designing dftsman , 1934 (May-July), and 1935 (July-Sept.), struct'l. designing engr., H.E.P.C. of Ontario; 1934 (Nov.-Dec.), dftsman., Truscon Steel Co.; 1935 (Oct.-Dec.), demonstrator in surveying and geodesy, Univ. of Toronto; 1936 (Feb.-Apr.), struct'l. dftsman., Canadian Bridge Co.; 1936 (May-June), struct'l. designer, G. L. Wallace, A.M.E.I.C., Consltg. Engr.; July 1936 to date, asst. engr., H. G. Acres & Co., Consltg. Engrs., Niagara Falls, Ont., design and preparation of drawings for power house superstructure, substructure, switching stations, hydraulic work, for Ontardes development, Quebec. (*St. 1930.*)
References: E. B. Dustan, E. E. H. Hugli, F. H. Mason, A. W. F. McQueen, W. L. Sagar, G. L. Wallace.

NESBITT—MICHAEL CULLUM, of 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.; 1927-28, B.C. Topog'l. Survey; 1929-30-31, Provisional Pilot Officer's course, R.C.A.F.; 1931-34, miner, logger, bridgeman, etc.; 1935 to date, foreman in chargesluicing plant, Columbia Development Co., Victoria, B.C. (*St. 1928.*)
References: J. C. MacDonald, I. C. Barltrop, E. A. Wheatley, P. H. Buchan, J. Robertson.

NICHOLS—JUDSON TIMMIS, of Flin Flon, Man., Born at Montreal, Que., Feb. 8th, 1909; Educ., B.Eng. (Mech.), McGill Univ., 1934; 1934 to date, mech'l. mtce. and design, The Hudson Bay Mining and Smelting Co., Flin Flon, Man. (*St. 1931.*)
References: N. M. Hall, A. Laurie, C. M. McKergow, H. W. McKiel, A. I. Cunningham, J. Stadler.

PHELAN—MICHAEL ALEXANDER AUSTIN, of Noranda, Que., Born at Antigonish, N.S., Aug. 27th, 1905; Educ., B.Sc., Queen's Univ., 1929; 1925-28, summer work, asst. on Geol. Survey, instr'man., Dept. National Defence, mechanic, John Ingalls Co. Ltd., instr'man., Fraser Brace Engrg. Co.; 1929-31, asst. in office of mgr. of manufacturing, Dominion Engineering Works Ltd.; 1932-34, pump and engine erecting, dfting., Canadian Fairbanks Morse Ltd.; 1934 to date, representative of Canadian Fairbanks Morse Ltd. in mining areas of Quebec; May 1936 to date, in charge of Noranda office, Peacock Bros. Ltd. (*St. 1928.*)
References: J. G. Notman, H. S. Van Patter, H. G. Welsford, H. A. Crombie, D. S. Ellis.

SILLITOE—SYDNEY, of Montreal, Que., Born at Edmonton, Alta., Dec. 15th, 1908; Educ., B.Sc. (E.E.), 1931, M.Sc., 1933, Univ. of Alta.; Summer work—1928, timekpr. on rly. constrn.; 1929, instr'man., Hudson's Bay Oil and Gas Co.; 1930, instr'man. and asst. geologist with above co.; 1931, engr. in charge of underground constrn., City of Edmonton Electric Light and Power Dept.; 1933-34, demonstrator in physics, McGill Univ.; 1934 to date, radio laboratory and design engr., Northern Electric Co. Ltd., Montreal. (*St. 1930.*)
References: H. J. MacLeod, R. S. L. Wilson, J. S. Cameron, A. B. Hunt, H. J. Vennes.

STRATTON—LESLIE ROBERTSON, of Saint John, N.B., Born at Saint John, Sept. 26th, 1908; Educ., B.Sc. (C.E.), Univ. of N.B., 1930; 1927-28 (summers), office work and instr'man., International Pulp and Paper Co.; 1929 (summer), instr'man., N.B. Highway Dept.; 1930-32, designing and field work for Monsarrat and Pratley, Consltg. Engrs., Montreal. 1934 (Sept.-Nov.), and 1935 (May to July), field work, Ile d'Orleans Bridge for same company; July 1935 to date, reinforced concrete designer, Saint John Harbour Commission, Saint John, N.B. (*St. 1930.*)
References: P. L. Pratley, C. N. Monsarrat, J. W. Roland, V. S. Chesnut, A. Gray, G. N. Hatfield, G. Stead.

TREBLE—HAROLD EDISON, of Ottawa, Ont., Born at Crysta City, Man., Feb. 5th, 1905; Educ., B.Sc., C.E., 1926, B.E.E., 1927, Univ. of Man.; 1925 (summer), rodman, Geodetic Survey; With the Canadian Westinghouse Co. as follows: 1927-29, graduate student ap'tice; Summer 1929, switchboard eng. design office staff, Hamilton; 1929-32, sales engr., heavy equipment, Winnipeg branch office; 1935-36, salesman and assistant mgr. in preparation of estimates, Automatic Heating Co., Iron Fireman dealers, Winnipeg; at present, plotting maps, Topog'l. and Air Survey Bureau, Dept. of the Interior, Ottawa, Ont. (*St. 1924.*)
References: J. N. Finlayson, E. P. Fetherstonhaugh, E. V. Caton, N. M. Hall, E. M. Dennis, F. H. Peters.

WILLOWS—FRED, of Red Lake, Ont., Born at Toronto, Ont., Dec. 20th, 1908; Educ., B.Sc. (C.E.), Univ. of Man., 1929; 1927 (5 mos.), field dftsman. and material clerk, C.P.R.; 1928 (5 mos.), City of Winnipeg Asphalt plant, i/c laboratory, testing raw and mixed materials; 1929 (4 mos.), engr. on constrn. of storage annex to Maple Leaf Milling Co.'s elevator at Medicine Hat, Alta.; 1929-30 (8 mos.), instructor, civil engrg. dept., Univ. of Manitoba; 1930 (4 mos.), constrn. of copper refinery for Ontario Refining Co. at Copper Cliff, Ont., for Fraser Brace Engrg. Co.; 1930 (3½ mos.), with C. D. Howe & Co., designer and night inspr., constrn. of storage annex to Moose Jaw elevator of Can. Govt.; 1931-32 (6 mos.), instr'man. and field dftsman., Dept. of Northern Development of Ontario; 1934 (4 mos.), Canadian Mining Projects of Winnipeg, geol. and topog'l. survey of property, and asst. on land surveying; 1935 (4 mos.), Geol. Survey of Canada, Herb Lake area, chief asst. i/c topog'l. work; 1936 (3 mos.), Blue Star Gold Mines, Kenora, Ont., preparing geol. and topog'l. map of property; at present, mines engr., Rahill Red Lake Mining Co. Ltd., Red Lake, Ont. (*St. 1929.*)
References: J. N. Finlayson, G. H. Herriot, S. E. McColl, C. D. Howe, W. F. Riddell.

YORK—FREDERICK GILBERT, of 560 Driveway, Ottawa, Ont., Born at Ottawa, Ont., May 28th, 1909; Educ., B.Eng., McGill Univ., 1935; 1926-34 (summers), lineman, May 1931 to Sept. 1932, station operator, and 1935 to date, asst. to line supt., Ottawa Hydro Electric Commission. (*St. 1935.*)
References: J. E. Brown, S. W. Canniff, F. Newell, C. V. Christie, J. E. Armstrong.

Time the Essence of the Contract

The statement that "Time is the essence of the contract" is of wide applicability. In engineering and building contracts it is extremely important in many cases; for example, when it becomes necessary to determine whether a penalty clause should be enforced and, if so, whether as a penalty in the sum (or at the rate) specified in the contract, or whether merely as a maximum possible sum to be awarded by way of damages to cover loss actually sustained by the employer, as and when proved. But there is another aspect of this legal maxim which is of great importance in engineering and building contracts, more especially as from this angle this class of contracts differs from many other types, for example, ordinary contracts for the sale of goods.

The broad principles of contract law apply to all manner of contracts, but special principles fall to be applied in particular types of contracts. For instance, each profession, craft and trade has its own customs, many of which have become incorporated into the general body of English law, and are enforced by the Courts just as if they were rules of general law. Furthermore, within a particular profession or industry, contracts are distinguishable by their nature and purposes, and the distinctions observable in fact find their reflection in law. Thus, an engineering contract may relate to the supply of machinery, or to installation of machinery, or to both, or it may be entered into to secure constructional work. The latter type, again, may be indistinguishable in legal implication from an ordinary building contract, or it may form part of such a contract; the functions of the engineer may be those of a contractor, or of a sub-contractor, or those of a technical supervisor, analogous to the functions of an architect. Each of those functions, constituted by a contract with an employer or a purchaser, will fall to be governed by distinct and special rules of contract law, and such rules will, by their application to the particular facts, and circumstances of particular contracts, involve differing interpretations of the maxim "time is the essence of the contract."

The primary meaning of this maxim, which is frequently quoted somewhat glibly and without any true conception of its real meaning and full implications, is that the completion of a contract by a specified date may be all important as to date; that is to say, that a contract may be completed with all due regard to specifications, plans and drawings and yet, by reason of delayed completion, prove valueless to the employer or purchaser. It is obvious that "delay" is a comparative term, for a contractor may be only slightly behind his scheduled time, or he may be considerably in arrear, and the consequent detriment to the interests of the other contracting party will vary accordingly. The law, in order to do justice between the parties to the contract, must hold the scales fairly, and in those scales it must assess and weigh, with such scientific accuracy as a court may upon evidence, the amount of detriment actually incurred in the circumstances. Further, although an unsatisfied employer may allege that delay on the part of the contractor has rendered the work valueless to him, and on that ground may seek to avoid payment, the court may find that in spite of the fact that the employer has received less value than he was entitled to have under his contract, the result is not valueless, and some payment is due from him. There are cases where delay may be compensated by payment of damages or an allowance off the contract price, and others where no such compensation can make good the contractor's default. The solution of the problem in each case must depend upon all its facts and circumstances, and it is determined by application of legal principles and not by any mathematical formula. The degree or extent of delay is a factor to be considered, certainly, but it is only one of many factors; delay of one day, or even of one hour, may in some cases prove fatal to the contractor's right to recover any portion at all of the sum provided for under the contract, whereas in other cases delay of weeks, or even of months, may justify diminution, but not extinction, of the contract price.—*Engineering.*

EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada

2050 Mansfield Street, Montreal

Situations Wanted

ELECTRICAL ENGINEER AND SUPT. Age 31, A.M.E.I.C., with combined electrical, mechanical and steel industry experience. Experience includes design and testing of all types of industrial electrical equipment, supervision of production and cost reduction, heat treating of steel, time study application in several plants. At present supt. of modern factory. Apply to Box No. 132-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

ENGINEER, A.M.E.I.C. Age 30. Single. Employed Civil and mining experience, capable of designing and superintending construction of timber, concrete and steel structures, rock crushing and ore plants. Would consider position with mining or engineering company designing and building mills. Apply to Box No. 431-W.

MECHANICAL ENGINEER, B.Sc. Age 31. Married. Last ten years includes:—Mechanical structural and reinforced concrete design in pulp and paper mills, industrial plants, hydro-electric, mine, sewers and sewage disposal plant construction. My experience also includes shop production, steam plant combustion, fuel analysing, inspecting, supervising and instrument work on industrial construction. Permanent position preferred. Apply to Box No. 521-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aero-photographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

ELECTRICAL ENGINEER, B.Sc., 1926. One year maintenance, one year operating, large hydro-electric plant. Five years hydro-electric construction, as wireman and foreman, on relay, metal, and remote control installations. Also conduit and switches. Three years maintenance electrician, in pulp and paper mill. Also small power system. Desires position of responsibility. Sober, reliable and not afraid of work. Available at once. Excellent references. Apply to Box No. 636-W.

ELECTRICAL ENGINEER, B.Sc. '28; M. Eng. '35. Two years student apprenticeship at Can. Westinghouse Co., including test and electrical machine design. Also about two years experience in operating dept. of large electrical power organization. Available on short notice. Apply to Box No. 660-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.Sc. Elec. '29, B.Sc. Civil '33. Jr.E.I.C. Age 29. Experience includes four months with Can. Gen. Elec. Co., approximately three years in engineering office of large electrical manufacturing company in Montreal, the last six months of which was spent as commercial engineer. For the last year and a half employed in electrical repair shop. Best of references. Apply to Box No. 693-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.Sc. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

Situations Wanted

CIVIL ENGINEER, M.Sc., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering. Read, write and talk French. Married. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

RADIO AND ELECTRICAL ENGINEER, B.Sc., '31, Jr.E.I.C. Single. Age 29. One year and a half actual field experience in power and lighting equipment. Extensive work in telephone and radio layouts in switchboard and installation depts. Particularly interested and experienced in sales and traffic work in telephone and radio company. At present supervisor over sales and service of radio and electrical company. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, B.Sc. '29, A.M.E.I.C. Married. One year building construction. One year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

Employment Service Bureau

This bureau is maintained by The Engineering Institute of Canada for the benefit of members and organizations employing technically trained men.

An enquiry addressed to 2050 Mansfield Street, Montreal, will bring full information concerning the services offered. Details can also be obtained from Branch secretaries who are located in the larger centres throughout Canada.

Brief announcements of men available and positions vacant will be published without charge in The Engineering Journal and the Bulletin. Replies addressed in care of the required box number will be forwarded to the advertiser without delay.

An additional service also offered those who are unemployed or wish to change their positions, is the opportunity of placing their names and records on file at 2050 Mansfield Street for consideration by employers wishing to employ engineers. This is of great assistance as many employers will not advertise or wish to locate a suitable man on short notice. If desired the information contained in these records can be kept confidential.

Forms for registration purposes may be obtained from The Institute Headquarters or Branch secretaries.

MANUFACTURERS' REPRESENTATIVE, at present doing business with leading industrial organizations in Canada, wishes to represent manufacturers of mechanical equipment. Such work as would involve technical data, and the preparation of plans where necessary, would be handled by an engineer whose experience with outstanding firms and projects, would be valuable to those seeking representation. Apply to Box No. 764-W.

PLANT ENGINEER or SUPERINTENDENT, capable of supervising all phases of industrial plant operation, graduate electrical, eleven years diversified industrial experience including test course, four years on large Quebec industrial development, on construction and operation, also six years with prominent consulting firm supervising electrical and mechanical engineering projects. Age 31, single. Apply to Box No. 795-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

Situations Wanted

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 32, married. Two years in pulp mills draughting and designing additions, maintenance and plant layout. Three and a half years in the Toronto Building Department, checking and designing for steel, reinforced concrete and ordinary structures. One and a half years as transitman and draughtsman on road location and maintenance work. Available at once. Location immaterial. Apply to Box No. 899-W.

CIVIL ENGINEER, B.Sc., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.Sc.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

MECHANICAL ENGINEER, B.Sc. (Queen's Univ. '28), age 36, married, desires position of trust and responsibility. Experience includes fitting and assembly of machine tools, production, draughting, and maintenance. Five years teaching draughting and mathematics. Available on reasonable notice. Location immaterial. Apply to Box No. 1210-W.

ENGINEER, with twenty years experience in industrial, pulp and paper mill, and general engineering and design. Age 41. Last five years chief engineer of paper mill making newsprint specialties and toilet tissues. Apply to Box No. 1246-W.

ELECTRICAL ENGINEER, B.Sc. '34 (Univ. of N.B.), S.E.I.C. Age 21, single. Desires any kind of electrical work. Will consider any location. Apply to Box No. 1262-W.

ENGINEER AND DRAUGHTSMAN, Jr.E.I.C., age 33, married. Diplomas from Mtl Tech. Inst. in R.C. and Structural Design. 11½ years experience in civil engineering, draughting and instrument work. This includes 7 years with M.L.H. & P. Cons. as field engineer on construction and maintenance of gas mains. Present location Montreal. Available at once. Apply to Box No. 1326-W.

CIVIL ENGINEER, M.E.I.C. Married. Age 38. Twenty years experience in organization, design and estimating, and cost accounting. Active service in France. Apply to Box No. 1367-W.

FIRE PROTECTION AND SAFETY ENGINEER, A.M.E.I.C., B.Sc. '24 (Mech. Engrg.). Age 33. Bilingual. Ten years experience with insurance underwriters inspection bureau covering phases of field work. Thoroughly familiar with insurance requirements. Position desired industrial or other concern maintaining self insurance or relative departments. Location Montreal or vicinity preferred. Apply to Box No. 1395-W.

ENGINEER SUPERINTENDENT, A.M.E.I.C., R.P.E., Que. and Alta. Age 47. Married. Twenty years experience as engineer and superintendent in charge of hydro-electric, industrial, railroad, and irrigation construction. Specialized in rock excavation and suction dredging. Intimate knowledge of costs, estimating and organizing. Available immediately. Apply to Box No. 1411-W.

1935 GRADUATE IN CIVIL ENGINEERING, B.Sc. (Queen's Univ.), S.E.I.C. Experience includes eleven months summer work as county engineer's assistant in charge of the surveying party, and two months as surveyor's assistant during construction of concrete formwork and installation of machinery. Keenly interested in graphical analysis, draughting, design, organization and report writing. Now available for any location. Apply to Box No. 1415-W.

CIVIL AND ELECTRICAL ENGINEER, Univ. of Man. '35 and '36. S.E.I.C. Experience in irrigation and mapping. Available at once. Location immaterial. Box No. 1418-W.

CIVIL ENGINEER, B.Sc. 1910, A.M.E.I.C. Married. Twenty-six years experience on heavy construction work, both field and office; rails, roads, power house, hotels, bridges, etc. Location immaterial. Available at once. Apply to Box No. 1470-W.

SALES ENGINEER, M.E.I.C. Age 50. Married. Several years in combustion and general machinery lines. Estimating and layout work (mechanical and electrical). Speaking French fluently. Executive ability. Apply to Box No. 1482-W.

New Publications of the C.E.S.A.

Canadian Electrical Code Part II

C22.2 No. 25—1936—*Enclosures (other than Explosion Proof) for Use in Hazardous Locations.*
Applies to enclosures of the dust-tight, water-tight, weatherproof (including drip-proof and splash-proof) construction for electrical equipment for potentials up to and including 2,500 volts between conductors. Covers enclosures for industrial control equipment, cabinets and cutout boxes for enclosing externally-operated switches, cartridge and plug-fuse cutout bases, etc., also outlet boxes and fittings. It is to be noted however that the specification does not include enclosures of the gas-tight, vapour-tight or explosion-proof type.

C22.2 No. 30—1936—*Enclosed Branch-circuit Cutouts.*
Covers enclosed branch-circuit cutouts used at distribution centres to accommodate plug fuses for the protection of branch-circuits for use on 125-volt and 125/250-volt circuits provided in the latter case, that no conductors of such circuits exceed 150 volts to ground.

C22.2 No. 32—1936—*Electrically-operated Refrigerating Machines.*
Covers electrically-operated refrigerating machines for domestic use, refrigeration, water-cooling, etc., of both compression and absorption types for use on circuits of 125/250-volts and less and to commercial refrigerating systems as used in cold-storage plants, air-conditioning systems, etc., for use on circuits of 600 volts and less.

C22.2 No. 33—1936—*Electric Cranes and Hoists.*
Covers electrically-operated cranes and hoists used in foundries, machine shops, power houses, etc., for potentials of 600 volts and less between conductors.

C22.2 No. 34—1936—*Electrode Receptacles for Luminous-tube Signs.*
Covers electrode receptacles which are adapted for enclosing the tube electrodes of luminous-tube signs for potentials of 15,000 volts and less, but not exceeding 7,500 volts to ground. Receptacles are used to afford electrical connection (except in the case of portable neon signs) between the supply circuit and the glass-tube electrodes of luminous-tube signs for both indoor and outdoor use.

C22.2 No. 36—1936—*Electrical Appliances for Hair-dressing and Hand-drying, etc.*
Covers electrical appliances for hair-dressing and for hand-drying, for potentials of 250 volts and less between ungrounded conductors and where the voltage to ground is not more than 150 volts.

C22.2 No. 38—1936—*Rubber-covered Wires and Cables.*
Covers rubber-insulated wires and cables used in accordance with Part I of the Canadian Electrical Code with the type designation R, RL, RD, RDL, RM and RML but does not cover wires and cables having conductors of any material other than soft-annealed copper. The second edition of this specification was issued in June and incorporated important revisions and additions to avoid repetition of standard regulations in the individual specifications. As this applies to all specifications published under Part II of the Canadian Electrical Code users of these specifications should have a copy of the second edition on their files for reference.

C22.2 No. 12—1936—*Electric Portable Lighting Devices (Portables)* (second edition).
A new edition with a few revisions.

C22.3 No. 3—1936—*Inductive Co-ordination—Definitions and Principles.*
Issued in mimeograph form and consisting of a report from the sub-panel on Inductive Co-ordination. It is proposed to publish a report on practices a little later. This report embodies the principles to be applied to supply and communication systems, for the purpose of controlling indictive influence and inductive susceptiveness and of keeping the resulting effects within such limits that the public in general and other users of these instrumentalities may receive safe, satisfactory and economical service.

C22.3 No. 4—1936—*Conductive Co-ordination—Principles and Practices for Protecting Underground Structures from the Effects of Stray Currents Originating in Direct Current Electric Railway Systems.*
Issued in mimeograph form, consists of a report from the sub-panel on Conductive Co-ordination covering principles and practices and are intended to be applied only where electrolysis damage might otherwise result. It is intended for the guidance of all parties owning, controlling or operating (*a*) direct current electric railways which use the tracks as return conductors, (*b*) metallic pipes, cable sheaths, or other underground metallic structures located in the vicinity of direct current electric railways.

Copies of these publications may be obtained on application to the Secretary, Room 3064, National Research Building, Ottawa, at 15 cents per copy.

Geological Field Work in Nova Scotia, New Brunswick, Northwestern Quebec and Ontario

Some twenty gold properties along the southeast coast of Nova Scotia are being examined this year by the Geological Survey, Department of Mines, Ottawa, in the continuation of a study of structural conditions governing the distribution of ore shoots. The programme includes also a topographical project in the Sydney coal area and two other geological projects.

Contact metamorphism associations with igneous intrusions are being examined, and the possible relation between the intrusives and the gold deposits is being investigated.

The other is a study of natural sections of carboniferous rocks to gather and record data on sedimentary deposition that may be of value in reconstructing the probable conditions favourable to coal deposition.

In New Brunswick mapping has been underway in the St. George, Plaster Rock, Petitcodiac-Salmon river and Loch Lomond areas. A party has been engaged in a geological study of the west-central portion of the province, near the headwaters of the Tobique river, to determine the geology of the pre-carboniferous rocks west of the granite area in central New Brunswick, and is a continuation of previous work in the Plaster Rock area.

Detailed geological mapping of the Petitcodiac-Salmon river area was undertaken to gain a thorough knowledge of the structures as a basis for later detailed surveys of the geology and mineral resources of the southeastern portion of the province. The area is regarded as having possibilities for the occurrence of oil and gas.

Mapping the Loch Lomond area is a continuation of work that was commenced in 1932, and mineral occurrences in the Nigadoo river area will be examined.

Geological investigations are under way in the Opemiska, Waswanipi, Malartic, Noranda and Amos areas, and in the Mistawak area to the north of the Normetal (Abana) property, with topographical projects in the Noranda and the Mistawak areas in northwestern Quebec this year. Investigations in the Opemiska area will furnish information for a detailed geological map. Operations at the Ventures controlled Opemiska property at the centre of interest in this increasingly active mining field. Prospecting and development work is also proceeding on deposits in the vicinities of David, Simon, Gwillim and Father lakes. Recent mineral discoveries in the Opawica-Chibougamau area will be visited.

The eastern and western portions of the Waswanipi area are being mapped on a four-mile-to-the-inch scale and is intended to meet the immediate needs of prospectors.

Detailed geological investigations are being made in Malartic and Fourniere townships and are intended to establish the relationship existing between the two principal gold camps in the area.

An area to the east of Amos is being mapped in detail in a continuation of the systematic geological mapping of this section of western Quebec as an aid to prospecting, as is also the Mistawak area lying between the Ontario boundary and the Waswanipi area. Bands of tuffs and sediments similar in character to those in Desmeloizes township to the south are being delimited, and prospects in the area are being examined.

A geological study of the Noranda mine is being completed as part of a study of various deposits in the area. This includes an investigation of the Horne creek fault east of Noranda in an attempt to determine its displacement. An examination is being made also of the Normetal property in a study of the relationship of the ore to the supposedly later diabase dykes.

A portion of the Noranda area, and the strip of country between Noranda and Malartic township are being mapped topographically as a control basis for later geological investigations.

In the Mistawak area, a 6,000-square mile territory lying mainly to the north of the Transcontinental Railway is being mapped for the benefit of prospectors and settlers.

In Ontario investigations are underway in six areas, two in the northern and four in the southern portion of the province.

In the Quetico area, to the west of Port Arthur, a 2,700-square mile territory extending from the International boundary northwards to the 49th parallel is being mapped. Many mining claims have been staked along the three belts of ancient greenstones and sediments occurring in the area, and the extensions of these favourable belts are being traced. In the Kapuskasing area, details of a large project that was commenced last year are being completed. The largest area being investigated covers the greater portion of the southwestern peninsula, where studies are continuing to determine the natural gas and oil potentialities. This includes investigations in Dereham township, Oxford county, where an important gas field has been developed in a hitherto unproductive area; the examination of a portion of Kent county to the north of Chatham, where a deep structural depression, probably similar to that in the Dover field is indicated; a resurvey of the Eden gas field in Norfolk county, and an examination of water wells and possible oil and gas structures in west Elgin.

In the Toronto-Hamilton area, an extensive survey of the ground water resources is being made. All available data are being obtained from wells and springs, and the information will be used to determine the conditions that exist in respect to the various sources of water supply; whether the supply is diminishing or remaining stationary; the dependence upon rainfall; the amount of water available; and the character of the water. Investigations will cover a 5,000-square mile area, including large portions of York, Peel, Halton, Wentworth, Lincoln, Welland and Haldimand counties.

In eastern Ontario an examination of the mining properties in Hastings, Lennox and Addington counties is being made. East of Ottawa, in Russell county, belts of Paleozoic rocks are to be mapped.

THE ENGINEERING JOURNAL

THE JOURNAL OF THE ENGINEERING INSTITUTE OF CANADA

Published monthly at 2050 Mansfield Street, Montreal, by The Engineering Institute of Canada, Incorporated in 1887 as The Canadian Society of Civil Engineers.

ENTERED AT THE POST OFFICE, MONTREAL, AS SECOND CLASS MATTER.

"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."

November, 1936 **Volume XIX, No. 11**

CONTENTS

Price 50 cents a copy, $3.00 a year, in Canada, British Possessions, United States and Mexico. $4.50 a year in Foreign Countries.
To Members and Affiliates, 25 cents a copy, $2.00 a year.

Published Monthly at 2050 Mansfield St., Montreal

THE ENGINEERING INSTITUTE OF CANADA

Incorporated in 1887 as The Canadian Society of Civil Engineers

BRANCHES:

Halifax Branch, Halifax, N.S.
Cape Breton Branch, Sydney, Cape Breton.
Moncton, Branch, Moncton, N.B.
Saint John Branch, Saint John, N.B.
Saguenay Branch, Kenogami, Que.
Quebec Branch, Quebec, Que.
St. Maurice Valley Branch, Three Rivers, Que.
Montreal Branch, Montreal, Que.
Ottawa Branch, Ottawa, Ont.
Kingston Branch, Kingston, Ont.
Peterborough Branch, Peterborough, Ont.
Toronto Branch, Toronto, Ont.
Hamilton Branch, Hamilton, Ont.
Niagara Peninsula Branch, Niagara Falls, Ont.
London Branch, London, Ont.
Border Cities Branch, Windsor, Ont.
Sault Ste. Marie Branch, Sault Ste. Marie, Ont.
Lakehead Branch, Port Arthur, Ont.
Winnipeg Branch, Winnipeg, Man.
Saskatchewan Branch, Regina, Sask.
Lethbridge Branch, Lethbridge, Alta.
Edmonton Branch, Edmonton, Alta.
Calgary Branch, Calgary, Alta.
Vancouver Branch, Vancouver, B.C.
Victoria Branch, Victoria, B.C.

Members of Council 1936

PRESIDENT
E. A. CLEVELAND, Vancouver, B.C.

VICE-PRESIDENTS

*E. V. CATON, Winnipeg, Man.
†R. L. DOBBIN, Peterborough, Ont.
†H. W. McKIEL, Sackville, N.B.
†A. B. NORMANDIN, Quebec, Que.
*P. L. PRATLEY, Montreal, Que.

PAST-PRESIDENTS

F. A. GABY, Toronto, Ont.
O. O. LEFEBVRE, Montreal, Que.
F. P. SHEARWOOD, Montreal, Que.

COUNCILLORS

*C. G. R. ARMSTRONG, Windsor, Ont.
†Y. C. BARRINGTON, Sydney Mines, N.S.
*C. B. BROWN, Montreal, Que.
†G. S. BROWN, Lethbridge, Alta.
*G. H. BURBIDGE, Port Arthur, Ont.
†H. CIMON, Quebec, Que.
*A. COUSINEAU, Montreal, Que.
†A. B CREALOCK, Toronto, Ont.
†T. H. DICKSON, Moncton, N.B.
†A. FRIGON, Montreal, Que.
†A. B. GATES, Peterborough, Ont.
*For 1936

*L. F. GOODWIN, Kingston, Ont.
*B. GRANDMONT, Three Rivers, Que.
†A. K. HAY, Ottawa, Ont.
‡F. S. B. HEWARD, Montreal, Que.
*G. H. KIRBY, Riverbend, Que.
*H. S. JOHNSTON, Halifax, N.S.
†T. C. MAIN, Winnipeg, Man.
†E. P. MUNTZ, Hamilton, Ont.
†E. P. MURPHY, Port Colborne, Ont.
†H. J. McLEAN, Calgary, Alta.
‡F. NEWELL, Montreal, Que.
†For 1936-37

†E. A. RYAN, Montreal, Que.
†F. SMALLWOOD, Sault Ste Marie, Ont.
*R. E. SMYTHE, Toronto, Ont.
*E. W. STEDMAN, Ottawa, Ont.
†H. L. SWAN, Victoria, B.C.
*J. A. VANCE, Woodstock, Ont.
*G. A. VANDERVOORT, Saint John, N.B.
*H. R. WEBB, Edmonton, Alta.
*A. S. WOOTTON, Vancouver, B.C.
*S. YOUNG, Regina, Sask.
‡For 1936-37-38

TREASURER
J. B. CHALLIES, Montreal, Que.

SECRETARY
R. J. DURLEY, Montreal, Que.

OFFICERS OF BRANCHES

HALIFAX
Chairman, C. S. BENNETT
Vice-Chair., C. SCRYMGEOUR
Sec.-Treas., R. R. MURRAY, Wm. Stairs Son & Morrow, Ltd., Halifax, N.S.
Executive, J. R. KAYE, I P. MACNAB, J. D. FRASER, J. F. F. MACKENZIE, W. H. NOONAN, J. W. McLEOD, J. B. HAYES
(Ex-Officio) H. FELLOWS, H. S. JOHNSTON

CAPE BRETON
Chairman, M. R. CHAPPELL
Sec.-Treas., S. C. MIFFLEN, 60 Whitney Ave., Sydney, N.S.
Executive, C. M. ANSON, S. G. NAISH, I. W. BUCKLEY, W. S. WILSON
(Ex-Officio) W. E. BOWN, Y. C. BARRINGTON

SAINT JOHN
Chairman, J. R. FREEMAN
Vice-Chair., G. H. THURBER
Sec.-Treas., F. A. PATRIQUEN, P.O. Box 24, Saint John, N.B.
Executive, T. C. MACNABB, T. MOFFAT, S. HOGG
(Ex-Officio) V. S. CHESNUT, G. A. VANDERVOORT

MONCTON
Chairman, G. L. DICKSON
Vice-Chair., E. B. MARTIN
Sec.-Treas., V. C. BLACKETT, Engrg. Dept., C.N.R., Moncton, N.B.
Executive, F. O. CONDON, C. S. G. ROGERS, R. H. EMMERSON, F. L. WEST, A. S. GUNN, G. C. TORRENS
(Ex-Officio) T. H. DICKSON, H. B. TITUS, H. W. McKIEL

SAGUENAY
Chairman, S. J. FISHER
Vice-Chair., F. L. LAWTON
Sec.-Treas., G. H. KIRBY, P.O. Box 22, Riverbend, Que.
Executive, G. F. LAYNE, H. PELLETIER, G. E. LAMOTHE, C. MILLER
(Ex-Officio) J. SHANLY, L. R. BEATH

QUEBEC
Hon. Chair., A. R. DECARY
Chairman, ALEX. LARIVIERE
Vice-Chair., J. T. F. KING
Sec.-Treas., J. JOYAL, Quebec Public Service Comm., Court House, Quebec, Que.
Executive, R. WOOD, L. P. METHE, M. BOURGET, A. O. DUFRESNE, J. G. O'DONNELL, A. ROBERGE
(Ex-Officio) A. B. NORMANDIN, HECTOR CIMON

ST. MAURICE VALLEY
Chairman, B. GRANDMONT
Vice-Chair., J. E. FLEURY
Sec.-Treas., J. A. HAMEL, 642 Notre Dame St., Three Rivers, Que.
Executive, F. W. BRADSHAW, C. L. ARCAND, H. J. WARD

MONTREAL
Chairman, J. B. D'AETH
Vice-Chair., H. MASSUE
Sec.-Treas., C. K. McLEOD, 1440 St. Catherine St. W., Montreal, Que.
Executive, R. H. FINDLAY, C. C. LINDSAY, B. R. PERRY, T. C. THOMPSON, J. A. LALONDE, J. A. E. GOHIER
(Ex-Officio) F. S. B. HEWARD, A. COUSINEAU, C. B BROWN, P. L. PRATLEY, O. O LEFEBVRE, E. A. RYAN, F. NEWELL, A. FRIGON, F P. SHEARWOOD

OTTAWA
Chairman, E. VIENS
Sec.-Treas., F. C. C. LYNCH, Dept. of Mines, Victoria Memorial Museum, Ottawa, Ont.
Executive, E. M. DENNIS, T. A. McELHANNEY, N. B. MACROSTIE, G. R. TURNER, B. F. HAANEL
(Ex-Officio) E. W. STEDMAN, R. W. BOYLE, A. K. HAY

PETERBOROUGH
Chairman, H. R. SILLS
Sec.-Treas., W. T. FANJOY, 627 Homewood Ave., Peterborough, Ont.
Executive, V. R. CURRIE, A. L. KILLALY, E. J. DAVIES, W. M. CRUTHERS
(Ex-Officio) A. L. DICKIESON, A. B. GATES, R. L. DOBBIN

KINGSTON
Chairman, R. A. LOW
Vice-Chair., Lt.-Col. N. C. SHERMAN
Sec.-Treas, Major L. F. GRANT, Royal Military College, Kingston, Ont.
Executive, G. G. CARR-HARRIS, S. STEPHENSON, J. E. GOODMAN
(Ex-Officio) W. CASEY, L. F. GOODWIN

TORONTO
Chairman, O. HOLDEN
Vice-Chair., A. U. SANDERSON
Sec.-Treas., W. S. WILSON, Mining Bldg., University of Toronto, Toronto, Ont.
Executive, W. P. DOBSON, N. MACNICOL, W. E. P. DUNCAN, A. M. REID, D. D. WHITSON, C. E. SISSON
(Ex-Officio) W. E. BONN, A. B. CREALOCK, R. E. SMYTHE, F. A. GABY

HAMILTON
Chairman, W. HOLLINGWORTH
Vice-Chair., E. G. MACKAY
Sec.-Treas., A. LOVE, 40 Paisley Ave. S., Hamilton, Ont.
Executive, W. J. W. REID, A. R. HANNAFORD, V. S. THOMPSON, D. W. CALLANDER
(Ex-Officio) E. P. MUNTZ

LONDON
Chairman, JAS. FERGUSON
Vice-Chair., A. O. WOLFF
Sec.-Treas., D. S. SCRYMGEOUR, London Structural Steel Co. Ltd., London, Ont.
Executive, E V. BUCHANAN, W. C. MILLER, J. R. ROSTRON, H. A. McKAY, W. M. VEITCH
(Ex-Officio) S. W. ARCHIBALD, S.G. JOHRE, J. A. VANCE

NIAGARA PENINSULA
Chairman, G. H. WOOD
Vice-Chair., L. C. McMURTRY
Sec.-Treas., P. A. DEWEY, 1224 Ontario Ave., Niagara Falls, Ont.
Executive, S. HAIRSINE, W. D. BRACKEN, M. H. JONES, C. S. BOYD, R. A. BRADLEY, C. G. MOON, A. W. F. McQUEEN
(Ex-Officio) P. E. BUSS, E. P. MURPHY

BORDER CITIES
Chairman, T. H. JENKINS
Vice-Chair., C. F. DAVISON,
Sec.-Treas., BOYD CANDLISH, 170 Rankin Blvd., Sandwich, Ont.
Executive, E. M. KREBSER, D. T. ALEXANDER, C. G. WALTON
(Ex-Officio) C. G. R. ARMSTRONG, H. J. COULTER

SAULT STE. MARIE
Chairman, J. L LANG
Vice-Chair., W. SEYMOUR
Sec.-Treas., N. C. COWIE, 15 Hearst St., Sault Ste. Marie, Ont.
Executive, E. M. MACQUARRIE, T. FOULKES, C. W. HOLMAN, H. W. SUTCLIFFE
(Ex-Officio) F. SMALLWOOD

LAKEHEAD
Chairman, F. C. GRAHAM
Vice-Chair., G. R. DUNCAN
Sec.-Treas., G. R. McLENNAN, 80 North High St., Port Arthur, Ont.
Executive: H. G. O'LEARY, J. M. FLEMING, K. A. DUNPHY, E. A. KELLY, E. L. GOODALL, W. J. BISHOP
(Ex-Officio) G. H. BURBIDGE, R. J. ASKIN

WINNIPEG
Chairman, G. E. COLE
Vice-Chair., A. E. MACDONALD
Sec.-Treas., H. L. BRIGGS, 609 Ingersoll St., Winnipeg, Man.
Executive, F. W. ALEXANDER, A. CAMPBELL, W. D. HURST, R. W. McKINNON, W. F. RIDDELL
(Ex-Officio) E. V. CATON, F. V. SEIBERT, T. C. MAIN

SASKATCHEWAN
Chairman, W. E. LOVELL
Vice-Chair., STEWART YOUNG
Sec.-Treas., J. J. WHITE, City Hall, Regina, Sask.
Executive, A. R. GREIG, J. W. D. FARRELL, J. McD. PATTON, H. S. CARPENTER, H. J. BYRD, S. R. MUIRHEAD
(Ex-Officio) A. P. LINTON

LETHBRIDGE
Chairman, P. M. SAUDER
Vice-Chair., R. F. P. BOWMAN
Sec.-Treas., E. A. LAWRENCE, 207-7th St. S., Lethbridge, Alta.
Executive, J. M. CAMPBELL, J. B. DEHART, W. MELDRUM
(Ex-Officio) W. L. McKENZIE, G. S. BROWN, C. S. CLENDENING

EDMONTON
Chairman, E. STANSFIELD
Vice-Chair., A. RITCHIE
Sec.-Treas., M. L. GALE, 9914-111 St., Edmonton Alta.
Executive, J. D. BAKER, W. E. CORNISH, C. E. GARNETT, A. J. GAYFER, E. NELSON
(Ex-Officio) F. K. BEACH, H. R. WEBB

CALGARY
Chairman, JOHN DOW
Vice-Chair., H. W. TOOKER
Sec.-Treas., JAS. McMILLAN, 506 Insurance Exchange Bldg., Calgary, Alta.
Executive, J. J. HANNA, W. T. McFARLANE, H. J. McEWEN
(Ex-Officio) J. HADDIN, F. M. STEEL, H. J. McLEAN

VANCOUVER
Chairman, JAS. ROBERTSON
Vice-Chair., H. N. MACPHERSON
Sec.-Treas., T. V. BERRY, 3007-36th Ave. W., Vancouver, B.C.
Executive, E. C. THRUPP, P. SANDWELL, G. L. BOOKER, J. P. MACKENZIE, P. H. BUCHAN, C. P. HAMILTON, F. O. MILLS
(Ex-Officio) G. M. GILBERT, E. A. CLEVELAND, A. S. WOOTTON

VICTORIA
Chairman, I. C. BARLTROP
Vice-Chair., J. C. MACDONALD
Sec.-Treas., KENNETH REID, 1336 Carnsew St., Victoria, B.C.
Executive, G. M. DUNCAN, G. M. IRWIN, G. M. TRIPP, C. D. SCHULTZ
(Ex-Officio) D. MACBRIDE, H. L. SWAN

THE
ENGINEERING JOURNAL

THE INSTITUTE as a body is not responsible either for the statements made
or for the opinions expressed in the following pages.

VOLUME XIX — MONTREAL, NOVEMBER, 1936 — NUMBER 11

The Design and Economics of the Small Industrial Steam Power Plant

W. D. Canan,
The Rust Engineering Company, Pittsburgh, Penna.

Paper presented before the Border Cities Branch of The Engineering Institute of Canada, November 15th, 1935.

SUMMARY.—The paper discusses the general conditions under which a small industrial steam power plant can show an adequate financial return in competition with purchased power. The instances for which figures are given are taken from practice in the United States; prices considered are those of the period 1930-1934.

With the recent improvement in business conditions, the desirability of the small industrial plant generating its own electrical energy should become a matter of increasing importance to management due to the possibility of such a power plant actually paying returns quite comparable with the production department of a business.

It is hoped that the information contained in the following article will be useful to those interested in or confronted with problems of this nature.

DESIGN

General Requirements

In the matter of design, the industrial power plant offers, and very often demands, greater latitude than a central station. The following general requirements should be given special consideration: cost, return on investment, simplicity, dependability and spare capacity. Of these requirements the most important by far is first cost. As will be shown later the first cost of the plant determines the fixed charges and as these charges remain constant regardless of the load or the economy of the plant the first cost influences to a great extent the return on the investment.

There seem to be no very fixed ideas on the part of the prospective purchaser of a power plant as to what an adequate return on his investment should be. There have been instances where projects were turned down that could have shown 30 per cent and others accepted on the basis of 16 per cent return. It is believed that for smaller installations up to about 1,000 kw. the return should not be less than 25 per cent, this return reducing to a minimum of 15 per cent for the larger installations.

It is essential that the plant be easy to operate. Usually the operating force is augmented or recruited from general plant personnel who have had little or no experience in handling modern power plant equipment, therefore the layout should be as simple and as compact as good engineering and reasonable economy will permit.

Assuming proper maintenance, the matter of dependability of individual pieces of equipment, and therefore the plant as a whole, takes care of itself if the proper study is given to the service which it will be called upon to give, and the selection made so as to have it operate well within its capacity at all ratings.

Seldom is 100 per cent spare capacity provided for any piece of equipment in the case of the main units. It has been found to be a more desirable practice, and at the same time more economical, to provide spare capacity in the oversize of boilers and electrical generating units. The units should be so proportioned as to require all to operate at the time of peak loads, with at least one out of service at the time of off-peak loads. In the case of outage of any unit, the remaining units are loaded to capacity and the load requirement reduced to meet this capacity.

In the case of the auxiliary equipment, it is usually the practice to install 100 per cent spare boiler feed pump capacity.

Pressure

For the small industrial power plant the steam pressure almost invariably falls within one of two ranges, 150 to 250 pounds, or 400 to 475 pounds. Superheat varies from 100 to 200 degrees F.

Boilers

The bent tube boiler of either the low head or three or four drum type is most popular. It will be found that for the lower pressure range and continuous ratings not over 225 per cent very excellent results will be experienced with the low head type.

Although somewhat higher efficiencies may be obtained with straight tube sectional header boilers they are usually not sufficient to offset the increased first cost as compared to the bent tube type.

In terms of present day practice the ratings at which the boilers in the smaller power plants operate are moderate. While ratings of as high as 300 per cent may occasionally be necessary it will be found that in the great majority of cases installations designed for 250 per cent continuous operation will be ample.

Every effort should be made to provide liberal boiler furnace volume. For pulverized fuel the heat release should be kept below 25,000 B.t.u. per cubic foot per hour and for stoker fired jobs this value may be increased to a range of from 30,000 to 40,000 B.t.u. For small installations and moderate ratings solid brick settings are found to be satisfactory, but for larger ones more or less artificial cooling of the furnace becomes necessary. Water cooled bridge walls and air cooled side walls seem to be the most common practice for stoker fired jobs, and for pulverized fuel, bare or refractory covered water cooled surfaces.

Fuel Firing Equipment

For the small coal-fired installation the single retort underfeed stoker for about 700 developed boiler horse power continuously is satisfactory. If loads higher than this figure are attempted with this type of stoker, good results should not be expected.

The overfeed type of stoker is sometimes recommended for small installations, and while no difficulty may be experienced in operating such a stoker at relatively high ratings on the boiler for short periods of time, the maintenance of the boiler brickwork becomes so high and the economy so poor that this type cannot be considered in the same class with the single retort underfeed.

The multi-retort underfeed stoker gives uniformly good operating results if the coal burning rate is kept within reasonable limits, say 40 to 45 pounds per square foot of effective grate area. When operating much beyond this rate for long periods of time maintenance is quite likely to mount rapidly. When it comes to a choice between the dump plate and continuous ash discharge type, it is mainly a matter of balancing the additional expense against the increase in efficiency.

The chain grate stoker provides the best means for burning anthracite in small sizes and coke breeze. Burning rates are low compared to multi-retort underfeed practice, going as low as 25 pounds per square foot of grate area for the smallest sizes of fuel.

While it may be found that pulverized fuel firing will be found desirable in some cases, this method of firing is open to two inherent objections. First is its initial cost, which is invariably higher than a stoker installation and for the size and type of plants in question the saving in fuel does not warrant the additional expenditure. Second the fly ash, both that emitted from the stack and that taken from the boilers, breeching and stack presents a problem which the average industrial power plant owner does not care to attempt to solve. Even though the plant is of such a type or is located in a vicinity where the fly ash from the stack is not objectionable, the disposal of that removed from the boiler, breeching and stack is a difficult matter.

Heat Recovery Equipment

Heat recovery equipment such as air preheaters and economizers do not seem to be warranted in the average small industrial power plant. It will be found that only in the exceptional case will either of these two pieces of equipment be justified. One item in connection with air preheaters which gives the designer considerable trouble is the hot air ducts. These ducts running down the sides of the boilers and into the basement for stoker installations make access to vital parts of the boiler difficult, take up valuable aisle and passage-way space and reduce head room.

Economizers present no such difficulties in connection with their installation as do air preheaters. This is particularly the case with the integral economizer so that the question of their inclusion in the design is purely a financial one.

Draft

A concrete or radial brick chimney is preferable to induced draft equipment. This is due not only to the fact that the first cost is less but also the maintenance and operating cost is negligible. It also tends to simplify the design and increase the dependability feature of the plant in that it eliminates an additional piece of equipment. The limiting feature for a chimney from an economic standpoint is the amount of draft it is required to produce and which determines its height. If the draft required at the breeching opening into the chimney is much over 1.5 inches it is quite likely that the induced draft fans will be cheaper.

There is no economic limitation as to diameter, the design being so proportioned as to give maximum gas velocities of from 35 to 40 feet per second for larger diameter chimneys, and approximately 25 feet per second for small ones. Care must be used in designing the chimney that the gas velocity at light loads will not be too low. If this velocity at low loads falls below 10 feet per second some impairment of draft may be found due to the cooling effect of the exposed chimney surface on the gases.

Piping

At best any piping layout is complicated and every effort should be made by the designer to simplify it as much as possible. Occasionally it will be found desirable to loop the main steam header or run duplicate feed water lines. However, this procedure will increase the cost considerably and should not be done unless continuity of operation and the particular layout demand it.

Van Stone joints should be used on the larger and more important lines even for the lower pressures if at all possible. Welded line construction is almost universal practice. Although it is permissible to use cast iron fittings, valves and flanges for steam pressures up to 250 pounds, cast steel is well worth the additional cost.

Lines are designed for velocities as follows:

High pressure steam	8,000 to 10.000 feet per minute
Intermediate pressure steam	6,000 to 8,000 feet per minute
Low pressure steam	4,000 to 6,000 feet per minute
Exhaust steam lines	3,000 to 4,000 feet per minute
Feed water lines	300 to 500 feet per minute

For the length of runs usually encountered it will be found that the above ranges give reasonable pressure drops. In the case of large vacuum lines such as would be used for connecting the exhaust of a condensing turbine to a barometric condenser, velocities up to 500 feet per second may be used. Condenser circulating water lines are so proportioned that the total frictional head loss will be approximately 1 to 2 feet per 100 feet equivalent length of line.

Electrical Generating Equipment

When it comes to selecting the electrical generating equipment for an industrial power plant there is not so much of an engineering problem involved as in the case of the boiler room equipment. The designing engineer is limited as to size, type and electrical characteristics of the units and his job is to pick those that best meet the operating requirements.

As to type, if the units are 1,000 kw. or over, the choice will invariably be turbo-generator sets. Below 500 kw. engine-generator sets likely will be preferable. From 500 to 1,000 kw. either type of unit may be selected, the choice usually favouring the engine-generator set for non-condensing jobs and turbo-generators for condensing jobs. While the above recommendations should not be considered as inflexible they will be found to apply in the majority of cases.

If it were not necessary to consider first cost the determination of the proper size and number of units to be installed would be not so difficult. Since, however, cost is so important and the generating units are the largest single item of the cost, every effort must be made to keep the installed capacity as small as is consistent with the need for continuity of operation demanded by the particular plant.

For loads up to about 5,000 kw. it is desirable to install two units to take care of the present requirements and make provision for a third for future requirements. If the plant requires continuous operation with no shut-down over week-ends, each unit should be of sufficient size to carry the total load as determined by the fifteen minute demand, the second being a 100 per cent spare. If continuous operation is not required, then the machines should be selected so that both operating at about 75 per cent rated capacity will carry the load. For plants where the load is over 5,000 kw. three units, one of which is a 50 per cent spare, will be found to be the best selection. There appears to be no great economy in the practice of installing small units for operation on off-peak loads nor different size or type of main units.

The generating voltage may be either 440 or 2,300 volts, being determined by the size of the plant and the length of the feeders. The average small industrial plant does not usually involve much in the way of a transmission system between the power plant and the centre or centres of distribution. However, in case such a system is required, if the transmission voltage is determined by allowing 1,000 volts per mile, it will be found that the cost, regulation and voltage drop of the line comes within reasonable limits.

In the case of a condensing plant the question of an adequate and dependable supply of condenser circulating water is one of the most difficult to solve. Most of the problems of design have one or more alternative courses which may be followed but with the circulating water the picture is different. The water is either available or it is not available. If it is available a very definite amount must be supplied under all conditions of weather and load, and the cost of getting the supply is equally well fixed. It is sometimes found necessary to abandon projects due to the impossibility of solving this problem satisfactorily.

Coal Handling Equipment

Coal handling equipment will vary widely depending upon the size and type of the plant and the fuel supply. For the small plant an unloading hopper, an elevator and an overhead steel storage bunker or coal tank with spouts to the stoker hopper is all that is required.

The elevator should have a handling capacity of 25 to 30 tons per hour and overhead storage capacity sufficient for at least two days' operation of the plant should be provided. For larger plants a crusher and scraper or belt conveyor is added and the handling capacity increased to possibly 50 tons per hour.

Special features such as travelling weigh larries, non-segregating coal spreaders, etc., usually are not called for in the average industrial plant although their inclusion is determined almost entirely by the amount of money available.

Ash Handling Equipment

An entirely satisfactory ash handling system for the smaller power plants which can be installed at a reasonable price is not available. For the size of plants being considered manual handling from the ash hopper gates or some one of the various types of steam jets or vacuum systems provides the best means for disposing of the ash. A portion of the overhead bunker can be used for storage of the ashes or an outside concrete or tile bin installed. In larger plants where the expense can be justified a modern sluicing system is in order.

Building

The building to house the power plant need not be pretentious and its cost rarely needs to be more than 20 per cent of the cost of the complete plant. This is based on the assumption that no unusual foundation conditions are encountered. For buildings with basements, all concrete can be used up to the operating floor with steel framing above this point. Side walls may be of corrugated iron, corrugated asbestos, hollow tile or brick, depending upon what the owner wishes. The relative cost is in the order given, the brick adding from 5 to 8 per cent to the total cost of the plant over corrugated iron. The roof is usually of cement tile or similiar material with some form of built up roofing.

The foregoing is not offered as a complete treatment of all of the features entering into the design of a power plant. Consideration, however, has been given to the more important items and certain standards have been indicated and various recommendations and suggestions made which have been found to be in accord with good engineering and practice.

Plant Costs

Table I gives physical data and plant costs for complete power plants and boiler plants only for a range of capacities such as this article is intended to cover. The costs are for the period 1930 to 1934, present day costs being 15 to 20 per cent higher.

The comparisons given for plant A are interesting in that they show possible variations in plant investment due to the selection of different types of equipment. However, these figures should not be taken as conclusive evidence that the application of the three types in question would result in the same conclusions for all cases. It will be noted that this plant shows rather low unit costs which are accounted for by the relatively inexpensive type of building selected to house the equipment, by the larger size of the units as compared with most of the other illustrations and by the fact that the material and equipment prices at the time the estimate was made were probably at their lowest for the period of the depression.

Plant B also shows a low cost but for a design using natural gas it must be remembered that the usual costs for expensive fuel burning equipment, coal and ash handling and storage are absent from the totals. The fact that the plant operates non-condensing serves also to cut down its cost.

Plants D, E, F, H, J and P are representative of what good practice indicates are reasonable costs for industrial power plants. The unit costs of these plants agree quite closely, any difference being due largely to variations in the cost of securing a proper circulating water supply together with some differences caused by the size of the units involved.

Plant Q is a good example of a power plant in connection with an industry in which the demand for process steam is quite large.

Plants K, L, M, N and R are representative of industrial boiler plants. These unit costs are consistent except in the case of plant R where the higher cost is due to the higher steam pressure.

Unit costs for all plants in the above table are based on installed rather than developed capacities of the equipment. The figure for total cost includes all engineering, field, overhead and profit charges involved in the work. In every instance the final result embodies a complete and workable plant.

Economics

Influence of Load Factor on Plant Cost

A most difficult matter to determine accurately in power plant design is the amount of money which can be justified for capital expenditure in cases where the load factor of the plant cannot be closely calculated for future conditions. The more efficient plant requires more investment than the less efficient and to pay for the added investment the more efficient plant must operate more nearly to the limit of its designed capacity than the less efficient. It therefore becomes necessary to make a more or less elaborate study of the economy resulting from the installation of various types of fuel burning, heat recovery and other equipment. It is often misleading to attempt to obtain this result by a simple comparison of the various manufacturer's offerings because it is only when the whole has been assembled into a given design that the true economic result can be known.

To illustrate this point there are given in Table II data showing the results of such a study and its bearing on the proper installation to be made.

In this case a plant was required for which it was difficult to predict anything very definite in the way of a future load due to the possible change in the load factor. It was therefore decided to make studies of three different designs, a low cost medium efficiency design, an intermediate design and a higher efficiency higher cost design. The comparison was made for two types of stoker plants with different costs and different efficiencies and for one involving pulverized fuel firing, good heat recovery and adequate provision for dust prevention. The plants may be identified in the above order as A, B and C. It should be noted that the dust prevention provided for in the case of plant C contributed nothing to its economical operation but was made necessary due to the use of pulverized coal.

This table indicates that for the particular conditions for which the study was made, that for load factors up to 60 per cent the chain grate stoker installation would give the best results, while for load factors between 60 and 80 per cent the underfeed stoker plant would be most economical and that the pulverized fuel plant would not be justified with a load factor under 80 per cent. This study of course was based on fuel at a certain cost and if this cost had been

Table I
Physical Data and Plant Costs

Plant	Price per h.p. Boiler End Only	Price per Kw. Total Plant	Total Plant Price	Boilers	Pressure	Super-heat or Total Temper-ature	Firing	Draft	Turbines	Cond. or Non-Cond.	Building	REMARKS
A	......	$55.80	$697,480	3-75,000 lbs./hr. Eff. 81.1 per cent	450 lbs.	700° T.T.	P.F.	I.D.	2-5000 1-2500	Cond.	Corr. Asb.	Integral Furnace Type Boilers.
A	......	61.86	773,390	3-75,000 lbs./hr. Eff. 83.5 per cent	475 "	700° T.T.	P.F.	I.D.	2-5000 1-2500	Cond.	Corr. Asb.	Bent Tube Boilers.
A	......	64.36	804,470	3-75,000 lbs./hr. Eff. 83.6 per cent	475 "	700° T.T.	P.F.	I.D.	2-5000 1-2500	Cond.	Corr. Asb.	Straight Tube Boilers.
B	$77.80	79.60	398,095	2-1368	450 "	150° S.H.	Gas	Conc.	2-2500	N.C.	Corr. Asb.	Natural Gas Fired Turbines Non-Cond. Bleeders.
C	82.18	.....	106,000	2-507	150 "	......	C.Gr.	Steel	......	......	Corr. Steel	Low Head Boiler.
D	82.71	73.74	221,221	3-355	250 "	150°	M. R.	I.D.	2-1500	Cond.	Corr. Asb.	Includes Complete Cond. Circulating Water Supply.
E	85.50	99.86	151,352	2-362	250 "	150°	C.Gr.	Conc.	2-750	Cond.	Corr. Asb.	Low Head Boilers.
F	88.77	92.02	285,598	3-507	250 "	90°	C.Gr.	Conc.	3-1000	N.C.	Brick	Low Head Boilers.
G	87.67	.....	263,000	3-1003	250 "	100°	B.F. Gas	Conc.	......	......	Corr. Steel	Bent Tube Boilers, Aux. Hand Fired Grates.
H	95.30	83.62	690,560	4-931	450 "	750° T.T.	C.Gr. and Gas	Conc.	2-4000	Cond.	Brick	Bent Tube-Anthracite Coal.
F	101.78	.....	832,277	6-1287	200 "	100°	M.R.	Conc.	......	......	Corr. Steel	Bent Tube Boilers.
J	106.00	99.08	148,620	2-507	250 "	150°	M.R.	Conc.	2-750	N.C.	Corr. Asb.	Low Head Boilers.
K	107.55	.....	65,215	2-290	250 "	....	S.R.	Conc.	......	....	Brick	Low Head Boilers.
L	107.66	.....	108,305	1-1006	160 "	....	M.R.	I.D.	......	......	Corr. Asb.	Bent Tube Boilers.
M	108.39	.....	419,494	3-1287	200 "	100°	M.R.	Conc.	......	......	Corr. Steel	Bent Tube Boilers.
N	109.34	.....	120,926	2-553	250 "	150°	C.Gr.	I.D.	......	......	Corr. Asb.	Bent Tube Boilers.
O	116.46	83.76	251,280	2-490	250 "	90°	C.Gr.	Conc.	3-1000	Cond.	Brick	Bent Tube Boilers.
P	112.40	90.83	272,345	3-362	250 "	140°	C.Gr.	Conc.	2-1500	Cond.	Corr. Asb.	Low Head Boilers.
Q	116.00	70.39	809,485	3-1260	450 "	200°	M.R.	Conc.	1-7500 1-4500	Cond.	Brick	Bent Tube Boilers. 7500 Kw. Condensing. 4000 Kw. Bleeder.
R	121.80	.....	428,045	2-1757	425 "	665° T.T.	M.R.	Conc	......	......	Gypsum	Bent Tube Boilers.

P.F. —Pulverized Fuel.
C.Gr.—Chain Grate Stoker.
M.R.—Multi-Retort Stoker.
S.R. —Single Retort Stoker.
B.F. —Blast Furnace Gas.
Conc.—Concrete Stack.
I.D. —Induced Draft.

Table II
Yearly Fuel Saving and Additional Investment Justified

Plant	Lbs. Steam per Hr. Gen. Cap. of Plant per $1.000 Invest.	Efficiency of Boilers Per cent	Difference in Plant Cost	Per cent Load Factor	Yearly Saving in Fuel	Additional Investment Justified at 15 per cent	Load Factor for which Plant is Economical
A Chain Grate	462	78.6	....	....	....	....	Up to 60 per cent
B—Underfeed	425	82.0	$157,000 over A	30 per cent	$11,700	$ 78,000	60 per cent to 80 per cent
				40 " "	15,300	102,000	
				50 " "	19,200	128,000	
				60 " "	23,000	133,000	
				70 " "	26,500	176,000	
				80 " "	30,200	201,000	
C—Pulverized Coal	400	83.7	$295,000 over A	30 per cent	$17,500	$117,000	Above 80 per cent
				40 " "	22,950	153,000	
				50 " "	28,700	192,000	
				60 " "	34,500	230,000	
				70 " "	40,000	266,000	
				80 " "	45,000	300,000	

different the study would have shown different results. For example, had the fuel cost been fifty per cent greater the economical operating range would have been as follows:—A plant for load factors up to 30 per cent, B plant for load factors 30 to 40 per cent, and C plant for load factors above 40 per cent. This illustrates very clearly the fact that increased capital expenditure for efficient equipment is justified in accordance with the increase in the cost of fuel and load factor.

While it is not always necessary to make such a detailed study for every item of equipment it is desirable to do so for all those having a direct bearing on economy and in which a considerable amount of money is involved.

Production Costs

While there are necessarily many questions which must be given thought and study when the matter of generating or buying power is under consideration, the one of most vital importance is whether or not any money can be saved by generating and how much. At the present time there are an unusually large number of buyers of public utility power who have more than a passing interest in generating their own electric power. A great many, of course, have relatively low power requirements and the possibility of showing an adequate return is very remote. For those who wish to make a quick check in this respect it will be found that a yearly power bill of about $50,000 and a demand of about 1,000 kw. is the smallest project on which it is worth while to spend much effort. This, of course, like all rules is subject to exception, some of which might be low fuel costs, use for a considerable quantity of process steam at relatively low pressures, possibility of using an existing boiler plant, or the installation of second-hand equipment. For demands from 1,000 to 1,500 kw. it is usually necessary to make a rather complete analysis before it can be determined whether or not the return will warrant the investment in a plant. Above 1,500 kw. demand there is not much doubt but that it will pay to generate in preference to buying power.

In order to provide something concrete to emphasize the points already mentioned there is given below in Table III and Table IV the total unit production cost for two typical power plants of considerably different size.

These two tables are of interest for a number of reasons. First they show how the total production cost varies with an increase in the size of the plant, all of the items of cost decreasing for the larger plant except fuel, and this is due in part to the fact that for the smaller plant the fuel cost was taken at $1.35 per ton and for the larger at $3 per ton.

In the second place they indicate that for the smaller plant to show a return of approximately 25 per cent it would have to compete against public utility power costing about 18 mills per kw. hour, while the larger plant would have to compete against public utility power costing about 10 mills to show the same percentage return. Obviously the larger plant has the advantage.

In the third place the necessity for low cost fuel in the case of the small plant can be seen. If instead of $1.35 for fuel the smaller plant had to pay $3 per ton, the fuel cost would be increased to 2.7 mills per kw. hour which would increase the total production cost from 9.39 mills to 10.91 mills. On the other hand if the large plant could get fuel at $1.35 per ton instead of $3 its fuel cost would be reduced to 0.60 mills per kw. hour or a reduction in the total production cost from 5.51 mills to 4.28 mills per kw. hour.

Table III
Production Cost
1,500-kw. Plant

4,200,000 kw. hours per year generation.	
Cost of plant	$160,000.00
Operating costs:	
Fuel	1.18 mills per kw. hour
Maintenance	0.82 mills per kw. hour
Miscellaneous	0.38 mills per kw. hour
Labour	2.06 mills per kw. hour
	4.44
Fixed charges—Interest, taxes, insurance, depreciation, etc.	4.95 mills per kw. hour
Total cost of production	9.39 mills per kw. hour

Table IV
Production Cost
10,000-kw. Plant

44,000,000 kw. hours per year generation.	
Cost of plant	$815,000.00
Operating costs:	
Fuel	1.83 mills per kw. hour
Maintenance	0.50 mills per kw. hour
Miscellaneous	0.10 mills per kw. hour
Labour	0.66 mills per kw. hour
	3.09
Fixed charges—Interest, taxes, insurance, depreciation, etc.	2.42 mills per kw. hour
Total cost of production	5.51 mills per kw. hour

To show the effect of varying fuel costs on the total production cost, Figs. 1 and 2 have been plotted, Fig. 1 for the 1,500-kw. plant and Fig. 2 for the 10,000-kw. plant. In plotting these curves the items of cost as given in Tables III and IV have been used.

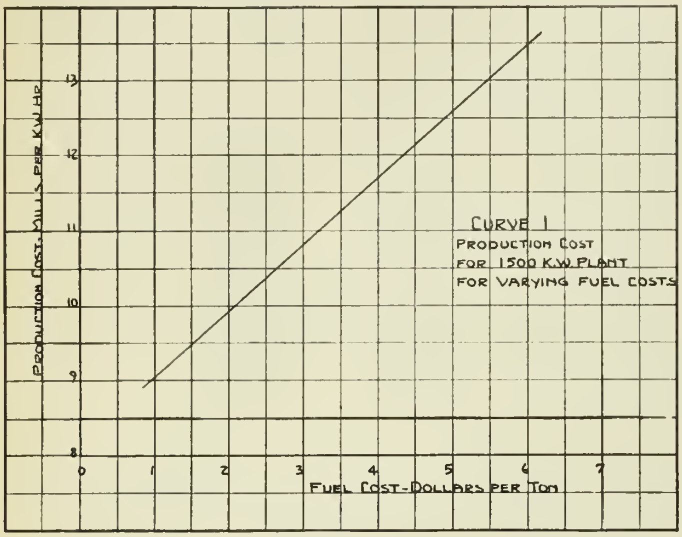


Fig. 1

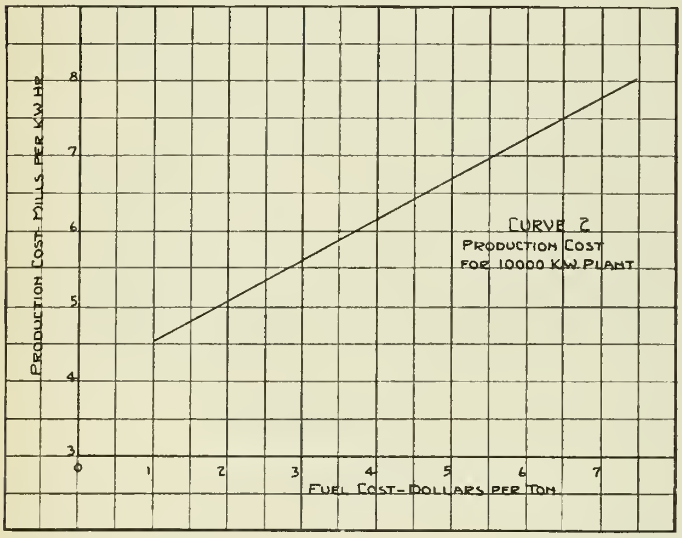


Fig. 2

Figures 3 and 4 are interesting in that they will serve in cases where great accuracy is not required as a quick means for determining whether or not it will be desirable from an economic standpoint to generate or buy power. All that it is necessary to know is the total yearly kw. hour consumption, the unit cost for this energy, if bought, and what would be considered an adequate return on money invested in a power plant. Further, the curves are based on average values for such items as plant construction costs, labour and interest on investment.

For example, if the yearly consumption is 25,000,000 kw. hours, the unit cost for this energy if bought is 15 mills and the fuel cost $3 per ton, it can be seen from Fig. 3 that if generated by the consumer the power plant would show a return of about 25 per cent. This curve also shows that the total production cost would be 8.2 mills. If for this assumed case the cost of fuel were $5 per ton instead of $3 then we find from Fig. 4 that the return would be 20 per cent and the production cost 9.7 mills.

Table III brings out quite clearly the fact that two items of the production cost, namely, labour and fixed charges, handicap the small plant considerably when it comes to producing low cost power. These two items alone make up about 75 per cent of the total production cost and even though the fuel cost was nothing, the picture would not be materially changed. As the size of the plant is reduced below 1,500 kw. this percentage tends to grow larger, so that for this reason if for no other plants below 1,000 kw. seldom can show an adequate return.

Table IV indicates why the large utility has difficulty in bettering the production costs of a moderate size industrial power plant. While the operating costs of a large central station might show a value as low as 1.8 to 2.0 mills, due to the large plant investment, the fixed charges may be from 50 per cent to 100 per cent greater than those shown for the industrial plant, and when to this cost is added transmission and metering losses as well as commercial, management and other costs it can be readily understood why utility power must be sold at from 8 to 10 mills as minimum, if a profit is to be made, compared to a generating cost of 4 to 5 mills if the relatively large consumer cares to generate his own electric power.

The average industrial plant operates with a load factor of from 35 to 50 per cent. In cases where this figure is bettered the production cost is considerably reduced.

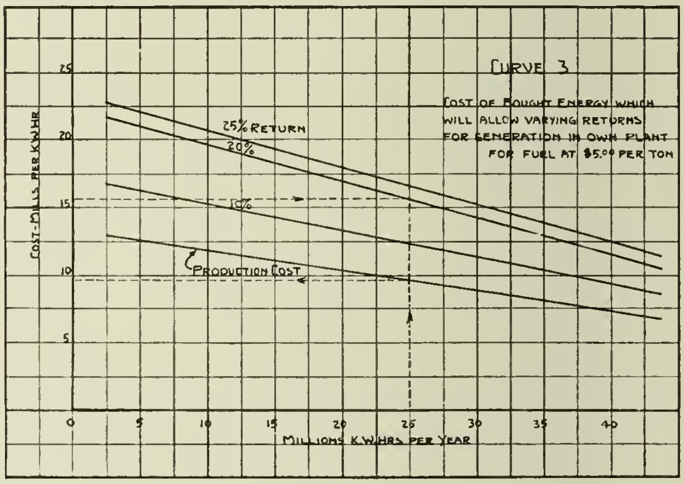


Fig. 3

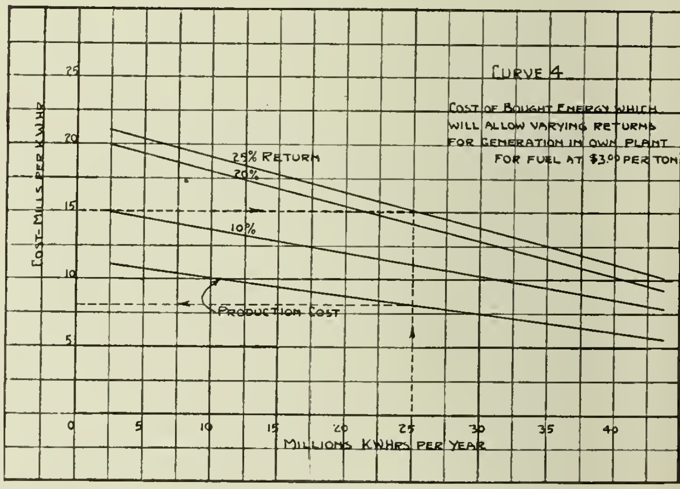


Fig. 4

For example a plant having an investment of $80 per kw. and operating on a load factor of 40 per cent will have fixed charges amounting to 3.42 mills per kw. hour. If the load factor is increased to 60 per cent the fixed charges will be decreased to 2.28 mills, and at 80 per cent load factor they will be 1.71 mills. In as much as the unit operating costs are only slightly affected by load factor the decrease in the unit fixed charges means a direct decrease in the total production cost.

Taking a specific example, the total production costs for the 10,000-kw. plant referred to in Table IV have been calculated for varying load factors with the following results:—

25 per cent....	8.49 mills	75 per cent....	4.30 mills
50 per cent....	5.41 mills	100 per cent....	3.76 mills

The effect of varying load factor is shown in a somewhat different light in the data given in Table II. Here we see that with an increasing load factor which results in the burning of a larger amount of fuel that the saving effected in fuel consumption justifies the spending of additional money for a more efficient plant. The need for improvement of their load factor is fully appreciated by central stations generally and quite often special rates are made to such of their customers as can use off-peak power.

We not infrequently hear the statement that it is unwise for the industrial plant to go into the power generating business. There seems to be no sound basis for such a statement as it should be no more difficult for industrials which are considerable users of power to master the administration and operation of their own power plant than to solve the many manufacturing and production problems with which they are continually confronted.

The Flow of International Rivers into Manitoba

Elwyn F. Chandler,
Professor of Civil Engineering, University of North Dakota, also Hydraulic Engineer, United States Geological Survey, Grand Forks, North Dakota.

Summary of paper presented before the Winnipeg Branch of The Engineering Institute of Canada, October 17th, 1935.

In addition to the duties of providing water of satisfactory quality, in sufficient amounts and at needed pressure, for domestic and municipal consumption, the engineer is concerned with water-power, flood protection and drainage, navigation, and irrigation. In most of these instances he must take a leading part or the leading part, either in plan, investigation, and design, in improvement, or in operation and management. Consideration of the location, quantities, qualities and behaviour of water supplies is therefore a very important duty of the engineer.

Water can be obtained directly from any one of several sources:—

(*a*) Rainfall.

(*b*) Underground supply, coming forth in springs or obtained by digging shallow wells, or from deep or artesian wells.

(*c*) Surface-water-supply, as flowing in smaller and larger brooks, creeks, and rivers, or found in the ponds and lakes fed by these surface streams.

As hydraulic engineer for the United States Geological Survey for thirty years past, the author has been responsible for continuous daily or monthly records of flow of the typical or important streams and rivers in a district including North Dakota, the Red River valley in Minnesota, and portions of adjoining states from time to time. This has involved either the direct personal oversight of continuance of the records, measurements of velocities, depths, etc., and computation of the totals for all the rivers, or, in the past few years, an occasional inspection of any special occurrences, floods, and low stages, and advisory duties on the whole area.

The international rivers flowing into Manitoba are as follows:—

The Red river of the North, with its tributaries from Minnesota and North Dakota entering before reaching the international boundary at Pembina-Emerson.

The Pembina river, mostly on the north side of the international boundary in Manitoba, but near the boundary and crossing so as to enter the Red a few miles south of Emerson.

The Roseau river, rising in Minnesota, but crossing the boundary at Caribou and entering the Red about ten miles north of Emerson.

The Souris river, otherwise known as the Mouse, rising in Saskatchewan, flowing southeast into North Dakota for a loop of a hundred and seventy miles through Minot and Towner and northward again across the international boundary into Manitoba and thence into the Assiniboine river which joins the Red at Winnipeg.

There is also the Rainy river, itself the international boundary, flowing westward along the north edge of Minnesota into the Lake of the Woods, thence outletting northward as the Winnipeg river, which after being joined by the English river from the east flows northwestward into Lake Winnipeg; this is of importance for power purposes.

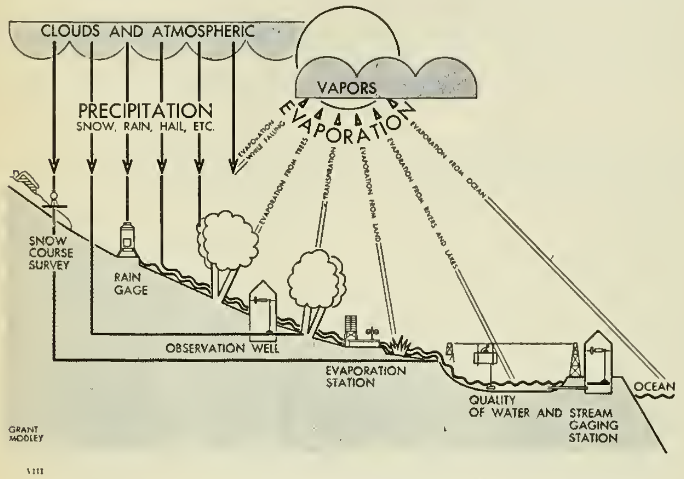
The earliest use of the Red river was for navigation purposes. Sixty years ago, before the construction of the railroads, it was the best and easiest route of travel "from the outside" for the dwellers at Fort Garry (Winnipeg). In those early days of inconvenient transportation by dog team, pack team, or Red River cart, the arrival in early spring of the first steamer, with its cases and crates of long-expected freight, was a marked event.

With the construction of the first railroad, about 1880, and the opening of other railroads, the importance of the river for this use lessened. But the population was growing, so that the total amount of commerce in prospect was increasing, and for many years there was an effort to continue and develop traffic and the transport of heavy freight along this route. Information is ready available as to the improvement of the river between Emerson and Lake Winnipeg in its different sections, the St. Andrews dam with its locks eighteen miles north of Winnipeg, and the present steamer transportation business (if any). On the south side of the boundary the purpose of the government was for many years to maintain at all stages of the river a channel 60 feet wide and 4 feet deep from Emerson to Grand Forks; 50 feet wide and 3 feet deep from Grand Forks to Fargo; and for high and medium stages a navigable channel from Fargo to Breckenridge.

With this purpose, the United States government maintained, and operated through part of the season, snagboat, dredge boat, etc., for the improvement and maintenance of such channels. Freight steamers did considerable business on the river; in particular, by hauling wheat from small grain elevators along the river bank to transfer elevators at Grand Forks from which it was shipped by railroad to the mills in the east.

In 1910, consequent upon a year with very deficient rainfall (approximately half the normal amount), the river was so shallow that freight steamers and barges could not run; freight business temporarily terminated, and has never resumed, and since that time nothing has operated except some small pleasure craft running for short distances.

There was for some years thereafter, especially in 1912, a popular movement to have the river sufficiently improved so as to be navigable even in the driest years. However, it was concluded that in occasional dry years the flow was so small as to be insufficient if permitted to flow naturally, and that the only effectual plan would be slackwater navigation by a series of low dams with locks. Therefore for a time an attempt was made to show the profit of such construction and secure a federal appropriation.



Courtesy of U.S. National Resources Committee.
Fig. 1.—How the Water Cycle is Measured.

At that same time the people in Manitoba were endeavouring to secure the improvement of the river outlet through Lake Winnipeg and the Nelson river to Hudson Bay and the ocean, and were using the slogan "Liverpool to Winnipeg" to bring to public attention the hoped-for possibilities of this through navigation. The author extended that slogan into the form "Liverpool to Grand Forks," and obtained harmonious co-operation with the Canadian committee. However, the inevitable difficulties in maintaining a channel, the comparatively small amount of traffic that could be guaranteed, and the fact that the river freezes for four or five months in the winter, whereas the railroads keep running summer and winter, led to finally dropping the question on the south side of the boundary. In fact, in subsequent years the authorities have granted permission to build fixed bridges across the river instead of the original requirements for a draw-span, or to build dams. These permits are customarily "revocable permits," of such form that whenever a trans-Atlantic steamer from Liverpool does finally appear at the downstream side of any bridge and finds its passage blocked, the permit will be revoked, and the owners of the bridge must remove it.

This introduces the consideration of the extremes of stage, high and low, of the Red river.

Why these flood extremes, and very low stages? Briefly, they are caused by excess and by deficient rainfall.

In the case of floods, if after a wet fall, at the close of winter the snow has accumulated to unusual depths, has thawed, but not sufficiently to open the ditches and furrows for the off-flowing water to follow; and then if the spring thaw moves north, loosening the snowdrifts and ice so that the peak flow reaches each further north point of the river just as the drifts and channels at those points have also begun to open up; and further if the weather brings a long continued warm rain, the flood that follows may be very extreme.

At Winnipeg, where there are longer records, there have been several floods of 10 or even 13 feet higher than that in 1897, which was the highest recorded at Grand Forks since 1882.

Conversely for extreme low stages, if rainfall has been deficient for a long time, so that the ground has become dry; and if the feeding lakes have been drained, to the low-water, and any limited rains come merely in frequent small rains which can all be absorbed by the dry soil with little run-off, and if it is in the warm dry season of the year so that evaporation is large, the stream flow will shrink and approach vanishing point.

Water comes originally by evaporation from the ocean, or from intermediate land, streams, and lakes, and appears as vapour in the atmosphere.

Changes in temperature, pressure, etc., bring the atmosphere to a condition of humidity above the saturation point, and the water is released in the form of mist or rain.

On reaching the ground, a portion of the water flows off immediately into the streams. This is termed run-off. Whether this portion is large, small, or nothing depends upon a number of factors, such as:—

Violence of storm (quantity of fall per minute).
Length of storm (minutes continuance), i.e. total amount falling.
Slope of the ground.
Condition of the ground as regards imperviousness.

Upon the conclusion of the rainstorm, the surface of the ground and all vegetation is wet. The sun comes out and the wind blows and this portion of moisture enters the air again, due to "evaporation and transpiration."

Part of the rainfall, dependent upon factors similar to those already listed, has already soaked into the ground, but in the following days some of this, perhaps all of it, is drawn to the surface by capillary action and gradually evaporates into the air as the soil dries, or is drawn up by the roots of vegetation and transpired from the pores of the foliage into the air, thus having finally entered the "evaporation and transpiration" section.

The remainder, if any, that passes down into the soil below the reach of capillary action or plant roots, finally reaches the groundwater level. As the groundwater supply is increased, it flows through the soil or rocks down the general slope of the country until it emerges in the open in springs or seeps, feeding the small streams, and thus finally entering the "run-off" section.

In other words, except for some small items comparatively so small as not to demand mention here, every drop of rainfall finally leaves either by the "evaporation and transpiration" route into the atmosphere again, or by the "run-off" route toward the ocean.

In earlier days it was the custom for most engineers to speak of the percentage of rainfall that enters the run-off. This is an indefensible and vicious phraseology, though sometimes a convenient brief phrase. The precipitation is not divided into run-off and evaporation-transpiration. Division is not at all the arithmetic to use, but subtraction.

To express it in a single sentence, run-off is the remainder left after evaporation and transpiration have taken their share. And in Manitoba, Saskatchewan and North Dakota, it is the remainder *if any*.

A portion of any sudden violent storm will of course immediately run off before evaporation can seize it. There are other minor exceptions, but the general statement above is in the main correct.

If an enquiry is made from records as to the quantity of run-off in the central part of the American continent, in fact at almost any portion of the usual climatic and topographic and cultural conditions between latitude thirty-five and fifty-five degrees, it will be found that the following statement will usually be reasonably near to the facts:

> Take the annual rainfall, measured in inches, subtract from it 20 inches, and the remainder will be the usual and to be expected annual run-off.

This statement is of course too abbreviated to cover the case entirely. Almost every year, even if the total rainfall were less than 20 inches, some portion of it would come in sudden showers so violent for a few minutes that at least a little would flow off the surface into the streams; or part of the drainage area (for example in a city) might be, so to speak, covered with impervious pavement. However, you will find the above to be quite near the truth, as will be illustrated by figures from many of these streams.

In other words, in any part of central North America where the total annual rainfall averages less than 20 inches, there is no dependable annual run-off at all; the run-off is merely accidental in time and amount.

The rainfall at Winnipeg, and at Grand Forks, normal annual total, is about 20 inches, as shown by the isohyetal rainfall map of North Dakota. At the western boundary of North Dakota, it is about 15 inches. Similarly, in Manitoba, it is 6 or 8 inches more at the eastern boundary of the province than at the western. At the eastern edge of the Red River valley, in central Minnesota, it is about 24 inches.

Thus the normal run-off for the Red River valley about Grand Forks, being about 4 inches at the eastern edge and merely a small fraction of an inch at the western edge, feeds down the river to Grand Forks a total amount equivalent to about one and one-half inches from the entire area.

This total of course depends, to a minor degree, not only upon the total normal rainfall and its distribution in gentle or sudden violent storms, but also upon topography and many other factors. Thus, though it gives an excellent basis for a rough preliminary estimate pending the searching out and study of long-period records, it is not exact for the entire area, as a table of average run-offs from several of the Red river tributaries shows plainly.

No one can predict weather and rainfall for a long period in advance with any certainty. Stream-flow is even more uncertain, although some experts have developed, by experience, when there are enough telegraph reports from upstream, the ability to predict for a few days or sometimes a few weeks ahead the prospective heights with fair accuracy. However, flow for oncoming seasons, and especially for definite future years, is a matter merely now of guesswork based on reasonable indications, as the variations are sometimes enormous.

The total rainfall of a single year, in the central North American region, never or almost never exceeds the long period normal by more than 50 per cent, nor is more than 50 per cent below the normal. For example, if the Winnipeg normal is 20 inches per year, it is beyond the bounds of probability that there will be more than 30 inches or less than 10 inches of rainfall in a year. However, for a river the variations from year to year will be enormously greater comparatively.

At Grand Forks, on the Red river, the years of largest total flow recorded (1882 and 1916) each had about two and a half times the normal long-period average total annual. There have been a dozen years with less than half the normal total, and the lowest year (1934) had only one-tenth of the normal total.

The Pembina river, at Neche, N.D., had a total flow in 1904 four times the long-period normal total, and a total flow for the year 1915 only about one-seventh of the normal total.

Even worse, on the Souris river at Minot. The greatest year (1904) brought more than five times the normal annual total; but 1931, the lowest year in thirty years of record, had less than one-hundredth of the normal annual total.

The variations in flow from day to day of course show enormously greater divergencies. For example at Grand Forks, on the Red river, the greatest recorded flow, one day in April, 1897, was 42,000 cubic feet per second. In fifteen years of the fifty-three-year period recorded it has gone above 20,000 second-feet, for at least one day. In twenty-five different years it has gone below 500 second-feet for at least a day, and its extreme minimum was recorded, in September 1934, and was 20.

Similarly the Pembina river, with recorded minimum flow of about 3,850 second-feet on two occasions, May

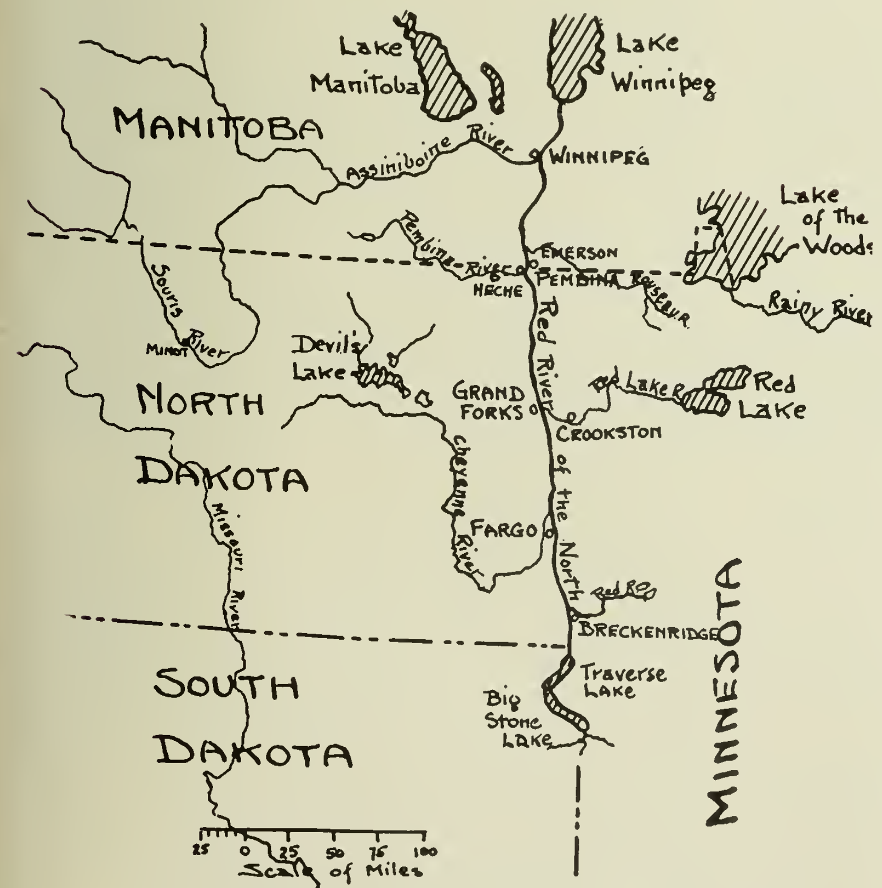


Fig. 2.—Map Showing International Rivers Flowing into Manitoba.

26th, 1904, and April 8th, 1913, and with flow above 1,000 for at least one day in half the years, goes down to the small flow of 10 or less at some time in about half the years, and has a minimum recorded of only one cubic foot per second in September, 1911, and again in February, 1925.

The Souris river at Minot, North Dakota, with its comparative variations still greater, has a maximum of 12,000 second-feet on April 20th, 1904, and rises above 2,000 in a third of all the years recorded; this is usually in late spring. However, in late summer or winter its flow usually shrinks for a time almost to zero, so that flows of less than one cubic foot per second are recorded in nearly three-quarters of the years.

The next question therefore is, "Can we, the inhabitants of the valley, by any artificial works improve upon nature, and regulate our rivers better?"

Apart from dredging and cleaning channels to improve navigation or building dams to make the water depth sufficient for navigation, and placing dams to give a head for water to pass through the wheels of power plants, which however form ponds large enough to store only a few days flow, all of which are merely local or minor projects which would not appreciably alter the amounts and times of arrival of the total flow, such improvements or supposed improvements are of two general types, namely, ditching and building reservoirs.

These two types have, in many respects, opposite effects on the flow. Under ditching is included straightening and deepening the main stream channels so as to make the stream flow faster, and grid-ironing the valley lands with drainage ditches so as to drain out the soil and bring quickly to the main stream much water that otherwise would have delayed long or perhaps evaporated in the field where it came as rain and never reached the main river.

Either of these forms would apparently have a tendency to increase the total quantity of water that comes down to the lower river, and might intensify the extremes of flow, making the floods greater as well as more prompt in arrival. But in many cases it is quite debatable whether the effect would be appreciable, or at least enough to be noticeable in comparison with the much greater natural variations of flow from season to season and year to year.

The Minnesota side of the Red River valley has been crossed with drainage ditches; if these do have appreciable effect, it surely should have been felt at some points before this time. At the extreme southern end, southeast of Breckinridge, these ditches were the occasion of a noted law suit that ran several years in the Supreme Court of the United States, in which the suit was originally brought by the State of North Dakota as complainant against the State of Minnesota. The effects may be either positive or negative, depending on many factors such as topography, soil condition and character, and so on; and although in that case it would seem that the effect was positive as increasing very greatly the flood injuries on the lands below, the Court finally dismissed the case without prejudice, because the lack of definite records of time and distribution of flow before the ditching had been done made it really impossible to establish absolute legal proof of the effect of the changes in ditching of the farm land upon the flow of the river below.

An interesting example of the reverse effect is shown by Devils lake, North Dakota, which at the time when white men first settled in any number on its shores, fifty-two years ago, had an area of 115 square miles. The tributary drainage area around it and especially to the north extending to the Turtle mountains and the international boundary, including the lake itself, is 3,500 square miles, from which the run-off would theoretically reach the lake. However, the lake had no outlet or chance to overflow unless it rose about 20 feet above its height when originally seen; and from the lake surface there was every year a gross evaporation of about 33 inches, while only 18 inches per year of rain and melted snow was falling directly on to the lake surface.

A little arithmetic shows at once that to replace each year the evaporation and keep the lake at a uniform level would consume an annual run-off of one-half of one inch from the entire tributary drainage area.

As an historical fact, since the country was settled, the lake, though going up and down and rising almost every spring, has fallen until it is now about 25 feet lower than in 1883, and has broken up into several smaller lakes whose aggregate area is only about one-third of that of the original lake.

The most plausible and probably correct solution of this is that the breaking up of the native buffalo prairie, which in the early days was so smooth and hard that water ran off easily into the lake, and its cultivation as a wheatfield increased slightly its receptivity to the water and diminished by that much the run-off into the lake.' This need not be any considerable change in the figures for evaporation-transpiration; merely an increase from, perhaps, a 17½-inch annual total to 17⁵⁄₆-inch, would have the observed total effect on the lake.

Building of reservoirs, if large enough to have any considerable effect, has the reverse influence from ditching. It tends to delay or detain the floods, and to equalize the flow from month to month, although for the most profitable effect each dam should have outlet gates that can be artificially operated, opened or closed when desired.

So far as they have effect, power plant headgate reservoirs, municipal or power plant storage reservoirs, and flood detention all have an effect in the same direction, equalizing the flow, although operated differently. Storage reservoirs usually are operated so as to hold as long as practicable the water from flood periods, keeping the reservoir full with water stored for release during a dry period. Flood prevention reservoirs also receive and hold water during flood times, diminishing the flood severity down stream by that much; but the detained water is released as soon thereafter as practicable without injury, so as to empty the reservoir and make it ready to receive and detain another flood.

Small reservoirs in great number have been built along the smaller streams in Dakota and Minnesota during the past few years, though usually without release gates for definite operation. There are many places where large reservoirs are feasible, and will probably be established within a few years, in the effort to obtain partial insurance against the most serious effects of another series of dry years such as the past few years.

An excellent opportunity for such reservoir location is Red lake, in Minnesota, which is on the upper Red Lake river, a stream almost identically equal in average volume to the Red river where it joins the Red at Grand Forks. This lake, with an area of 440 square miles, is so large that it can serve as a storage reservoir and flood-prevention reservoir combined. If a depth of 6 feet is controlled by a dam at its outlet, and the upper 3 feet of this 6 is used as a flood prevention reservoir, it could be so operated as to reduce by about a foot the largest floods on the Red river at and below Grand Forks; the other 3 feet of reservoir storage being used to hold water for release at times of deficient flow, would be of value to the water-power companies along the Red Lake river and to the cities using it for municipal supply and they should be willing to pay the entire expense of maintenance and operation of the reservoir.

There are many other points of interest that might be mentioned or discussed fully in connection with this, such as the proposed Missouri river diversion plan, for taking in central western North Dakota about 1,000 second-feet of water from the Missouri river through a tunnel many miles long, turning it into the headwaters of the James river, and the Cheyenne river, and Devils lake, and other Red river tributaries, and into the Souris river valley, to the benefit of each of these in dry seasons. The final effect of this would be to increase the flow of some of these, and thus some small portion of it would reach Winnipeg. It could however be operated so as not to make the slightest increase in the flow during flood seasons (perhaps, for example, by the use of Devils lake as an excellent detaining reservoir), and during dry periods all would be glad to see the flow increased.

Another subject is the construction of fixed dams in the Red river, a so-called navigable stream, of which there are now several along the North Dakota portion, one at Grand Forks being about 10 feet high above low water. These however have been found to be very agreeable and beneficial in every respect except that they prevent through navigation; and there seems now to be no prospect that that will ever resume.

Another is the pollution of the streams by sewage from the cities. The population of North Dakota and Minnesota cities having sewers that discharge into the Red river or its tributaries is approximately 80,000; and besides these there is another 20,000 in the North Dakota cities on the Souris river, which empties into the Assiniboine, which also flows to Winnipeg.

At some points, in years of extremely low flow such as the last few record-breaking years, the streams have become for some miles an offensive nuisance, and at a few localities the normal flow is so small that this is the condition through a large portion of the average year. However, the installation of efficient sewage treatment plants is proceeding gradually, so that the equipment for this purpose is much better from year to year, and it is not likely that a serious hardship will ever be worked on Canadians by this pollution hereafter. Of course, this makes the river water unsafe for municipal or domestic use without careful treatment.

It is appropriate to quote a few paragraphs from the report of the International Joint Commission on the Pollution of Boundary Waters (between the United States and Canada) which reported about 1915, thus:—

"1. Speaking generally, water supplies taken from streams and lakes which receive the drainage of agricultural and grazing lands, rural communities, and unsewered towns are unsafe for use without purification, but are safe for use if purified.

"2. Water supplies taken from streams and lakes into which the sewage of cities and towns is directly discharged are safe for use after purification, provided the load upon the purifying mechanism is not too great and that a sufficient factor of safety is maintained, and further, provided the plant is properly operated.

"5. In waterways where some pollution is inevitable and where the ratio of the volume of water to the volume of sewage is so large that no local nuisance can result, it is our judgment that the method of sewage disposal by dilution represents a natural resource and that the utilization of this resource is justifiable for economic reasons, provided that an unreasonable burden or responsibility is not placed upon any water purification plant and that no menace to the public health is occasioned thereby.

"11. It is our opinion that, in general, protection of public water supplies is more economically secured by water purification at the intake than by sewage purification at the sewer outlet, but that under some conditions both water purification and sewage treatment may be necessary."

The Red river is now, and for years has been, polluted by sewage and other causes to a considerable extent, so that it is absolutely unsafe for domestic or municipal use without thorough careful treatment and purification. It is, and always has been, very irregular in the quantity of its flow, sometimes shrinking to a mere trickle scarcely navigable by any craft larger than a canoe, at other times rising in floods overflowing the banks even occasionally to widths of miles; thus it is undependable for use either for navigation or water-power. Both of these faults, and some others, have been or may have been intensified by the building of cities on its banks, and by artificial constructions such as drainage systems—although by certain types of artificial construction it may ultimately be improved.

However, the Red river of the North is the only river that flows by Fargo, Grand Forks, Pembina, Emerson and Winnipeg, into Lake Winnipeg. It may be susceptible of some improvement for safer and better use, but undoubtedly, whether it is good or bad, due knowledge of and recognition of the inevitable limitations are needed in order to make the best use of it.

Note:—Although there have been droughts in some localities of the drainage area this year, precipitation during the past two years has not been sufficiently abnormal to change the averages appreciably, or to make any higher maxima or lower minima than already recorded, and although the desirability of certain river improvement schemes has been taken up with Federal or state governments concerned, nothing has yet been started, though there is reason to hope that within another year something may be done.

Some Observations About Railway Rails

T. Lees, M.E.I.C.,
District Engineer, Canadian Pacific Railway Company, Calgary, Alta.

Paper presented before the Lethbridge Branch of The Engineering Institute of Canada, January 25th, 1936.

SUMMARY.—Notes on such points as the development of the present day rail, mechanical efficiency of rail haulage, stresses in track, composition and treatment of rail steel, wear of rails, and the occurrence and prevention of defects in service, particularly shatter cracks.

Before dealing with modern rails in some detail, let us inquire into some phases of the introduction of rails, their development, and also the work they now do.

The first rails were made of wood. There were few highways then and it was long before the advent of the steam locomotive. They were used with horse-drawn vehicles, more particularly in connection with the operation of coal mines in England. The conception was for the purpose of minimizing frictional resistance to traction so that much heavier loads could be hauled by the horses than would otherwise have been possible.

These wooden rails quickly became worn out so they were later reinforced with strips of cast iron plate fastened to the top. Later these cast iron strips were improved upon by the use of malleable iron strips and it was in this form that track to carry steam locomotives on the American continent was first constructed.

These so-called "snake rails" constituted one of the early perils of railway travel as it was no uncommon thing for some of these strips to become detached from their fastenings and, as the train moved, suddenly turn upwards causing a derailment, or perhaps even penetrate through the floor of a carriage and some unfortunate passenger would be impaled. It is said that in those days each train carried a sledge hammer and, whenever it passed over a loose rail or was leaving a "snake head" in its wake, it was customary to stop and make repairs.

The next advance was the use of light cast iron edge rails which were but 3 to 5 feet long, carried at their joints on stone blocks. These stone blocks were improved on by the use of longitudinal wood stringers and then the cross tie arrangement was devised which became universal and is still so.

The very early tracks including many of those for the steam railways were narrow gauge, but it was about the time of the transformation to the cross tie that the standard gauge was more generally adopted. It is sometimes a source of wonder that such an odd dimension as 4 feet 8½ inches should have been used for this standard. The story is that in England with the first edge rails on the Stockton and Darlington Railway (1825) it was the practice to lay them at 5 feet from the outside to outside of the rail head, which had a thickness of 1¾ inches. George Stephenson was later asked for his advice in connection with other English railway projects and said "Make them the same width. They may be a long way apart now but depend upon it they will be joined some day."

An interesting phase of early rail manufacture was the development of increasing lengths as weights increased. The cast iron rails were only up to five feet, then malleable iron rails were made from 12 feet to 15 feet long, but up to the year 1850 it is doubtful if there were any rails more than 18 feet in length.

About the year 1855 the first fish plate type of fastening for connecting the ends of rails came into use. Its basic principle is the same as that of our present-day fastenings.

Up to this time all rails used on the American continent were imported from Europe. The most important development in rail manufacture and track construction came with the advent of steel and the first steel rails were cast. They were manufactured in England and used on the London and North Western Railway.

A test begun in May 1862 demonstrated that the life of these cast steel rails, which were the reversible double head design, up to the middle of 1865 had been such that only one head had yet been in service, and they had worn out seventeen faces of iron rails in adjacent tracks with similar traffic, and these cast steel rails still had considerable remaining life in the one head, before they would have to be reversed.

The rolled steel rails were the next advance. The first in America were rolled in 1865, and are said to have cost $166 per gross ton.

From the date of the advent of steel rails, notable advances in every detail of track construction have been made so that today it bears but little resemblance to its early prototype. This progress has been essential to meet the increasing loads imposed by engines and cars. It may, in general, be said that the development of the steel industry has been collateral to the growth and importance of steam railways and their rolling stock, and that the problems that have required solution in that growth have provided the greatest single incentive for the improvement in its product.

The loads that were carried on the early railways were very small compared with modern equipment. It is a far cry from the first locomotives like the "Rocket" and "Tom Thumb" of a hundred odd years ago to modern engines, and even in comparatively recent years there have been great increases in weights and axle loads.

In the earlier fifties the average weight of a steam locomotive was 20 to 25 tons; in the eighties, 40 to 45 tons. In the nineties it had increased to 50 and 60 tons. From 1900 to 1910 they reached 100 tons and we are now operating engines weighing as much as 226 tons and having driving axle loads of 60,000 pounds and higher.*

So much for the inception and development, and now what are these rails for? What do they do? The answer is that they transport our commodities and carry passengers in, from our engineering view point, the most economical manner.

It is as true today as it was more than a hundred years ago, that rails "minimize frictional resistance to traction so that much heavier loads can be hauled." In the old days of horse-drawn vehicles, this was very apparent, but it was no more the case then than now although not so obviously demonstrated. However it can be made quite evident by the study of a few appropriate figures.

Having average grades and conditions, a steam locomotive will transport 1,000 gross tons a distance of one mile, consuming not more than 120 pounds of steam coal with a heat value of 12,500 B.t.u. per pound.

This is a heat consumption of one and one-half million B.t.u. and is equivalent to 75 pounds of commercial gasoline having 20,000 B.t.u. per pound. Ordinary gasoline weighs about 7.2 pounds per gallon, so the 75 pounds is equal to 10.4 Imperial gallons.

*C.P.R. engine "8000" loaded weighs 247½ tons.

Disregarding the much higher thermal efficiency of the internal combustion engine as compared to the steam engine, we deduce from this that to equal the performance of the locomotive on the railway, a loaded automobile having a weight, say, of two tons, should travel a distance with the 10.4 gallons of 500 miles or 48 miles per gallon. In other words, the gallon of gasoline should give about 96 ton miles of transportation instead of less than half that amount.

Fig. 1—Section of Rail on Victoria Bridge, Montreal, 1859.

The Canadian Pacific Railway operates some gasoline driven cars that weigh, when loaded with passengers, express, and baggage, approximately 80 tons. Under good conditions, these cars can accomplish two miles of distance on one gallon of gasoline or the equivalent of 160 ton miles per gallon, to equal which the automobile with its passengers would have to travel 80 miles on one gallon.

Recently there was the case of a small railway built only five years ago in the United States, twenty miles in length, called the Mound City and Eastern, in South Dakota.* For several years it was operated as an ordinary steam line and was losing money so that abandonment appeared inevitable. However, a pilot car arrangement was devised to run on these rails with a highway truck fixed in place so that the front end rested on a cradle carried by the pilot car and the rear wheels exerted their tractive effort on the rails.

The change from road to rail and vice versa could be made quickly, and what was the result? This novel power unit consisting of a 1½-ton truck hauls trains of cars. A double header one day handled 23 empties and 23 loads of live stock, the loads requiring only three trips and the empties, because of adverse grades, required four; 450 net pay tonnage was hauled that day, by two trucks in three and a half round trips.

This railway is now showing profits and abandonment is no longer being considered. In addition to the lesson that frictional resistance was minimized by the use of rails, there is another one concealed, which is that, because formerly a steam railway, they had to use five men on a crew to comply with the law; by the new method there are but two men on a single unit train and the conductor is the only full-time man, and when not engaged in this unique type of train service he gets a lot of odd jobs to do.

The weights of modern locomotives have already been mentioned. To impress this, let us refer again to the highway. The heaviest capacity trucks operating on Alberta highways are 15 tons, and there are but few of these. Compare these with the haulage capacity of the locomotives. One of the engines on a railway having fair grades, will pull about 2,000 tons of freight in one trip, the equivalent of two hundred trucks with an average of 10 tons contents, which is high.

A class 'A' railway in this country is a section that in addition to having passenger trains at a speed of over 50 miles per hour, hauls over 8,000,000 tons in freight trains per annum. This is comparable to our transcontinental main lines. Can you visualize 8,000,000 tons of freight per annum being hauled by trucks between, for example, Calgary and Medicine Hat, in a year—the contents of at least 800,000 trucks—2,200 per day.

The low frictional resistance of the rail will have been abundantly demonstrated long before such a transfer from it could possibly occur, and if natural economic laws are not interfered with, the railway will continue to serve for a long time.

Now to pass to the consideration of a modern rail. As development has resulted in heavier motive power and rolling stocks, it has been necessary to increase the weight of rails. Thirty-five years ago there would be very few if any rails weighing more than 56 pounds per yard. Today many miles of track in Canada are laid with rails weighing 130 pounds per yard. Canadian Pacific Railway standards are 130 pounds for very heavy main track service, 100 pounds for most main line services, and 85 pounds for branch lines.

In earlier years, rails for Canada were purchased in Europe. The Canadian Pacific Railway bought its first Canadian-made rails in 1905.

The rails generally constitute the most expensive unit of outlay in the construction of a railway. Their life depends on traffic density, and on grade and curvature. On straight track with fairly heavy traffic, good rails carefully maintained may last about twenty years; but on the other hand, where there are sharp curves, and especially when there are also steep grades, they may only wear for four or five years. There are even very busy lines on which rails may not last for one year until they become so worn that they must be replaced and relegated to a minor branch line.

Until recent years, the greatest difficulty in the way of longer service from rails not subject to curve wear, has been joint batter. Rails not otherwise worn, would frequently require removal for this, and then would be shortened by having the ends cut off, and put back into service on some less important line. Now, however, these battered ends are welded up and in this way preserve the entire length of the rails for normal wear throughout.

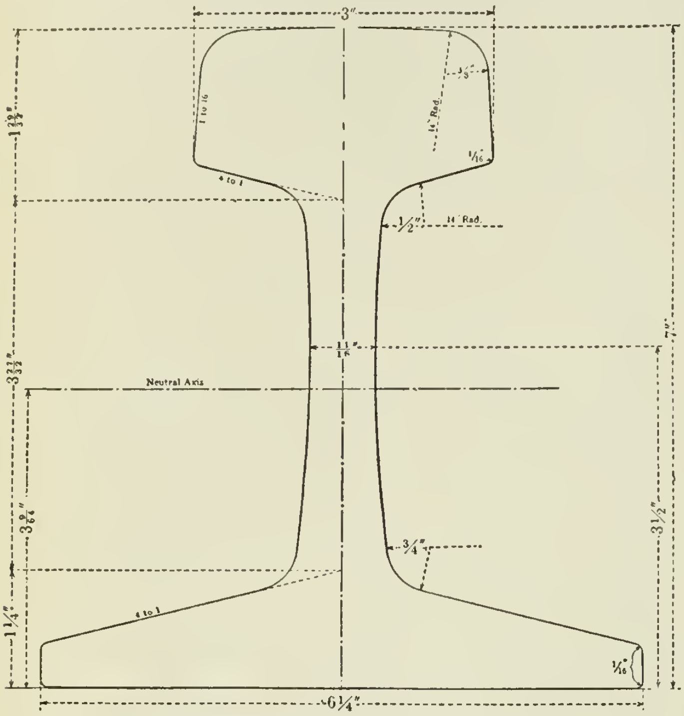
A most important matter in regard to rails is their manufacture, the processes of which have been materially improved. Years of intensive study have produced rails that are claimed by the manufacturers to be of much better quality than those earlier rolled steel rails, as in fact they are, but still we have a good many defects that develop from these modern rails, subjected to such severe service.

In the old days of railroading, the bridge engineers used to design the bridges to carry the heaviest locomotive on the line. Then later came Theodore Cooper with his loading series which is now universally used in the design of railway bridges. At first, what was called Cooper's E27 was used. This was for two engines coupled together, having 27,000 pounds axle load on the drivers and pulling a train with a weight of 2,700 pounds per lineal foot. When Cooper's loading got up to E40, it was considered that it would represent the heaviest load for many years, and then when surprisingly it was found that Cooper's E50 was required, viz. 50,000 pounds on the driving axles of two engines coupled, and hauling a train having a weight of 5,000 pounds per foot, it was beyond any doubt that

*See Railway Age, November 23, 1935.

this would not be exceeded, and indeed in European railways, it has not been exceeded. In this country, however, and in the United States, the size of our engines was increased and the weight of our trains until now we need to design our bridges to Cooper E60 and there are engines with axle loads as high as 70,000 pounds.

The function of a rail being to transmit these wheel loads to the ties, in order to do so it must be of adequate strength, be manufactured to the most rigid specifications



Courtesy of Am. Railway Engineering Association.
Fig. 2—Rail Section—R.E.C. 140-Pound.

and possess a head of such shape and hardness as to stand the pound and wear of wheels. Rails must also be of sufficient girder strength to avoid undue stress. A great deal of study has been applied to the design to meet these requirements and the greatest progress on this continent has been made since the inception of the American Railway Engineering Association in 1899. During the thirty-six years of its existence much has been accomplished with the co-operation of the railways.

The committee on the Stresses in Track under the chairmanship of Professor Arthur N. Talbot of the University of Illinois, has performed a most valuable service since its inauguration in 1914. This committee has conducted many tests on actual track as well as in the laboratory and their findings have probably been the greatest single contribution to the knowledge of these stresses. The rail committee of the same organization has also provided us with very valuable information.

The greater fibre stresses appear to occur generally in the base of the rail, due to those for lateral flexure being superimposed on those of vertical bending.

On the Illinois Central Railroad, one of their heavy locomotives running at a speed of 50 miles per hour produced some very high stresses in some lighter rails. With the 100-pound A.R.E.A. rail, however, the fibre stresses varied from 28,000 pounds per square inch on the best road bed, to 32,000 pounds per square inch on the poorest. With the 130-pound A.R.E.A. rail the similar figures are given as 20,500 to 24,500. Girder strength is attained by increasing the section modulus, and comparatively few modern rails fail from the cause of lack of strength in that respect. The section modulus of a 100-pound rail is about equal to that of a standard 9-inch I beam.

Bending stresses in the track and from gagging when straightening rails at the rolling mills are within safe limits, and are therefore not generally responsible for the introduction of internal strains of high degree. The causes of rail failures in the track must therefore be looked for elsewhere, but it must be borne in mind that a rail cannot be designed with any mathematical nicety, but rather from experience, as the imposed conditions and therefore the duty and stresses must be variable to a rather wide range.

In point of fact a rail is a continuous girder. The problem of finding the bending moments in a continuous girder has formed the subject of many learned and extensive treatises, and a definite mathematical theory has been successfully built up. It could not, however, be applied to the calculation of rail stresses in view of the varied conditions and the yielding supports. There are therefore still a few rail breakages not due to any flaws.

The chemical composition of steel rails is a matter of importance as they must not be so hard as to lose too much ductility. The properties of steel most commonly desired are strength and ductility. Unfortunately, there is more or less incompatibility between those two. That is to say, as the strength of the steel increases, the ductility usually decreases; and conversely, as the ductility increases, the strength usually decreases.

In a rail, there must be sufficient strength to resist the high fibre stresses of bending and the metal must be hard enough to successfully withstand the high concentration of pressure that results from the heavy wheel loads and also to prevent batter from flow at the rail ends.

These requirements call for a high carbon steel, and the usual composition for ordinary open hearth 100-pound rails in Canada is:

Carbon, 0.62 to 0.77 per cent.
Manganese, 0.60 to 0.90 per cent.
Phosphorus, not to exceed 0.04 per cent.
Silicon, 0.10 to 0.20 per cent.
Sulphur, not to exceed 0.055 per cent.

The general effects of these elements in the steel are as follows:*

Carbon gives an increased tensile strength until a maximum of 0.8 to 0.9 per cent is reached.

Manganese benefits the tensile strength only when it is over 0.3 to 0.4 per cent.

When manganese in steel is over 1 per cent, the metal becomes hard and somewhat brittle, and these qualities increase in intensity with every increase in manganese until when there is 4 per cent to 5.5 per cent, the steel can be powdered under the hammer.

But as manganese is increased still further, these properties do not increase, and when 7 per cent is reached an entirely new set of properties begins to appear. These are well marked at 10 per cent and reach a maximum at 12 per cent to 15 per cent, and then there is what is called manganese steel.†

Phosphorus increases the strength but this is accompanied by a much greater decrease in ductility than when the same increase in strength is obtained through the medium of carbon.

Silicon. The effect on strength is probably very small in the case of rolled steel. In the case of castings, however, an important increase in tensile strength may be obtained by increasing the silicon to 0.3 per cent or 0.4 per cent. This practice results in practically no decrease

*See "Metallurgy of Iron and Steel" by Bradley Stoughton, pages 340-349.

†See Stoughton, page 435.

in ductility, but it is necessary to supply larger risers on account of the deep piping produced.

Sulphur is limited by the purchaser to amounts which will insure the ductility desired, and the manufacturer must limit it in order that the steel will roll well.

The physical qualities of ductility and resistance to impact of steel rails are ascertained by a standard drop test. The ultimate tensile strength of a high carbon open hearth steel such as that indicated, should be not less than 120,000 pounds per square inch with a yield point of about 60,000 pounds per square inch.

In good strong and stiff track, the rail stresses should be well below that. Stresses that are too high for such steel may sometimes occur even with adequately heavy rail if the track is undermaintained or where unbalanced rolling stock has been permitted to run at a high rate of speed. Apart from unbalanced equipment, which should, of course, not be operated beyond a safe speed, the remedies for rail overstress resulting in damaged or broken rails consist entirely of better track conditions including adequate well drained subgrade, ample thickness of good ballast, and large stiff cross ties, all coupled with sufficient labour to keep the track well tamped up in prime surface and line.

All these conditions signify lessened stresses, but track labour intelligently applied is the bulwark of it all, the others losing their economical effect in proportion as the effectiveness of the track labour declines. However, for the best results, an adequately strong and stiff rail as a most important part of the structure is an absolute necessity for heavy fast traffic.

The standard length of rails usually adopted today is 39 feet. Every step in their manufacture is closely inspected and the resulting rails are carefully classified and used in the track according to certain rules laid down for each class. They bear distinctive marks for classification by prick punch and different colours painted on the ends.

First quality full length rails satisfactory for any main track service bear no mark or colour except that rails from the top of the ingot, after the discard, are coloured on the ends, for identification so that they can be laid in stretches together for closer observation as, being from the top, they are more susceptible to defects due to gases in the molten ingot rising.

It would take too long to go fully into other classifications, but they vary from first quality to other rails that while not suitable for any main track use, a small proportion are yet accepted and used for the siding side of switches. These matters are mentioned to indicate that the acceptance of a shipment is not merely taking delivery of so many car loads and using them indiscriminately as just rails. There is a big responsibility involved in the correct acceptance and distribution of a consignment, just as there is a similar responsibility in regard to correct marking, resting upon the inspector at the mills.

An interesting aspect of the service demanded from rails relates to the intensity of pressure of the loads as transmitted from the wheels to the rail head, which has also been the subject of some inquiry.*

The apparent areas of stationary and rolling contacts were found by means of very thin copper strips and, dividing the known loads by these areas, it has been calculated that after comparatively small loads, the intensity of pressure appears to become fairly constant due to the fact that the area of contact increases about proportionately to the increase in load, but this is only a general statement.

The results of the experiments that the author has been able to find record of are not uniform, and a great deal depends upon the distribution of the contact across the head. The indications are that when wheels and rails were, in general, well adapted to one another, the intensity of pressure may be moderate, although sometimes it is as high as 80,000 pounds per square inch.

If but one wheel contour and but one rail contour existed and could be maintained, this would go far towards settling the question, but it must be remembered that with the existing diversity due to modifications of the original contour produced in service, the ideal condition is not likely to be reached.

Pressures as high as 150,000 pounds per square inch have been found to result from existing loads causing very severe kneading in the steel and rapid rail wear, from which it would appear that the practice of allowing wheel contours to depart too widely from the original standard before renewal or re-turning, is at the direct expense of more intensive punishment to any rail section that can be devised.

As already mentioned, rail failures are in general caused by defects, and it may be of interest to discuss these. They are not, of course, visible during the rolling, and as all processes of the manufacture are subject to rigid inspection, every possible care has been taken to obtain perfection.

When the rail metal is homogeneous and of the prescribed strength, they should last until worn out by abrasion. Rail wear is being constantly studied, not as a factor in breakage, but in an effort to obtain metal of greater resistance in order to bring about economy in renewals.

Rail metal however is, sometimes, not homogeneous and then the rails may serve for a while, frequently for several years, but sooner or later defects develop under traffic and necessitate removal. Defects that become visible are generally due to a laminated or segregated condition. They are described as: flowed head, crushed head, split head, split web, separation of the web from the head, piped rail, and so on.

Such cases are always being very carefully watched for, and as it becomes necessary, the rails concerned are replaced.

The defects that do not become visible before resulting in failure are the most difficult to deal with, and indeed until within recent years, were impossible to locate. They are designated as transverse fissures (about which it may be said that very few had been reported before 1900, and they were not generally recognized until about 1911), and compound fissures. Several of them may exist in one rail.

They tend to occur in particular rollings, as well as in certain heats of these rollings, and a heat in which several fissured rails have been found is considered "suspicious," as it is likely that others will develop in the remaining rails of that heat. Transverse fissures are the most dangerous type of rail defects, because they cannot be discovered by visual inspection until they have grown large enough to reach the surface of the rail head, long before which the girder strength is so seriously impaired that failure generally occurs.

In the year 1923, the late Dr. E. A. Sperry discussed transverse fissure rail failures with some of his friends in Chicago, and learned how they grew. The fact that these were explained to him as a "rail cancer" and that they grew like cancer in the human body impressed him very forcibly.

In 1927 he perfected in a laboratory a device which actually detected them. In that year an experimental car equipped with the apparatus was tested on track near New York, and after some difficulties had been overcome, the Sperry detector car was turned out in 1928. There are now several of these, owned by the Sperry Rail Service Corporation, and operated over the railways under con-

*A.R.E.A. Proceedings 1920, from page 1145.

tract.* The period between tests varies according to density of traffic.

This system of testing has come into general use on important lines and many thousands of these hidden defects have thus been found and the rails promptly removed.

It is very obvious that this method of detection of these hidden perils has been a great step, but until rails can be produced that will not be susceptible to this type of failure, the situation cannot be considered satisfactory.

Courtesy of Sperry Rail Service.
Fig. 3—Head Check (Detailed Fracture). Note growth of crack from gauge side.

The transverse fissure is the most insidious and dangerous type of failure and is quite prevalent at the present time, occurring even in the heaviest sections. Perhaps the exact cause has not yet been quite definitely determined, but most encouraging progress has lately been made. The late Dr. Howard, engineer physicist of the United States Bureau of Safety, several years ago contended that the transverse fissure was a result of wheel loads beyond the capacity of steel in the form of rails to withstand.

In 1931 an American correspondent to the International Railway Congress, writing to England, took a gloomy view, saying "The question immediately presented is as to whether service conditions of today have not practically destroyed the residual elements of safety in all grades of steel."

Transverse fissures are not unknown in Great Britain, but, far from occurring by the hundreds as in the United States and Canada, they are still a comparatively rare defect, and no derailment or other casualty has as yet been attributed to their presence in British rails.

The reason, which, over there, they have given for the difference in respect to this type of rail failure as between the two countries, has been the addiction of American rail users to extremely high percentages of carbon increasing out of all proportion the sensitiveness of the steel during cooling.

The report in this connection mentions that the analysis of the rail in question gave a carbon content of 0.75 per cent, whereas in normal British practice no higher carbon content than 0.65 per cent is permitted. The report goes on to say that Americans are in a quandary, as with axle loads exceeding 30 tons as compared with the British maximum of 20 to 22½ tons, the punishment suffered by the rails is such that, unless a very hard quality of steel is used, they fail by mashing.

There is no doubt some truth in these observations from Great Britain, but in the last few years, a good deal of progress has been made which it is hoped will soon show the definite way out of past difficulties.

It is a matter of common railroad experience, especially in Canada and the Northern United States, that rail failures are more frequent in cold weather than in warm weather.

There are two general types of explanation offered for this:—

(1) Changed track conditions due to the low temperature.
(2) Changes in the physical properties of the steel at low temperatures.

In regard to the first, extensometer tests have been made and some increase in dynamic augment of wheel loads was noted.

In regard to the second, during the past year† a series of experiments has been conducted under the auspices of the American Railway Engineering Association in the cold room at the Wright Flying Field, Dayton, Ohio, to determine the effect of low temperatures on rail steel. Evidence was obtained that the general tendency is for a small increase in strength properties as temperature decreases to −40 degrees F., but brittleness increases.

The increased tensile strength to zero temperature was found in all three specimens tested, but in only one was there a further increase to −40 degrees F., in the other two there was even a slight recession in that feature. Averages of three specimens in tensile strength were:—

At +50 degrees F.	135,000 pounds per square inch.
At zero F.	139,000 pounds per square inch.
At −40 degrees F.	137,000 pounds per square inch.
At −50 degrees F.	134,000 pounds per square inch.

There apparently is not sufficient difference to justify increased failures, but we also have the decrease in ductility.

The high carbon steel that is used for rails in this country appears to behave in these low temperature conditions like a slightly more highly tempered product would in normal temperature conditions and it would appear as if the loss of ductility added to the augment in the dynamic loads would account for a sufficient difference in the service conditions to result in the increased failures during cold weather.

Courtesy of Sperry Rail Service.
Fig. 4—Horizontal Split Head.

During all these discussions, American and Canadian railway engineers have considered the transverse fissure type of failure to be due entirely to some mill condition. All of course agreed that the fissures developed under traffic.

Continued study developed the fact that whenever a rail was found to have a transverse fissure there could be seen, by etching the metal of the head, minute separations or checks in the granular structure which are designated

*See The Engineering Journal, December 1933, H. B. Titus, "The Detection of Internal Defects in Steel Rails."

†Page 1083, A.R.E.A. 1935.

as shatter cracks. It was also found that, conversely, rails having no shatter cracks did not develop transverse fissures. The results of investigations, as well as the experience of rail manufacturers and users for the past several years, has placed emphasis on shatter cracks, which are the result of strains set up by unequal cooling in the rail head after the rolling.

So far the processes proposed and in commercial use for the reduction or elimination of shatter cracks are:—

(1) A controlled cooling of the rail.

(2) The cooling of the rail through its critical stage, followed by reheating above the critical range to give a grain refinement, followed by cooling in air.

The latter is the special normalizing process perfected by the Illinois Steel Company, who claim that it produces rails with greater ductility, resistance to impact, wear and end batter as well as being believed to eliminate those conditions which give rise to transverse fissures and other interior defects.

The process is said to be the result of more than twenty-five years of research on the part of the rail producing subsidiaries of the United States Steel Corporation. They had found that in cooling from the molten state, the steel passes through numerous stages, one of which is known as the critical range, in which important changes take place in the character and properties of the metal. At a somewhat lower temperature it enters what is known as the brittle range, when it is again subjected to important internal influences.

In applying the normalizing process the rails, after rolling, are allowed to air cool until the temperature in the interior of the section is slightly below the so-called thermal critical range, but above the thermal brittle range. They are then placed in a furnace and reheated under careful control until the entire section has reached a uniform temperature slightly above the thermal critical range. They are then removed from the furnace and blasts of compressed air are applied to the top of the head at both ends of each rail for a sufficient time to bring about the desired hardness at these particular locations.

The most severe and searching tests that can be devised for application in the laboratory are reported to have indicated that normalized rails are markedly superior to those cooled by ordinary processes. Rails produced by this special process in an experimental furnace have been laid in test sections on a number of railways in the United States and in locations to include a wide range of conditions. These are being watched closely and compared with similar rails that have been cooled on the hot bed in the usual way.

The other method mentioned for minimizing these shatter cracks, namely, controlled cooling, is even more interesting as it has been applied commercially during the last four years and was developed in Canada. It is the so-called "Mackie process" and was devised by Mr. I. G. Mackie, engineer of tests for the Dominion Steel and Coal Corporation. It is claimed that it accomplishes the following improvements:—

(1) Entirely prevents internal ruptures in the rail head which develop when allowed to cool naturally.

(2) Produces a rail in which internal cooling stresses are decidedly reduced.

(3) Produces a tougher rail which stands up much better under the falling weight test, especially when made with the base uppermost.

(4) Accomplishes all the above without affecting the Brinell hardness of the rail, or its deflection under the drop test.

In the investigations at the Dominion Steel and Coal Corporation, it had been early discovered that shatter cracks occurred at a comparatively late stage in cooling, long after the rails had ceased to be visibly red hot. By retarding the cooling sufficiently while passing through the dangerous temperature range, cracks were prevented. This dangerous range was found to be below 660 degrees F. and an entirely safe degree of retardation was effected merely by stacking a fairly large number of cooling rails closely together inside sheet iron enclosures, sealed at the bottom to prevent currents of cool air.

The following describes the Mackie process as actually employed at the mill.

Rails are allowed to cool naturally on the ordinary cooling beds to below 900 degrees F. Then before they have reached 660 degrees F. they are assembled in groups of four or five, the heads being turned up and lifted by a magnet crane. They are then stowed in large sheet iron boxes, each of which will hold about 120 rails of 130 pounds per yard section. When filled, a cover is placed on each box and the rails are allowed to cool slowly for twenty-four to thirty hours, by which time they have reached a temperature within 100 degrees F. of the surrounding atmosphere. They are then ready to be discharged and the finishing operations of straightening, drilling, etc., performed.

It is stated that since the development of the process, many thousands of Mackie process rail samples have been etched in strong acid and compared with similar rail pieces allowed to cool naturally. Although many of the latter samples are free from cracks, some contain cracks to a greater or less degree, whereas the Mackie processed rails are always found entirely free from this defect. Both the large railways in this country are now specifying exclusively rails treated by this process.

There are only two rail mills in Canada, the Sydney mill of the Dominion Steel and Coal Corporation where the process was developed, and the mill of the Algoma Steel Corporation at Sault Ste. Marie, Ontario. The Algoma Corporation, several years ago, was granted a license under the Mackie patent and installed the necessary equipment for retarded cooling. The first Mackie processed rails were produced at the Sydney mills in 1931. Up to September of this year, 225,000 tons of Mackie processed rails have been produced by Canadian mills, some of them for export.

The Canadian Pacific Railway has 17,000 tons of 100 pound, and 24,000 tons of 85 pound Mackie rails now in service, and it is felt that they will be free from shatter. Although it has not yet been definitely proved that a shatter crack is necessary to the formation of a transverse fissure, there is now ample evidence that shatter cracks are intimately concerned in many fissures, and strong presumptive evidence that they may be the essential pre-formation requisite in all fissures.

The new treatment is, therefore, being adopted with a considerable hope that transverse fissure failures will be minimized. For these "Mackie" rails, there is used a supplement to the general rail specifications so as to provide that they will be branded with the word "Mackie," but that only when the test pieces show no sign of shatter cracks will the premium for the special process be paid.

The author has faith in rails, and in their still further development. Granting the usefulness to the public and even the need of other forms of transportation, he believes that when the true costs of operation are set up against the service rendered, and when equitable regulation has been provided, it will be found that rails will retain their major position in the transportation world for the reason that they are still the medium for cheaper and safer shipments of freight and for the carriage of passengers than can be offered by any other means.

Trends in Aviation Lighting in the United States

Dr. F. C. Breckenridge,
In charge of Aviation Lighting Research, National Bureau of Standards, Washington, D.C.

Paper presented before the Aeronautical Section of the Ottawa Branch of The Engineering Institute of Canada, September 4th, 1936, and published by permission of the Illuminating Engineering Society*

SUMMARY.—Two U.S. Department of Commerce specifications covering the installation and performance of airport lighting equipment are analyzed. The requirements for the more important items of equipment are outlined, novel methods of specification are pointed out and departures from standards previously considered satisfactory in the United States are emphasized.

Introduction

Among the projects which the Congress has authorized to be carried out with W.P.A. funds is the improvement of airports, including their lighting. This authorization made government funds available for the purchase of considerable quantities of airport lighting equipment and made it necessary to prepare as complete specifications as the urgent demand for their immediate use would permit.

The Airport Section of the Bureau of Air Commerce was given the responsibility for the preparation of these specifications and assigned the task successively to three members of its staff. Mr. A. P. Seeley began the work, Mr. Paul Morris carried on through the thick of it, and Mr. H. J. C. Pearson brought it to a useful conclusion. With all three it was the writer's privilege to collaborate. Throughout the work, the authors of the specifications have profited by the constructive criticism of the illuminating engineers of practically all the companies that are actively engaged in building aviation lighting equipment in this country.

It was evident that the specifications must meet three tests. They must contribute as fully as possible to the safety of air transportation. They must stimulate and not impede the art of aviation lighting. They must deal equitably with all makers of aviation lighting equipment.

To meet these tests it was felt that the specifications should be drafted more broadly than is generally customary for purchase specifications, that the requirements should be strictly limited to performance requirements with no more limitations on the means of attaining the performance than reliability and efficiency require. It also seemed proper to utilize generally accepted specifications such as the Federal Specifications, the specifications of the Air Navigation Division, and the Underwriters' requirements.

In another respect the specifications are unusual. It has been necessary to design them for unusually flexible application. In some cases they may be used for a blanket contract covering the furnishing and installation of a complete airport lighting system ready for use. In other cases they may be used for the purchase of one or two items of equipment with no services at all furnished, all the labour being provided by the W.P.A. In still other cases it may be desired to contract for certain items of equipment and for the technical supervision necessary for its installation by W.P.A. workers. The specifications have been designed to serve in any of these circumstances.

Organization of the Specifications

At the time of the writer's first contact with these specifications, their general plan had already been adopted. In accordance with that plan they were to be developed under two titles: (1) "Standard Specifications for the Installation of Airport Lighting Equipment and Materials" and (2) "Performance Specifications for Airport Lighting Equipment and Materials." The installation specification is intended for the use of the various airport sponsors who are equipping airports with the aid of W.P.A. funds. The performance specification is a basic specification containing technical requirements with which the airport sponsors need not be personally familiar. In view of the intended use, the titles are not altogether happy selections since it is impossible to eliminate all performance requirements from the installation specification and it is essential to include many testing requirements in the performance specification.

The first part of the installation specification, about one-fifth of the whole subject matter, relates to general requirements. Following the general requirements are the specific requirements for the various types of lighting equipment. The last third of the specification is devoted to requirements for wiring and wiring devices.

The performance specification contains three general sections and seven sections devoted to specific types of lighting equipment. Of the general sections the first sets forth definitions of contractual terms; the second gives the definitions of the aviation colours together with requirements for testing the colours of lighting equipment; the third section gives the definitions of technical terms used in specifying the performance of equipment, and also instructions for photometric measurements. The types of equipment covered in the two specifications are listed below:

Rotating airport beacon	Wind cone
Intermediate airport beacon	Wind tee
Airport code beacon	Automatic control of lighting
Code beacon flasher	Landing-area floodlight system
Beacon tower	Ceiling projector
Boundary-light units	Alidade
Boundary-light circuit	Clinometer
Obstruction-light units	Parabolic hangar floodlights
Field-approach lights	Fresnel hangar floodlights
Contact lights	

In many cases it was found advisable to include in the specifications material intended primarily as information for airport sponsors. An outstanding case of this is Section 19 of the installation specification which is devoted to recommendations regarding the selection of equipment to meet the needs of various types of airports.

The preparation of the specifications led to several innovations in the manner of specifying the various types of equipment, and these are discussed in the remaining sections of this paper.

Airport Beacons

To specify an airport beacon by its performance and, at the same time, not to specify any particular model of beacon, presented a problem. Obviously two beacons having beams of the same maximum candlepower, but of different divergence, will not be equally visible under all conditions. On the other hand, to require a specified divergence, stated as a certain percentage of the maximum candlepower, places a penalty on a high maximum candlepower. To obtain a characteristic which is more representative of the actual visibility of a beam, the concept of "integrated horizontal intensity" has been introduced. This is defined as "the integral, or summation, of the area under the curve showing the horizontal candlepower distribution taken between the angles on either side of the axis of the

*"The Airport Lighting Specifications of the Department of Commerce," paper presented by Dr. Breckenridge before the thirtieth annual convention of the Illuminating Engineering Society, Buffalo, N.Y., August 31st to September 3rd, 1936. Publication approved jointly by the directors of the Bureau of Air Commerce and the National Bureau of Standards, Department of Commerce.

beam at which the candlepower first drops to 10 per cent of the specified axial candlepower." The candlepower distribution curve is to be drawn in rectangular co-ordinates and the unit area is that represented by a rectangle, the height of which corresponds to one candle, and the width of which corresponds to one degree. The combination of requirements setting minimum values for the axial intensity and for the integrated horizontal intensity insures a beam that is adequately powerful at its maximum and contains

Courtesy of Canadian General Electric Co.
Fig. 1.—Lethbridge, Alta. Airport, showing Boundary Lights, Revolving Beacon and Floodlight.

a sufficient cross section of luminous flux to give a good signal.

It has been found convenient to make a differentiation between beam spread and divergence. The beam spread has been defined in the usual manner to include the diverging light on both sides of the axis of a beam. The divergence, on the other hand, has been defined as an angle on one side of the axis only. It is believed that this differentiation between beam spread and divergence would be found a very convenient one if it were generally adopted.

The intermediate airport beacons constitute a new category set up to cover a recently-developed type which seems to have real merits for certain applications. These beacons, by virtue of their long flashes and high angles of vertical divergence, are especially adapted for visibility at relatively short distances in bad weather. They approach more nearly to the British theory of aviation beacons than any beacon previously developed in this country.

The requirements for codes flashed by airport code-beacons introduce a change in the relative lengths of some of the code elements. These requirements are based upon some unpublished experimental work done by Mr. J. A. Bartelt at the National Bureau of Standards several years ago. This work indicated that for the 500-watt lamp commonly used in those beacons, a period of 0.3 second is necessary to allow the lamp to reach approximately its full candlepower. The experiments also showed that it is very difficult for the average observer to differentiate between eclipses which have durations in a 5:3 ratio. For this reason the eclipse between repetitions of the code signal has been specified as nine times the duration of the dot flash, instead of five times the duration of this element.

Boundary, Obstruction, and Other Marker Lights

Boundary-light practice in the United States presents an unfortunately and unnecessarily confused picture. Many types of lamps and glassware are being used. Some of the glassware is inherently inefficient, and some of it is rendered very inefficient through the use of wrong lamps. In general, little or no effort has been made to make the candlepower of the red and green units equal to that of the "clear" or "white" units. A conference was held with lamp manufacturers, and the lamps available for boundary-light use carefully considered. As a result of this conference the requirements for boundary lights have been based upon the use of four types of lamps—two for multiple circuits and two for series circuits. For multiple circuits a 15-watt general-service lamp without frosting and a 60-watt traffic signal lamp have been selected. For series circuits a 320-lumen, 6.6-ampere lamp and a 1,000-lumen, 6.6-ampere lamp have been adopted as standard. The two multiple lamps have the same base and approximately the same light-centre length, and, similarly, the series lamps are interchangeable in these respects. This makes it unnecessary for any airport to have on hand more than one type of boundary-light fittings, and reduces by half or more the types of fittings which manufacturers must carry in stock. A similar simplification in practice has been brought about by adopting the threads heretofore used on series units as standard for both series and multiple units. This not only has the advantage of making the glassware interchangeable between series and multiple units, but also is more convenient for the airport mechanics as the threaded neck provided on the old multiple units was so small that it was not possible for the average mechanic to insert his hand into the glassware to clean it. The adoption by all airports of the standard lamps, and, as soon as feasible, of the standard fittings and glassware, is strongly recommended in the interests of efficiency. A comparison of the additional cost of refracting glassware for boundary lights with the cost of the additional electric power and copper to conduct it, which are necessary to make the non-refracting glassware as effective as the refracting glassware, convinced the Airport Section that efficiency dictates the use of refracting glassware for boundary and obstruction lights.

It is generally held that boundary-light circuits for large fields should be of the series type but that multiple circuits are more economical for small airports. In selecting lamps for the two types of circuits, it was found to be impracticable to obtain series lamps of as low wattage and light output as the multiple lamps which have been considered satisfactory. Since series circuits are generally used at the larger airports, which are likely to be located in metropolitan areas where competing highway lights add to the difficulty of finding an airport from the air, it seems reasonable that the series lamps should be of higher candlepower. In comparing costs based on the use of the recommended lamps, however, it must be borne in mind that the systems compared are not equally effective.

At the time Section 19 of the installation specification was written, the best information we were able to obtain indicated that for fields larger than 12,000 feet in perimeter, the multiple system would be more expensive than the series system. Subsequently it was found that these estimates were based upon unnecessarily expensive equipment for the multiple system and did not sufficiently consider operating costs. It therefore seemed advisable to make our own estimates of the costs of the series and multiple systems. In making these computations, it occurred to Mr. A. L. Lewis of our staff that a 550-volt multiple system with individual transformers at each unit might be less expensive than either the 230-volt system or the series system. We therefore included the 550-volt multiple system in our estimates. Figure 2 shows the costs, exclusive of labour costs, for installing a series system, a 230-volt multiple system and a 550-volt multiple system. Labour costs are omitted from these estimates because we have no means of determining what they would be. So far as we have been able to learn, the labour costs of installing the series and multiple systems are equal and would not, therefore, affect the conclusions to be drawn from these figures. Figure 3 shows the total operating costs for the three systems. The unit costs assumed for these estimates are shown in Table I.

In computing operating costs, 10 per cent of the installation cost has been allowed for depreciation and 5 per cent of one-half the installation costs has been allowed for interest. Interest has been allowed on only one-half the installation cost because the depreciation allowance will, in effect, cut the average amount outstanding during the life of the installation to one-half its initial cost. The exclusion of the labour costs makes the figures lower than they should be, but affects all of the costs equally. It is probable that the use of booster transformers, which would make it possible to use smaller wire for the 230-volt multiple circuits, would reduce the cost of such circuits slightly. We have not had an opportunity to investigate this.

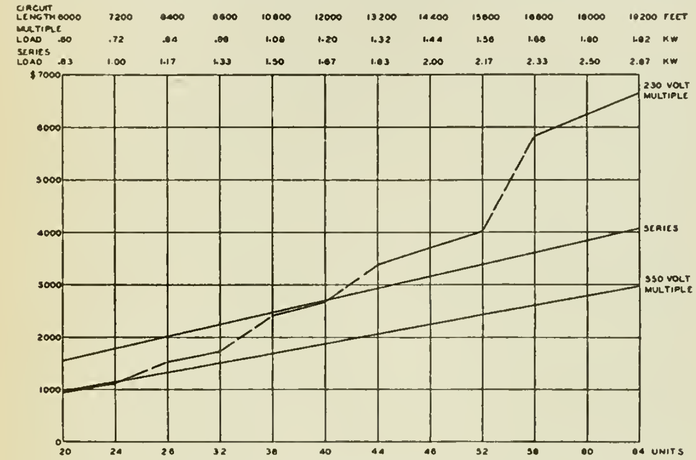


Fig. 2.—Estimated Cost of Materials required to Install three types of Boundary light circuits*.

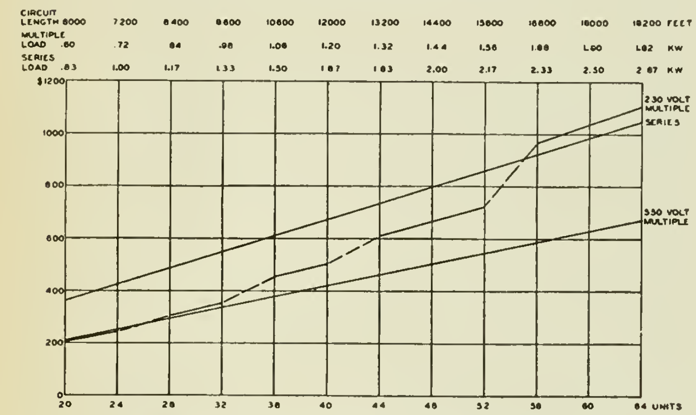


Fig. 3.—Estimated Annual Costs exclusive of Labour, for three types of Boundary Light Circuits*.

In addition to the considerations of cost and candlepower, the choice of boundary-light circuits may be influenced by considerations of safety. Many airport engineers consider the multiple system safer than the series system because the maintenance of airport lighting equipment is generally entrusted to personnel who are not adequately trained in the use of the series system. It should also be pointed out that the multiple system, especially the 550-volt system, is more elastic and can be more easily extended to include additional lights than is the series system. In view of these facts and the results of our estimates of costs, it now appears that the choice of

*See explanatory statement and Table I for basis of estimates.

Table I

Unit Costs and Other Data Used for Estimates of Boundary Light Circuit Costs

	Series 6.6 Amp.	Multiple 230/115 v.	Multiple 550/110 v.
Lamps for clear units			
Type	St. ltg.	Gen. ser. cl.	Gen. ser. cl.
Lumens	320		
Watts	30	15	15
Life in hours	1333	1000	1000
Net cost (30 per cent off list)	$ .665	$ .140	$ .140
Cost/year	$1.995	$ .560	$ .560
Lamps for red and green units			
Type	St. ltg.	Tr. sig.	Tr. sig.
Lumens	1000		
Watts	65	60	60
Life in hours	1333	1333	1333
Net cost (30 per cent off list)	$ .455	$ .210	$ .210
Cost/year	$1.365	$ .630	$ .630
Lamp—weighted average (4 clear, 1 red, 1 green)			
Watts	41.7	30	30
Cost/year	$1.785	$ .583	$ .583
Cut-out films/year	$ .090		
Glassware			
Clear	$3.00	$3.00	$3.00
Green	4.00	4.00	4.00
Red	5.00	5.00	5.00
Weighted average (4 clear, 1 red, 1 green)	3.50	3.50	3.50
Assemblies			
Fixtures	$6.30	$2.50	$2.50
Cut-outs	10.35		
Transformers			2.00
Cones	9.00	9.00	9.00
Boxes		1.50	1.50

	Series 6.6 Amp. Size	Series 6.6 Amp. Cost/M	Multiple 230/115 v. Size	Multiple 230/115 v. Cost/M	Multiple 550/110 v. Size	Multiple 550/110 v. Cost/M
Parkway cable						
6,000-foot field	8	$93	12–10–12	$95	12–12	$91.80
7,200-foot field	8	93	12–10–12	95	12–12	91.80
8,400-foot field	8	93	10–10–10	122	12–12	91.80
9,600-foot field	8	93	10–10–10	122	12–12	91.80
10,800-foot field	8	93	8–10–8	165	12–12	91.80
12,000-foot field	8	93	8–10–8	165	12–12	91.80
13,200-foot field	8	93	6–10–6	200	12–12	91.80
14,400-foot field	8	93	6–10–6	200	12–12	91.80
15,600-foot field	8	93	6–10–6	200	12–12	91.80
16,800-foot field	8	93	4–10–4	290	12–12	91.80
18,000-foot field	8	93	4–10–4	290	12–12	91.80
19,200-foot field	8	93	4–10–4	290	12–12	91.80
Power						
Transformer, C.C.	2 kv.a.	$170.00				
	3 kv.a.	183.50				
Protector		60.00				
Fused cut-outs (2)		12.00				
Switch, magnetic		71.00		$30.00		$30.00
Power cost/kw.hr.		.03		.03		.03
Operation/yr. (hr.)		4000		4000		4000

Transformer losses are assumed to be 10 per cent of secondary load in all cases.

Explanation of estimates of boundary-light circuit costs

The estimated costs given in Figs. 2 and 3 are costs, exclusive of labour costs, for conventionalized circuits having the lights spaced at regular 300-foot intervals. The systems are assumed to include one-sixth red units, one-sixth green units, and four-sixths clear units. To facilitate computation the separate types are replaced by an average unit based on these ratios. These assumptions make no allowance for additional range-light units to distinguish runways from each other or for obstruction lights on branch circuits. Where such lights are used in significant numbers, the total wattage should be considered. The power and material costs will generally lie between those corresponding to the perimeter of the circuit and those corresponding to the total wattage for the circuit. For multiple 230/115 volt circuits the smallest available wire giving less than 5 per cent voltage drop was selected. In every case 12.5 per cent of the material costs has been included in the annual costs to cover interest on and amortization of the original investment. These curves are only intended as approximate indications of relative costs and should not be taken as estimates for any particular field. Unit costs are given in Table I.

the series system for boundary lights is only indicated when the location of the field requires the higher candlepower obtainable with this system.

In setting up specifications for obstruction lights, it was apparent that the angles and distances from which these lights must be visible bore very much the same functional relationship as in the case of boundary lights. It was therefore considered that the candlepower distribution required for the boundary lights was also appropriate for the obstruction lights, except that in the case of obstruction lights on relatively high obstructions it would be advantageous to have the maximum candlepower more nearly horizontal. The candlepower distribution specified for obstruction lights is, accordingly, the same as that specified for the boundary lights, with the axis of the maximum candlepower adjusted in three steps to accord with the height at which the unit is to be used.

At the time when the specifications were being prepared, field approach lights and contact lights had already demonstrated their value. Nevertheless, in view of the lack of any general agreement as to what types of lights were most suitable for these applications, the lack of commercial units giving even approximately the candlepower distribution which seemed theoretically desirable, and the lack of data on the performance of those commercial units which appeared most promising, it appeared advisable to put no specific requirements for field approach lights and contact lights into the original specifications. By the time these specifications had been released, however, new developments in the field of contact lights and candlepower data on their performance had become available and a specification for contact lights has now been issued as a separate specification.

Wind Indicators and Ceiling Projectors

The requirements for wind cones permit the use of either internally- or externally-lighted wind cones, but require that internally-lighted cones shall be made in accordance with the standard design of the Air Navigation Division.

The wind tee most generally used in the United States is 12 feet across the head and 23 feet along the stroke. These dimensions do not conform to the recommended standards of the International Commission on Illumination, which stipulate a wind tee 4 meters, approximately 13 feet, in both dimensions. Pilots in this country seem to favour a tee having the stroke longer than the head, but no evidence was offered to show that so great a difference as a 23:12 ratio is desirable. The specification has, therefore, been worded broadly to permit a wind tee 12 by 18 feet, or any larger tee in which the length of the head does not exceed two-thirds the length of the stroke. This permits the use of a 12 by 23 foot tee, but does not prevent the development of a new tee approximating somewhat more closely to the dimensions recommended by the I.C.I. The lighting of the tee may be either by incandescent lamps or by means of green gaseous-discharge tube lamps. While the use of gaseous-discharge tubes for wind tees has not been very common in this country, it has been popular in Europe and it was therefore felt desirable to leave the way open for the development of such wind tee illumination in the United States.

The ceiling projector is another unit which could not be as satisfactorily specified as was desired. If any scientific tests have been made to determine the proper candlepower characteristics for a good ceiling-light projector, the results were not available to the writers of these specifications. Ceiling projectors, however, are indispensable items of equipment for many airports and it was therefore deemed advisable to include them in the specification. The requirements stated in the specification are based on the

Courtesy of Canadian General Electric Co.

Fig. 4.—Winnipeg, Man. Airport, showing 24-inch Revolving Beacon and Externally Illuminated Wind Cone on 51-Foot Steel Tower.

specification then in use by the Weather Bureau. The Weather Bureau has, however, arranged with the Bureau of Air Commerce to have the characteristics of ceiling projectors analyzed as one of their projects at the National Bureau of Standards to determine whether the present design is the most satisfactory that can be made. At the conclusion of this study it may be possible to prepare more satisfactory requirements for ceiling projectors.

The specifications make provision for automatic photoelectric control of the airport lighting, but the Airport Section does not feel that any special emphasis should be laid upon this type of control at this time.

Landing-area Floodlight Systems

In preparing the requirements for landing-area floodlights, it was felt that the most important consideration was the prevention of glare. It has been the history of all lighting developments that in their early days the tendency is to devote nearly all of the attention to means for increasing the amount of light available. After a period of attempting to make things visible by radiating as much light as possible with little regard for how much shines into the eyes, illuminating engineers again demonstrate that in this new application as in older ones the eyes will readily accommodate themselves to low illumination if they are protected from the glare of naked light sources. It is generally conceded that good pilots can land safely with the very low illumination available from bright moonlight if there are no disturbing lights in sight. On the other hand, a pilot with a bright glaring floodlight in his eyes is in danger of making a false estimate of the ground level regardless of how well lighted the ground itself may be. The first consideration, therefore, in planning a landing-area floodlight system is to make certain that the installation will not increase the hazard by introducing glare.

Three methods of avoiding glare in landing-area floodlighting are available. With a decentralized system properly designed, it is possible to obtain adequate illumination by using only those units of the system which will illuminate the ground from such angles that glare is avoided. If the lighting is accomplished by a single unit, it is possible to introduce a movable shadow-bar which, with careful control, will entirely shield the eyes of the pilot from a view of the light source. The single-unit shadow-bar system has the disadvantage of suddenly introducing a hazard in case of any failure to keep the shadow on the pilot. It is also disadvantageous when the airplane is landing against the light because the pilot must look at the unilluminated side of the blades of grass, sticks, stones and other material which makes up most of the ground surface. On the other hand, there are available single-unit landing-area floodlight systems which give a higher intensity and greater uniformity of illumination than is generally achieved with the decentralized units. On some fields this system also proves to be the less expensive, because of the great saving on cable costs.

The third method of avoiding glare is to use a mobile single unit and to locate it according to the existing wind. This method has been successfully used in Europe, but has never been seriously tried by any commercial airport in this country.

Next to the avoidance of glare, uniformity of illumination is perhaps the most important characteristic of a good landing-area floodlight system. This characteristic is considerably emphasized by airport lighting engineers in Europe, but the lack of sufficient experimental data made it impossible to write an adequate specification to control the uniformity of the illumination. No experiments have been carried out in this country to show whether it is sufficient to limit the spread between the highest and lowest illumination levels on a landing area, or whether it is more important to control the gradient of illumination from point to point over the surface of the landing area. It was therefore deemed advisable to confine the specifications to a requirement that the candlepower characteristics of any floodlighting system proposed for an airport be furnished in such a form that the airport engineers can

Courtesy of Canadian General Electric Co.

Fig. 5.—Floodlighting at Saskatoon, Sask. Airport.

determine, with the aid of a contour map, what shadow areas will exist. To accomplish this, provision was made for vertical isolux curves plotted with the vertical distances exaggerated.

For small fields these isolux curves are to be plotted with a horizontal scale of 100 feet to the inch and a vertical scale of 10 feet to the inch. For larger airports the horizontal scale is decreased to 200 feet to the inch, but the vertical scale becomes 20 feet to the inch. By plotting the contour of the airport along any line radiating from the floodlight to the same scale as the vertical isolux curves and superimposing the isolux and contour curves the points of intersection projected back on the radial line give the locations along that radial line at which the illumination will have the intensities represented by the isolux curves. The minimum illumination allowable for the landing area has been increased from 0.15 foot-candle to 0.20 foot-candle. This is a compromise between the old requirement and the value of 0.25 foot-candle which has been recommended by the Committee on Aviation Lighting of the I.E.S. It is in substantial agreement with the value 0.19 foot-candle recommended by the I.C.I. at its sessions in Karlsruhe in July, 1935.

The old airport rating regulations required that the whole landing area should be illuminated. No adequate reason for this requirement is known, especially in view of the fact that oftentimes the landing area exceeded that required for the rating given. Moreover if decentralized lighting is used satisfactory landings can be made when only the landing strip on which a landing is about to be made is floodlighted. The floodlighting of a wider area gives a better perspective but this does not seem indispensable. The specification therefore was worded to require an elliptical illuminated area not less than 3,000 feet long and 500 feet wide, with a provision for increasing the length of the illuminated area in the case of airports located at high altitudes.

Another desirable characteristic in a landing-area floodlight is a sharp cut-off on the upper side of the beam. The specification contains a requirement that the intensity shall "be reduced to 10 per cent of the maximum intensity within 3 degrees." This is not as sharp a cut-off as is desirable, especially if there is slight haze in the atmosphere, but there are so few commercial floodlights that can qualify for a narrower upward divergence that a closer requirement was not warranted.

Aviation Colours

Prior to the issuing of the performance specification, the only official definition of aviation colours in the United States applied solely to red and green airplane position lights. These definitions were stated* in terms of dominant wave-length and purity with no reference to which of several possible sets of constants were to be used in determining these values. The present performance specification defines aviation red, yellow, green, and white in terms of the Standard Observer and Co-ordinate System adopted by the International Commission on Illumination at Cambridge in 1931. The definitions are illustrated by a diagram which has been reproduced as Fig. 6. For the convenience of those who are not familiar with the I.C.I. co-ordinate system, the specifications also interpret the fundamental definitions in terms of dominant wave-length and purity except for aviation "white" which is described in terms of familiar light sources.

It is impracticable to inspect any quantity of service glassware by a direct application of the fundamental definitions. To overcome this difficulty testing definitions have been included in the section on aviation colours. These definitions are based on the National Bureau of Standards' primary standard filters for aviation colours.

To assist manufacturers, provision is made for certifying working standards which give colours within the fundamental definitions and conform to certain physical requirements. This procedure seems more equitable and more practical than requiring that working standards be replicas of the primary standards; more equitable

*Airworthiness Requirements for Aircraft Components and Accessories, Aeronautics Bulletin 7-F, p. 8.

because some manufacturers might have difficulty in producing replicas of the primary standards and more practical because the working standards can be made of the same type of glass as the service glassware to be tested and this simplifies the colour comparisons which must be made in the course of inspecting the glassware.

The fundamental definitions adopted in the performance specification are more restrictive than those adopted

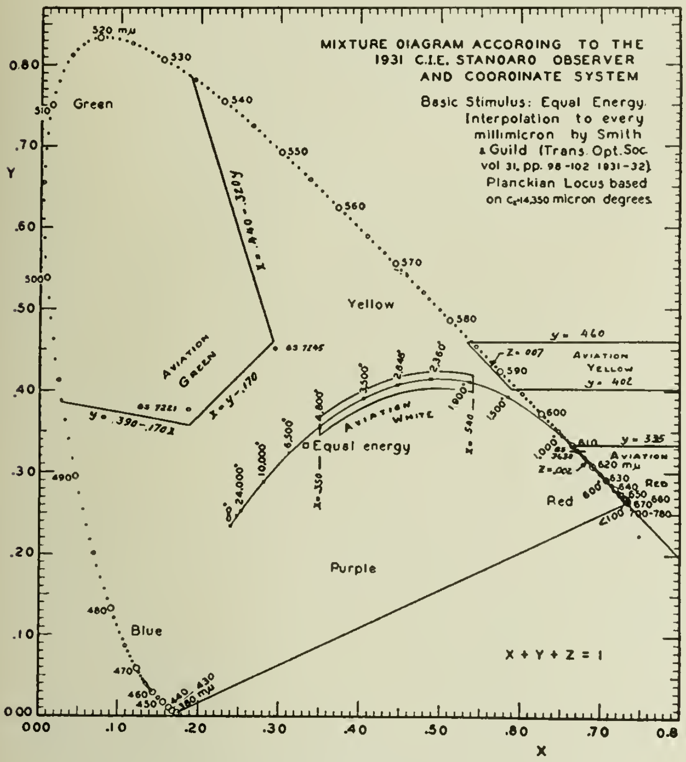


Fig. 6—Diagrammatical Representation of Acceptable Aviation Colours.

by the I.C.I. at Karlsruhe in 1935. This restrictiveness is dictated by caution rather than experience. It did not seem prudent to broaden the requirements beyond what had been previously found satisfactory. Research on proper limits for aviation colours is now in progress with funds supplied by the Air Navigation Division of the Bureau of Air Commerce. It is hoped that these experiments will definitely establish what limits for aviation colours are safe.

Photometric Measurements

Under the caption "Photometric Measurements" the performance specification sets up a standard procedure for measuring the candlepower distribution of aviation lighting equipment purchased under these specifications. This equipment is usually of one of two types, projectors giving highly-concentrated beams, or units having horizontal annular prisms which give a candlepower distribution approximately the same at all angles of azimuth.

The requirements of the performance specification differ in several particulars from those of the "I.E.S. Standard Testing Specifications."* These differences arise both from the higher concentration characteristic of the aviation lighting equipment and from the fact that we are interested in the visibility of the light rather than its capacity to illuminate other objects. For these reasons it is not sufficient to obtain average values of intensity over solid angles of appreciable size and it is necessary to make the measurements with much longer photometric distances than those which suffice for floodlights. Instead of a fixed minimum testing distance, the performance specification gives the minimum photometric distance by Benford's formula† in terms of the diameter of the unit and the minimum angle subtended by the source as seen from the reflector or lens.

This review of the Standard Specification for the Installation of Airport Lighting Equipment and Materials and the Performance Specification for Airport Lighting Equipment and Materials covers the novel aspects of these specifications so far as the writer is competent to do so. For the most part, the requirements of the specifications relating to wiring and wiring devices merely insist on adherence to what is generally recognized as good wiring practice.

*Trans. I.E.S. 28, 479 (1933).
†Gen. Elec. Rev. 4, 230 (1923).

THE
ENGINEERING JOURNAL
THE JOURNAL OF
THE ENGINEERING INSTITUTE
OF CANADA

VOLUME XIX NOVEMBER 1936 No. 11

The Seventh Plenary Meeting of Council and By-law Revision

In order to deal with important matters of Institute policy it has been customary in the past to hold Plenary Meetings of The Institute Council, at which the attendance of practically all the councillors is made possible by providing for their transportation expenses. The principal business of the seventh meeting of this kind, which has just concluded, was somewhat similar to that of the sixth meeting which was held in 1933. At that time a number of revisions to the by-laws proposed by the then Committee on Development were considered and put forward for debate at the Annual General Meeting of 1934. This year a Plenary Meeting was called for the consideration of another set of proposals to revise The Institute by-laws, namely, those prepared by The Institute's Committee on Consolidation which was appointed by the Annual General Meeting of 1935 in Toronto. Under the by-laws, Council is directed to consider such proposals and express its opinion thereon for the guidance, but not necessarily the acceptance, of the proposers of the revisions. Then, after being put in their final form by the proposers, the revisions are published in The Journal, debated at the Annual General Meeting, and accepted or rejected by a letter ballot of the whole membership of The Institute.

During the past eighteen months the Committee on Consolidation has been actively at work, and has had as its principal object the establishment of closer relations with the eight Provincial Associations of Professional Engineers, this being intended as a first step towards the organization of the engineering profession in Canada on a truly national basis. All will agree that the diversity of the interests concerned make the problem difficult of solution. While there are a large number of Canadian engineers who actively support the registration movement by belonging to the Associations, there are many who do not do so. About half the corporate members of The Institute are not registered. As regards non-members of The Institute, some belong to no organization at all, some belong only to a Professional Association, and others have joined non-Canadian engineering bodies.

There seem to be at least two main schools of thought on this question. On the one hand we have the view that everyone should be registered who is engaged in any kind of engineering work requiring professional training as distinguished from the work of a foreman or skilled craftsman. On the other hand there is the idea that legal registration as a professional engineer should be required only of those whose work makes them personally responsible for the protection of the public. A totally different doctrine (which now seems somewhat heretical) is held by those few who do not believe in registration, and are of the opinion that legal authorization to practise is unnecessary for any engineer, either in his own interest or that of the public.

Any scheme for the better organization of the profession which can commend itself to all, or even a majority, of the holders of these divergent opinions must evidently contain features on which some compromise has been made. In fact, the engineers whose main interest lies with the legal work of the Associations, and those who attach more importance to the technical and educational work of The Institute, must both be prepared to give effective recognition to their opponents' views if any workable plan is to be evolved.

In regard to this matter, the attitude of the Council of The Institute has been consistent ever since 1919, when it gave approval to the proposed provincial legislation based on the Model Act prepared by an Institute committee. It is true that at that time no attempt was made to relate the new legal organizations to The Institute, and, in the light of later developments this was perhaps unfortunate. The Institute Council, however, has for years endeavoured to promote closer relations with the Provincial Associations and thus bring about a measure of unity in the profession in Canada. The history of these efforts was ably summarized in the report of the Committee on Consolidation which its chairman presented at the Annual Meeting of 1936. The work of that committee has now resulted in a series of definite proposals for the amendment of The Institute by-laws; these proposals, in accordance with Section 75 of the existing by-laws, have been duly put forward over the signatures of more than twenty corporate members. Under the same section it therefore became Council's duty to consider and express an opinion on such proposals, and as previously noted, it was mainly for this purpose that the recent Plenary Meeting was convened. Fortunately, in this case, the modifications suggested at the Plenary Meeting were almost all of a character likely to be acceptable to the proposers, a result which was perhaps to be expected, in view of the conferences and joint sittings which Council has held with the committee, on which it is very satisfactory to note that the Professional Associations are represented by two members.

The principal features of the present proposals, if modified so as to meet the views expressed at the Plenary Meeting of Council, may be summarized as follows:

(1) The Institute adopts as one of its main objects co-operation with the Provincial Associations of Professional Engineers.

(2) To facilitate the attainment of this object, it is proposed that The Institute in future shall have only one class of corporate member, the present Associate Member class being merged in that of Member. Further, corporate members of any Professional Association will be admitted as Members of The Institute on certification of their Association standing.

(3) The Associations are invited to co-operate with The Institute under the provisions of the proposed

new by-laws. Those which agree to do so will be known as "Component Associations," and will have individual representation on The Institute Council.

(4) The Institute will not admit to membership persons resident in any province where there is a Component Association unless they are members of that Association, or are not required by law to be members of it.

(5) An Association may also become a Component Association by registering all its corporate members at one time as Members of The Institute. In such a case that Association can pay a per capita fee for the group thus registered, the amount to be arranged by Council.

(6) To meet the case of a Component Association which does not register all its members, it is proposed that those of its members who do not desire to belong to The Institute will be recognized as "Associates" of The Institute. They will be exempt from annual fees, and will rank as non-corporate members.

(7) Members of Component Associations will be exempt from entrance fees on joining The Institute.

(8) The members of The Institute Council who represent the Component Associations will form a Standing Committee on Association Affairs, which will hold at least one meeting annually, to which their travelling expenses will be paid by The Institute. The principal duty of that committee will be to assist the Associations to undertake combined action in such matters as public relations; the securing of improved legislation and uniform standards of membership; reciprocity for interprovincial licensing, and other matters of common interest to the Associations. Thus the committee will be available to act in cases where a body is needed that can speak for the engineering profession in Canada as a whole.

(9) A contribution of fifty cents per capita of its members will be paid to The Institute by each Component Association. This sum will be available to meet the expenses of the Standing Committee on Association Affairs.

(10) In provinces where no Component Association exists, the procedure for admission of Members to The Institute will remain practically unchanged, except that for non-graduates Council can only waive The Institute's examinations in the case of applicants who are over thirty-five years of age and have had ten years experience.

(11) No more Affiliates of The Institute will be admitted, this class of membership thus gradually disappearing.

(12) As regards fees, the members of Component Associations, Juniors and Students will be exempt from entrance fees. It is proposed that the annual fees for Members shall be one dollar more than the present Associate Member fee, this being necessary in the opinion of the Finance Committee in order to compensate for the loss of revenue from the present Members (who will in future pay a lower fee) and also for the prospective loss in entrance fees.

(13) Council will be authorized to arrange with any Component Association for the collection of the annual fees of Institute members who are also members of such Associations.

Many Institute members who may object to certain details of the present scheme are nevertheless sincere supporters of the principle of co-operation between the Associations and The Institute. The proposals which will be submitted to the membership as a result of the work of the Committee on Consolidation are intended to be such a compromise as will safeguard their interests as well as those of all members of The Institute. It is believed that the proposals constitute a scheme which will meet with the approval of the majority of Institute members and will also enable the Professional Associations to unite in co-operating with The Institute. Such co-operation would make it possible ultimately to build up a Dominion-wide organization which would represent the profession as a whole. Any weak points in the plan now presented will no doubt become evident when experience is gained in its practical working. They can then be corrected as found necessary. When this has been done the first stage in the organization of the profession will have been completed, and the way will be open for further progress.

Apart from The Institute and the Professional Associations there exist in Canada a number of important technical societies, some of which are branches of non-Canadian organizations, whose ultimate co-operation is essential for the full development of the organization movement. Up to the present it has not been feasible to consult officially with these bodies, since it has first been necessary to find a solution for a more pressing problem, that of co-operation with and between the Professional Associations. Is it not possible that as a result of some future development of the plan which is now being put before The Institute members, we may look forward to an arrangement which will provide satisfactorily for the effective representation of all these bodies?

It is sincerely to be hoped that in voting on these proposals when they do come to a ballot, individual members of The Institute will waive all minor objections and will support a scheme which is admittedly not perfect, but seems feasible, and which will permit of further development leading towards the ultimate aim of united action on the part of all members of the profession in Canada.

Canadian Engineering Standards Association Recent Changes in Organization

The Executive and Main Committees of the Canadian Engineering Standards Association have recently undergone an important reorganization. It has been felt for some time that closer co-operation with Canadian industrial interests was desirable and to that end membership has been extended to include a larger number of leading industrial and professional associations while representation from the Canadian Manufacturers' Association has been increased from three to twenty-two.

Under the new scheme the membership of the Main Committee will be limited to eighty nominated members to which twenty co-opted members may be added. Representation on the Main Committee will now consist of universities, professional bodies, industrial associations, Dominion government departments, public utilities (including power commissions), the Canadian Electrical Association, the National Research Council, and the Canadian Manufacturers' Association. The Executive Committee will consist of twenty members, of which six may be co-opted, each of the different groups outlined above nominating their own representatives. A complete list showing members of both committees was published in the C.E.S.A. Bulletins for March 31st and June 30th, 1936.

The chief object of the reorganization is to stabilize the position of the C.E.S.A. in Canada and especially to secure additional financial support which will enable the Association to carry on its work more satisfactorily. The work is only limited by the amount of funds available, and it is believed that its field of usefulness can be materially increased, with consequent benefit to industry, if a substantial increase in the working budget can be secured.

Considerable misunderstanding prevails in many quarters as to the position of the C.E.S.A. and its functions. It is important to note that the Association is not a government institution but operates under a charter granted in 1919. During the first seven years of its operation it was supported by a special grant from the Department of Trade and Commerce, but since 1926 it has operated with funds provided by a special grant from the National Research Council and by subscriptions received from industry under a system of sustaining memberships. The National Research Council provides office space and mimeographing services in addition to the grant, and it is believed that the time has now come for industry to realize the value of the work and to subscribe more generously to the support of the Association.

The Association has issued many specifications which have proved invaluable to manufacturers, engineers, architects, etc., and in addition has sponsored the work of the Canadian Electrical Code covering electrical wiring regulations. This Code has gone through three editions and has been officially adopted by the nine provinces of Canada. At the present time the Association is very actively engaged in the preparation of approval specifications for electrical apparatus outlining conditions which must be met to secure approval for the sale of any particular device. In the preparation of these specifications the Association gives the manufacturers every opportunity of presenting their views and the specifications are not issued until a satisfactory agreement has been obtained. In this way manufacturers are advised in advance of any proposed regulations and can request revision or consideration of their problems before the specifications become regulatory. The work of the Association is carried on by its working committees, the members of which give voluntary service. The Association has no regulatory powers itself but simply prepares the specifications or codes after consultation with those concerned and then presents them to the different authorities for adoption at their discretion.

Manufacturers and industrial organizations generally will be well advised in getting more closely in touch with the Association and full information on its policy and operation will be gladly supplied on application to headquarters at Ottawa. It is hoped that the reorganization which has just been completed will be appreciated by those concerned and that interest in the work will be so stimulated that there will be a notable increase in sustaining membership. With an assured budget the Canadian Engineering Standards Association can soon establish itself in the national position to which it is entitled by virtue of the importance, and value to industry, of the work in which it is engaged.

Executive Committee

Chairman
J. G. Morrow

Vice-Chairmen
J. M. R. Fairbairn, M.E.I.C.
H. H. Vaughan, M.E.I.C.

Honorary Secretary
R. J. Durley, M.E.I.C.

Canadian Electrical Association
G. Gordon Gale, M.E.I.C.

Canadian Manufacturers' Assoc.
J. C. Callaghan
J. S. Cameron, A.M.E.I.C.
A. H. Cowie, M.E.I.C.
W. E. Ross, A.M.E.I.C.

Government Departments
K. M. Cameron, M.E.I.C.
C. P. Edwards, A.M.E.I.C.

Industrial Associations
H. D. Johnston
A. C. Ross, M.E.I.C.

National Research Council
A. G. L. Macnaughton, M.E.I.C.

Professional Bodies
P. L. Pratley, M.E.I.C.

Public Utilities
T. H. Hogg, M.E.I.C.
R. V. Macaulay, M.E.I.C.

Universities
R. E. Jamieson, M.E.I.C.

Co-Opted
C. V. Christie, M.E.I.C.
W. P. Dobson, M.E.I.C.

List of Nominees for Officers

The report of the Nominating Committee was presented to and accepted by Council at the meeting held on October 16th, 1936. The following is the list of nominees for officers as prepared by the Nominating Committee and published for the information of all corporate members as provided by Sections 68 and 74 of the By-laws.

List of Nominees for Officers for 1937 as Proposed by the Nominating Committee

President:	G. J. Desbarats, Hon.M.E.I.C.	Ottawa.
Vice-Presidents:		
*Zone "A"	H. S. Carpenter, M.E.I.C.	Regina.
*Zone "C"	J. L. Busfield, M.E.I.C.	Montreal.
	J. A. McCrory, M.E.I.C.	Montreal.
Councillors:		
‡Halifax Branch	H. S. Johnston, M.E.I.C.	Halifax.
‡Saint John Branch	E. J. Owens, A.M.E.I.C.	Saint John.
‡Saguenay Branch	A. C. Johnston, A.M.E.I.C.	Arvida, Que.
‡St. Maurice Valley Branch	B. Grandmont, A.M.E.I.C.	Three Rivers.
††Montreal Branch	J. B. D'Aeth, M.E.I.C.	Montreal.
	A. Duperron, M.E.I.C.	Montreal.
	E. Gohier, M.E.I.C.	Montreal.
‡Ottawa Branch	R. W. Boyle, M.E.I.C.	Ottawa.
‡Kingston Branch	J. E. Goodman, A.M.E.I.C.	Kingston
‡Toronto Branch	W. E. Bonn, M.E.I.C.	Toronto.
‡London Branch	J. A. Vance, A.M.E.I.C.	Woodstock.
‡Border Cities Branch	H. J. A. Chambers, A.M.E.I.C.	Walkerville.
	H. J. Coulter, A.M.E.I.C.	Detroit, Mich.
‡Lakehead Branch	R. J. Askin, A.M.E.I.C.	Port Arthur
‡Saskatchewan Branch	R. A. Spencer, A.M.E.I.C.	Saskatoon.
‡Edmonton Branch	R. M. Dingwall, A.M.E.I.C.	Edmonton.
‡Vancouver Branch	P. H. Buchan, M.E.I.C.	Vancouver.

*One Vice-President to be elected for two years.
‡One Councillor to be elected for two years.
††Two Councillors to be elected for three years each.

Additional Nominations

Section 68 provides also that "Additional nominations for the list of nominees for officers signed by ten or more corporate members and accompanied by written acceptances of those nominated, if received by the Secretary on or before the first day of December, shall be accepted by the Council and shall be placed on the officers' ballot."

The Responsibility of the Engineer

Extracts from an address "Why the Engineer?" given before the American Engineering Council

By Dr. W. F. Durand,
Chairman, Third World Power Conference,
Past-President, American Society of Mechanical Engineers.

The engineer has been defined as one who is concerned with the utilization of the materials and the energies of nature in the service of man. Amplifying, in terms which define his field of activity and which stand in the preamble to the constitution of American Engineering Council, "Engineering is the science of controlling the forces and of utilizing the materials of nature for the benefit of man, and the art of organizing and directing human activities in connection therewith."

Thus, obviously, we are specially concerned with the constructive materials of nature and again with the inorganic energies. These may be accepted as limiting, in suitable fashion, the field of our work. On the other hand, this modern concept contains an amplification of the very highest order of importance. We are concerned with the "organizing and directing of human activities." That is, not only are we concerned with inanimate materials and inorganic energies, but also with the human agencies through which our ends are to be attained.

* * *

We cannot escape the fact that, in a direct sense, we are responsible to society at large and to future generations for the wise and economic use of these gifts of Nature in the development and utilization of which we are now engaged, as our share in the work of the progress of civilization. If society needs to be awakened, if new laws are needed, we must remember that we are more than engineers; we are members of society and members of the body politic. We must take our part in arousing society and our due share in the work of framing, enacting and enforcing salutary laws and regulations looking to the ends which I have indicated. If we do not, it can hardly be expected that others will. In this way, lies plainly the open path of duty for the engineer.

* * *

We have already seen that through the co-operative work of the scientist and the engineer, the world has, in a material sense, been made over. The enumeration of details is not necessary. Compare the material content of our civilization of the time just preceding James Watt, 200 odd years ago, with the present; or again, that of the period just following the Civil War between our states—within the memory of many of us—with that of the present time. In a large sense, the external world is new; but have we made commensurate and parallel progress in the adaptation of ourselves to these new external conditions? A changed world externally must call for adaptations especially in our nervous and emotional systems, to all these new appeals to interest and stimulus. There is here needed a growth in wisdom directed to the most beneficial use of these new conditions of life. We may indeed ask if we have grown in wisdom in the use of these new products of science and engineering, commensurate with the conditions themselves, which these new products have brought about.

It would be a brave man, I believe, who would be prepared to assert and defend the affirmative. If we mean by wisdom, a sense of values, an appreciation of the significant and abiding as contrasted with the insignificant and transient, a capacity for effective judgment based on accurate analysis of the elements into which our problems resolved themselves—then we can hardly say that we are wiser than our fathers or our grandfathers, or even wiser than those of centuries long gone by. We have enormously more information, but that is a different thing.

My question in brief is whether the world of today is indeed as well adjusted to the material content of our present civilization as was that of, for example, 50 or 75 years ago, to the content of that day and age. This new environment, these new conditions of life which have been brought about by the material advances of recent times have brought with them new and pressing problems, social, economic, political and international.

* * *

The displacement of human operatives by mechanical agencies, the tendency toward the concentration of populations in large centres, the problems of capital and labour, the new conditions and agencies of warfare; these are only examples.

Now what is our responsibility as engineers with regard to these problems? It is clear that the responsibility is not ours alone; but it is equally certain a share is ours; because here again, no class or stratum of society stands nearer to the source of these problems than do we who have shared in the creation and production of their causes. We cannot evade the responsibility which rests upon us to take our due share, even the lead in the study of the problems which our own activities have, in a large measure, developed.

What I am urging is a quickened sense on the part of the engineer, of his responsibilities, not alone in a purely professional sense, but as a citizen of his community, of his state, of his country, of the world; a responsibility in the fulfilment of which he will take such part as he may in the earnest study of social, economic and political problems, and in particular of the special conditions which his own activities have brought about, to the end that we may attain some better condition of balance as between the material content of our present day civilization and the uses which we are making of it.

SEMICENTENNIAL 1887 1937 JUNE 15-18 1937

THE ENGINEERING INSTITUTE OF CANADA FOUNDED 1887

SEMICENTENNIAL COMMITTEE

A. Cousineau, A.M.E.I.C.	**R. H. Findlay, M.E.I.C.**
R. L. Dobbin, M.E.I.C.	**F. S. B. Heward, A.M.E.I.C.**
J. M. Fairbairn, A.M.E.I.C.	**J. L. Busfield, M.E.I.C., Chairman**

Visitors

As a result of the publicity given by various engineering societies in other countries, we are already receiving numbers of inquiries from engineers who anticipate taking part in our Semicentennial meeting.

Technical Papers

During the technical sessions papers will be presented (among others) by:—

R. E. CHADWICK, M.E.I.C., President of the Foundation Co. of Canada, Limited, who will deal with modern methods of precasting large concrete construction units, especially developing the idea that such units can be built better and more economically at a suitable construction yard rather than *in situ*. Mr. Chadwick has, of course, had unique experience, and is a recognized authority for this type of work.

E. M. WOOD, B.A.Sc., Electrical Engineer, Hydro Electric Power Commission of Ontario, will deal with electrical relay protection, treating the subject in a general way to show the importance of protective relay equipment on transmission systems and on various types of stations connected thereto. Mr. Wood has been with the Ontario Hydro for many years, specializing in station design, system arrangements, and relaying, and is well qualified to speak on this subject.

Branch Delegates

Arrangements are being made to hold a Round Table Conference of delegates from The Institute Branches concurrently with the Semicentennial meeting. This will provide an unusual opportunity for wider contact between The Institute's official personnel, and for the interchange of ideas in connection with the operation of the Branches.

Committee on Consolidation

Report for October 1936

The proposals for revisions to the By-laws of The Institute as prepared by the Committee on Consolidation, were submitted to the Council under date of September 21st, over the signatures of all the members of the Committee, and eighty-nine members of The Institute, and in accordance with the provisions of Section 75 of the By-laws, were considered by Council at its Seventh Plenary Meeting held in Montreal on October 16th and 17th.

There were present at this meeting:—President E. A. Cleveland in the chair; Past-Presidents A. R. Decary, A. J. Grant, O. O. Lefebvre, F. P. Shearwood and H. H. Vaughan; Vice-Presidents R. L. Dobbin (Province of Ontario), H. W. McKiel (Maritime Provinces), P. L. Pratley (Province of Quebec); Councillors C. G. R. Armstrong (Border Cities), G. S. Brown (Lethbridge), G. H. Burbidge (Lakehead), H. Cimon (Quebec), A. B. Crealock (Toronto), T. H. Dickson (Moncton), A. B. Gates (Peterborough), L. F. Goodwin (Kingston), A. K. Hay (Ottawa), F. S. B. Heward (Montreal), G. H. Kirby (Saguenay), E. P. Murphy, (Niagara Peninsula), H. J. McLean (Calgary), F. Newell (Montreal), E. A. Ryan (Montreal), F. Smallwood (Sault Ste. Marie), R. E. Smythe (Toronto), H. L. Swan (Victoria), J. A. Vance (London), G. A. Vandervoort (Saint John), H. R. Webb (Edmonton), and S. Young (Saskatchewan); Treasurer J. B. Challies, and by special invitation President-elect G. J. Desbarats. There were also present Mr. James Robertson, representing Councillor A. S. Wootton of Vancouver, and Major A. J. Taunton representing Vice-President E. V. Caton and Councillor T. C. Main of Winnipeg. There were also present by special invitation—Mr. J. L. Busfield chairman of the former Committee on Development; Mr. C. C. Kirby, President of the Dominion Council of Professional Engineers, and Mr. Gordon McL. Pitts, Chairman of the Committee on Consolidation.

Resolutions in identical form were submitted from the Executive Committees of the Toronto, Hamilton, Peterborough, St. Maurice Valley, Edmonton and Winnipeg Branches of The Institute, requesting the Council of The Institute to take under consideration the advisability of applying to His Excellency the Governor-General, through the Department of State of the Dominion of Canada, for the privilege of using the prefix "Royal" in connection with the title "Engineering Institute of Canada," in order that if possible this privilege may be conferred at the Semi-centennial ceremonies in June, 1937.

On the motion of Mr. Pratley consideration of these Resolutions was postponed until more Branches of The Institute have been heard from.

Although it is not possible at this time to make a final statement of the wording of the revisions to the By-laws as they will be submitted to the membership by the Committee on Consolidation, the following extract from a presentation made to the meeting by Mr. C. C. Kirby, President of the Dominion Council, will indicate the general lines along which your Committee has developed its suggestions:—

"Action now being taken on behalf of The Engineering Institute to bring this whole matter to a head by definite proposals for the consideration of each individual member of the associations and The Institute arises from the fact that some men are members of both types of organization and see the possibility of benefit by the development of proposals for close co-operation. In justice to the Council of The Institute it must be acknowledged that they had previously taken the stand that any proposals for such close co-operation should come from the Professional Associations. It was not until the passing of several years of waiting for such proposals that the membership at large of The Institute forced the issue by the appointment of a Committee to study the matter from The Institute's viewpoint. Representation on this Committee was granted to the Associations as a result of the last annual meeting of The Engineering Institute at Hamilton in February 1936. The proposals now being made are the result of the considerations of this joint Committee on Consolidation and represent the ideas of the accredited representatives of both parties. In a country such as Canada it is not feasible to obtain individual representation of each Province at Committee Meetings at fairly frequent intervals. The component parties represented at such committee meetings should therefore be very reluctant to withhold a large measure of support to those who have to accept such responsibilities, realizing that a mean between very divergent views is the only practical step to take if any progress is to be made.

"To come to the essence of what has been proposed by the Joint Committee.

"The status of an Engineer who is registered as entitled to practice by any one of the Associations is acknowledged by The Institute as sufficient evidence of eligibility to become a member of The Institute, with merely the formality of a signed application to complete the admission, providing proper credentials are submitted. No entrance fee will be required of such an applicant.

"The detail work of furthering co-operation between the various Provincial Associations on Interprovincial matters and of endeavouring to obtain more uniformity in their Provincial requirements will be delegated to a Standing Committee of The Institute to be known as 'The Committee on Association Affairs.'

"The Associations may appoint or elect one member each to the Council of The Institute who may act as ordinary Councillors on the affairs of The Institute and who shall also constitute the 'Standing Committee on Association Affairs.' This Committee will report to the Council and to their respective Associations.

"In order that this 'Committee on Association Affairs' shall have the opportunity to do effective work by meeting together, provision is made that such a meeting shall be held annually with expenses of the members paid by The Institute. The Institute to be recompensed for this expense by a payment or grant from each Association on the basis of 50c per capita for each of its members entitled to practice.

"The Associations are to signify their willingness to co-operate with The Institute by entering into individual agreements with The Institute to carry out their several parts of the undertaking. The Associations so agreeing will be styled 'Component Associations' for purposes of reference.

"Membership in The Institute will remain optional on the part of each member of an Association. Those who do not wish to join The Institute will be styled 'Associates' of The Institute for purposes of reference and can if they wish participate in Institute Branch meetings and receive the 'Journal' of The Institute at the same rate as other members.

"The present grade of 'Associate Member' of The Institute will be abolished and all such present members will be styled 'Members' without increase of fees. The fees for present 'Members' will be lowered to that of present 'Associate Members.'

"The Institute will confine itself for future members in a Province where there is a 'Component Association' to members of such Associations.

"The Component Associations who wish to do so for the benefit of their members, may collect the fees of The Institute along with their own and forward them to The Institute, subject to arrangement with The Institute Council.

"'Engineers in Training' and 'Pupils' of any of the Associations may be admitted to classifications of 'Juniors' or 'Students' of The Institute with similar nominal formality to that of corporate members.

"The above proposals are as far as the Joint Committee felt it was able to go with reasonable prospects for general acceptance. Various proposals of more drastic character were received and considered but not accepted. It is sincerely hoped that the above will be found to be a basis upon which The Institute and the Associations can 'Consolidate' their aspirations without trying to enter into a form of organic union which may prove to be impracticable in any of the Provinces."

In arriving at its conclusions the Committee on Consolidation has adhered to the principles established by the Report of the "Committee on Relations of The Institute with the various Provincial Associations," as adopted by the Annual Meeting of February 12th, 1930, one member dissenting; the unanimous Resolution of the Annual Meeting of February 7th, 1935; the overwhelming majority of opinion as expressed in the replies to the questionnaire of the Committee on Consolidation issued in 1935; the principles laid down in the report of the Committee on Consolidation as received and unanimously accepted as a progress report by the Annual Meeting of February 1936; and the Memorandum of the joint conference between the Dominion Council and representatives of the Provincial Professional Associations and the Committee on Consolidation representing The Institute, of February 7th, 1936, which Memorandum was subsequently approved by the Committee on Consolidation at its meetings of March 21st, and May 30th; and by the joint meeting of the Council and the Committee of May 30th, with the added proviso that the members of the Committee on Association Affairs should be members of The Institute.

In all its discussions and proposals the Committee on Consolidation has been guided by and has endeavoured to implement the wishes of the general membership of the profession in so far as it has been within its power to ascertain them.

In accordance with the provisions of Section 75 of the By-laws, the reply of Council to the proposals of the Committee on Consolidation is now being considered by the Committee, whose final proposals must be returned to the Council on or before December 15th. It is hoped that the Committee will be in a position to present to the membership its proposed revisions to the By-laws in the December issue of The Journal.

GORDON McL. PITTS,
Chairman.

Elections and Transfers

At the meeting of Council held on October 17th, 1936, the following elections and transfers were effected:—

Member

MORTON, Archibald Marshall, (Heriot Watt College), R.P.E. of B.C., res. engr., Rhokana Corporation, Nkana, Northern Rhodesia.

Associate Members

BANCROFT, Gilbert Howard, (Bradford Tech. Coll.), R.P.E. of B.C., mech. dftsman., Cons. Mining and Smelting Co. of Canada Ltd., Tadanac, B.C.

RICHARDSON, Edward William, B.A.Sc., (Univ. of B.C.), engr., Wells Townsite Co., Wells, B.C.

Juniors

CHAMBERS, Robert John, B.Sc., M.Sc., (Queen's Univ.), mech. engr., Anglo-Canadian Pulp and Paper Co. Ltd., Quebec, Que.

DEMERS, Georges, B.A.Sc., C.E., (Ecole Polytechnique, Montreal), asst. divn. engr., Roads Dept., Prov. of Quebec, Riviere du Loup, Que.

VERSCHOYLE, Patrick Donnithorne, B.Eng., (McGill Univ.), Lafarge Aluminous Cement Co. Ltd., Fondu Works, West Thurrock, Grays, Essex, England.

Transferred from the class of Associate Member to that of Member

EADIE, Robert Scott, B.Sc., M.Sc., (McGill Univ.), designing engr., Dominion Bridge Co. Ltd., Lachine, Que.

GARNETT, Charles Ernest, (Manchester Coll. of Technology), R.P.E. of Alta., vice-president, Gorman's Ltd., Edmonton, Alta.

LAWTON, Frederic Lewis, B.A.Sc., (Univ. of Toronto), elect'l. engr., Saguenay Power Company, Arvida, Que.

Transferred from the class of Junior to that of Associate Member

LANCTOT, Raymond, B.Sc., (McGill Univ.), asst. to aluminum plant supt., Aluminum Company of Canada, Arvida, Que.

PRINGLE, George Hugh, B.Sc., (McGill Univ.), asst. chief engr., Mead Corporation, 244 Caldwell St., Chillicothe, Ohio.

Transferred from the class of Student to that of Associate Member

HARVEY, William M., B.Sc., (Queen's Univ.), mech. engr., Noranda Mines Ltd., Noranda, Que.

Transferred from the class of Student to that of Junior

COSSER, Walter Geoffrey, B.Sc., (McGill Univ.), dftsman., Hollinger Cons. Gold Mines Ltd., Schumacher, Ont.

HULL, Roland Street, B.Sc., (N.S. Tech. Coll.), engr., wire and cable engrg. dept., Can. Gen. Elec. Co. Ltd., Peterborough, Ont.

Students Admitted

KIRSCH, Leonard, B.Eng., (McGill Univ.), 12 Windsor Ave., Westmount, Que.

LYONS, Joseph Harvey Kent, B.Sc., (Univ. of Man.), 2063 Stanley St., Montreal, Que.

OBITUARIES

James Atkinson Douglas, M.E.I.C.

Regret is expressed in placing on record the death at Winnipeg on September 19th, 1936, of James Atkinson Douglas, M.E.I.C., a member of The Institute of many years standing.

Mr. Douglas was born at Montreal, Que., on May 31st, 1865, and from 1884 until 1889 served his apprenticeship in the Canadian Pacific Railway Company's shops in that city. On the completion of his apprenticeship in 1889 he joined the staff of the Dominion Bridge Company as an electrician, and from 1890 until 1893 he was engaged on general construction with the L. W. Ness Company. In March, 1893, Mr. Douglas became connected with the Canadian General Electric Company as a draughtsman, and in August of the same year he entered the service of the Montreal Electric Company, where he remained for two years, doing general construction work. In 1895 Mr. Douglas was with the Royal Electric Company as superintendent of the wiring department, and in 1904 he was superintendent with the Hill Electric Switch Company. In 1905 he was appointed resident electrician for the Canadian Pacific Railway at Winnipeg, Man., and in 1910 was made electrical engineer for the company's western lines, which office he held until 1935 when he retired from active service.

Mr. Douglas became a Student of The Institute (then the Canadian Society of Civil Engineers) on May 22nd, 1890, an Associate Member on April 25th, 1901, and a Member on January 22nd, 1917. On December 16th, 1932, he was made a Life Member.

Robert Hutchison Murray, A.M.E.I.C.

It is with regret that we place on record the death on August 28th, 1936, while on holiday in Scotland, of Robert Hutchison Murray, A.M.E.I.C., of Regina, Sask.

Mr. Murray was born in Glasgow, Scotland, on July 29th, 1886, and graduated from the Glasgow and West of Scotland Technical College in 1903. From 1903 until 1908 he served his apprenticeship with Andrew Laird and the Glasgow Corporation Main Drainage staff, and from 1908 to 1910 was resident engineer in charge of sewer contracts in connection with the Glasgow Main Drainage scheme. Coming to this country in 1910, Mr. Murray was until 1911 assistant engineer with the Main Drainage Department of the city engineer's office, Toronto, and in 1911-1912 he was resident engineer for the late T. Aird Murray, M.E.I.C., in charge of the North Toronto main sewerage and sewage disposal works. In September 1912 Mr. Murray entered the service of the Saskatchewan government as engineer in the Provincial Health Department. He served overseas in Egypt and France, and, returning to Regina in June 1919, was appointed Director, Division of Sanitation, and Director of Union Hospital Organization, Provincial Department of Public Health, which office he held until his death.

After returning from overseas, Mr. Murray was O.C. 14th Field Company, Canadian Engineers, and later O.C. Divisional Engineers with the rank of Lieutenant-Colonel. He was subsequently Brigade Major with the 7th Mounted Brigade. He was active in the formation of the Saskatchewan Health Officials Association of which he was Secretary-Treasurer from its inception. Mr. Murray took an active part in the Canadian Public Health Association and at the time of his death was vice-chairman of the Public Health Engineering Section. He was an associate member of the Institution of Civil Engineers, Great Britain.

Mr. Murray joined The Institute (then the Canadian Society of Civil Engineers) as an Associate Member on October 14th, 1911.

John Henry Walshaw, A.M.E.I.C.

Regret is expressed in placing on record the death at Calgary, Alberta, on September 15th, 1936, of John Henry Walshaw, A.M.E.I.C.

Mr. Walshaw was born at Auckland, New Zealand, on November 18th, 1880, and received his early education in South Shields, England, attending St. John's Technical School in 1897-99. From 1895 until 1901 he was an articled apprentice with R. Goodwin and Sons, constractors and engineers, South Shields. Coming to Canada, Mr. Walshaw was superintendent of construction for J. C. McNeil, Calgary, in 1904-1905, and in 1906 he joined the staff of the Alberta Building Company. Later he supervised the erection of the court house at Wetaskiwin, Alberta, and the Brett hospital and Mount Royal hotel at Banff, Alberta. Returning to Calgary in 1910, Mr. Walshaw was appointed assistant building inspector for the city; in 1912 he became chief assistant building inspector, and in 1915 building inspector, which office he held until his retirement three years ago.

Mr. Walshaw joined The Engineering Institute as an Associate Member on July 23rd, 1918.

PERSONALS

H. C. Brown, A.M.E.I.C., is now connected with the engineering division of the World's Fair Inc., New York, N.Y. The New York World's Fair is to be held in 1939 and 1940. Mr. Brown was formerly at Huntington, W.Va.

Henri Branchaud, S.E.I.C., who graduated from the Ecole Polytechnique, Montreal, in May, 1936, with the degrees of C.I. and B.A.Sc., has been sent to Paris, France, by the Canadian Liquid Air Company, to study welding for a year at the Ecole Superieure de Soudure.

Wm. Schofield, Jr.E.I.C., who was formerly with the Howard Smith Paper Mills Limited at Cornwall, Ontario, is now connected with the Alliance Paper Mills Limited, at Merritton, Ontario. Mr. Schofield graduated from McGill University in 1933 with the degree of B.Eng.

R. F. Legget, A.M.E.I.C., has received a sessional appointment on the civil engineering staff of the Faculty of Applied Science of Queen's University, Kingston, Ont. Mr. Legget has for the past four years been engineer to the Canadian Sheet Piling Company, Limited, of Montreal, and he will be maintaining contact with this company in an advisory capacity on special piling problems.

J. S. Kyle, Jr.E.I.C., who since 1931 has been with the Tropical Oil Company in Colombia, South America, is now in the contract service department of the Canadian General Electric Company, Toronto, Ontario. Mr. Kyle graduated from the University of Alberta in 1928 with the degree of B.Sc.

Lieut.-Colonel J. E. Tremayne, A.M.E.I.C., of Toronto, has entered private practice as a consulting engineer, specializing in all classes of structural design. Following graduation from the University of Toronto in 1916 with the degree of B.A.Sc., Colonel Tremayne went overseas with the Canadian Engineers, and following demobilization he was for a time with the Ontario Department of Northern Development. He was later with the Toronto and York Radial Railway, and subsequently served for over three years in the city architect's department of the City of Toronto. Following this Colonel Tremayne was for a time with the Trussed Concrete Steel Company of Canada Ltd., and was then for five years structural engineer for the Toronto Hydro-Electric System. He was also for a time associated with G. L. Wallace, A.M.E.I.C., consulting engineer, Toronto.

Edward C. Hay, Jr.E.I.C., formerly sales correspondent with the Canadian Westinghouse Company at Hamilton, Ontario, has been transferred by that company to Toronto where he is connected with the merchandise division of the sales office. Mr. Hay graduated from the University of British Columbia in 1930 with the degree of B.A.Sc.

Edgar Stansfield, M.E.I.C., was recently elected chairman of the Edmonton Branch of The Institute. Mr. Stansfield graduated in the honours school of chemistry at Victoria University, Manchester, England, and came to Canada in 1906 to take a position as chemist with the Dominion Iron and Steel Company. From 1907 to 1910 he was chief chemist to an investigation of Canadian coals for the Dominion government at McGill University, and from 1910 to 1920 he was chief engineering chemist for the Fuel Testing Division of the Department of Mines at Ottawa. From 1918 until 1921 Mr. Stansfield was also chief chemical engineer for the Lignite Utilization Board of Canada, and since 1921 he has been chief chemical engineer for the Research Council of Alberta and research professor of fuels at the University of Alberta.

Brigadier T. V. Anderson, D.S.O., A.M.E.I.C., Quartermaster-General National Defence Headquarters, Ottawa, has been promoted to the rank of Major-General. Major-General Anderson graduated from the Royal Military College, Kingston, with honours in 1900, and from McGill University, with the degree of B.Sc., in 1901. From 1902 until 1906 he was on the staff of the Royal Military College, Kingston, and in 1906-1907 he was district engineer of London Military District. In 1909 Major-General Anderson was appointed adjutant of the Corps of Royal Canadian Engineers and from 1914 until 1919 he served overseas. In 1920 he attended the Staff College at Camberley, England, and in 1921 was acting director of military training and staff duties at National Defence Headquarters. From 1921 to 1925 Major-General Anderson was General Staff Officer, 1st Grade, at the Royal Military College, Kingston. In 1925 he was appointed director of military training and staff duties at National Defence Headquarters, and from 1929 to 1933 he was District Officer Commanding Military District No. 10, at Winnipeg, Man. From 1933 to 1935 Major-General Anderson was District Officer Commanding Military District No. 2, Toronto, Ont., and in 1935 he received his present appointment.

Government Departments Reorganized

Plans to combine the departments of the Interior, Mines, Immigration and Indian Affairs into one Department of Mines and Natural Resources were recently announced at Ottawa. The new department will be presided over by the Hon. T. A. Crerar as Minister, and Dr. Charles Camsell, C.M.G., LL.D., F.R.S.C., F.G.S.A., M.E.I.C., a Past-President of The Institute, will become the deputy minister of the entire new department, of which mining and geology will be a leading division.

The department will have five branches, each under a director. John McLeish, M.E.I.C., will have charge of Mines and Geology; J. M. Wardle, M.E.I.C., of Surveys and Engineering; Roy A. Gibson, of Lands, Parks and Forests; Dr. H. W. McGill, of Indian Affairs; and F. C. Blair, of Immigration.

From the time when he graduated from the University of Manitoba in 1894 until his appointment as Deputy Minister of Mines in 1920, Dr. Camsell was engaged in the study and exploration needed to ascertain geological data of the kind on which mining and engineering work must be based. Later, his duties at Ottawa have given him a thorough acquaintance with the Canadian mining industry and with Canadian problems connected with fuel and power supply. Dr. Camsell joined the Canadian Geological Survey in 1904, and much of the mapping of the north was due to his exploration. He was vice-president of the Canadian Institute of Mining and Metallurgy in 1921-22, becoming its president in 1931, and was president and one of the founders of the Canadian Geographical Society. Dr. Camsell was president of The Engineering Institute in 1932. Among his academic honours may be noted the degrees of LL.D., which he received from Queen's University in 1922 and from the University of Alberta in 1929. His achievements as an explorer were recognized in 1922 by the award to him of the Murchison Grant by the Royal Geographical Society as an appreciation of his services in exploring northern Canada; his long connection with the mining industry was fittingly acknowledged in 1931 when the Institution of Mining and Metallurgy, London, presented him with its gold medal for his work in promoting the development of the natural resources of the Dominion and furthering the general interests of the mining industry, and he was made a Companion of the Order of St. Michael and St. George in 1935.

John McLeish, M.E.I.C., graduated from the University of Toronto in 1896 with the degree of B.A., and from 1897 until 1907 he was an assistant in the mines section of the Geological Survey. In 1907 he was appointed chief of the division of mineral resources and statistics of the Mines Department, which office he held until 1920 when he became acting director of the Mines Branch, being made director of the branch in 1921.

J. M. Wardle, M.E.I.C., graduated from Queen's University with the degree of B.Sc., in 1912. Following graduation he was assistant to the city and municipal engineer of Chilliwack, B.C., and in 1914 he joined the Dominion Parks Branch of the Department of the Interior as assistant highway engineer. From 1915 until 1918 Mr. Wardle was acting chief highway engineer, with the Dominion Parks Branch, and in 1918-1920 he was superintendent of the Banff National Park, at Banff, Alta. In 1920 Mr. Wardle was appointed chief engineer of the Canadian National Parks Branch, Department of the Interior, Ottawa, and held that office until 1935 when he became deputy minister of the Department of the Interior, Ottawa.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Canadian Electrical Association: Proceedings of 46th Annual Convention, 1936.

Society for the Promotion of Engineering Education: Proceedings of 43rd Annual Meeting, 1935.

Reports, etc.

American Society for Testing Materials: Year Book 1936.

Royal Technical College, Glasgow: Calendar, 1936-1937.

Tennessee Valley Authority: Unified Development of the Tennessee River System.

Canada, Department of Marine: Annual report 1935-1936.

Canada, Bureau of Statistics, Transportation Branch: Preliminary report, on Statistics of Steam Railways in Canada, 1935.

The Smithsonian Institute: Annual report of the Board of Regents, 1935.

Technical Books, etc.

The Future of Canadian Mining, by the Hon. T. A. Crerar, Minister of Mines.

Principles of Heating, Ventilating and Air Conditioning, by Arthur M. Greene, Jr. (*John Wiley and Sons, New York.*) (*Renouf Publishing Company, Montreal.*)

Handbook of Engineering Fundamentals, O. W. Eshbach. (*John Wiley and Sons, New York.*)

Electrical Engineers' Handbook, H. Pender. (*John Wiley and Sons, New York.*)

Hydraulics, C. W. Harris. (*John Wiley and Sons, New York.*)

Engineering Geology, H. Ries and the late T. L. Watson. (*John Wiley and Sons, New York.*)

Road Curves for safe modern traffic, and how to set them out, by F. G. Royal-Dawson. (*E. and F. N. Spon Ltd., London.*)

BULLETINS

Packing.—A 40-page booklet received from the Garlock Packing Company, Palmyra, New York, contains particulars and sizes of the Klozure oil seal. This sealing ring comprises adapter, spreader or spring, the sealing member and the case, and the design lends itself to many modifications for specific services and requirements.

Refrigerating Machines.—The Carbondale Machine Corporation, Harrison, New Jersey, have issued a 16-page pamphlet (Bulletin No. 1104) illustrating three types of absorption machines: atmospheric, double-pipe and tubular.

Shovel Crane.—A 4-page leaflet received from Dominion Hoist and Shovel Company Limited, Montreal, describes their Model 350, which can be used as shovel, crane, for hook work, clamshell work, or grab work, dragline or trench digging.

Contractors' Equipment.—A 24-page bulletin received from the Worthington Pump and Machinery Corporation, Harrison, N.J., describes and illustrates the equipment offered to contractors by that company, and includes compressed air, drilling and pumping plants, and miscellaneous equipment, for the job and the shop.

BOOK REVIEWS

A Universal Stress Sag Chart

By J. T. Hattingh. Blackie and Son Ltd., London. 1936. 6 by 8¾ inches. 74 pages. 12s. 6d. Cloth.

Reviewed by C. F. Phipps, Jr.E.I.C.*

This book deals with the solution of simple and intricate problems, arising in the study of suspended conductors, in a quick and relatively accurate manner by the use of a universal stress sag chart. The solving of transmission line problems by the methods used in this book should be of interest to engineers engaged in this work. The chart requires a little study in order to become familiar with its construction and the symbols used.

Chapter I and Appendix I explains the derivation of equations, respecting suspended conductors, used in the development of the chart.

Chapter II deals with ice and wind loads on conductors and the reactions at conductor supports.

Chapter III explains the universal stress sag chart and gives some practical examples of its use in solving problems, some of which are: calculation of sags and tensions under different temperatures and loadings; calculation of sags in a span if a conductor breaks adjacent to a suspension support; deflection of supports if conductors should break between two anchor supports; and calculations involving series spans of different lengths—particularly where suspension insulators are used.

Chapter IV deals with problems encountered with loaded catenaries, and two particular cases are considered:

(1) Concentrated load at mid point in a span.
(2) Concentrated loads at third points in a span.

This type of problem comes up in cases where a messenger is used to support a cable.

Appendix II comprises a set of tables giving the characteristics and constants of different types of conductors used for power transmission.

A universal stress sag chart is enclosed in a pocket at the end of the book.

*Shawinigan Water and Power Company, Montreal.

Handbook of Engineering Fundamentals

Edited by Ovid W. Eshbach. John Wiley and Sons Inc. New York (Renouf Publishing Company, Montreal). 1936. 6 by 9 inches. 1081 pages. $5.00. Leather.

Since mathematics, physics and chemistry form the basis of all engineering, these are the fields dealt with in this, the first volume in the proposed new Wiley Engineering Handbook series. "Eshbach" is designed to present in one compact volume a summary of the facts pertaining to the fundamental theory underlying engineering practice.

The first section presents a selection of mathematical and physical tables, in addition to well arranged tables on engineering constants, properties of numbers, logarithms, trigonometric and hyperbolic functions. There follows a series of tables of conversion factors for weights and measures arranged in order of dimensional sequence, tables of integrals, standard structural shapes, and physical properties of metallic and non-metallic materials.

Other sections offer such features as: the presentation of dimension systems, systems of units, standards, and introduction to the theory of dimensional analysis; the systematically arranged and clearly illustrated fundamentals of theoretical mechanics and mechanics of materials with applications to beams, columns, shafts and reinforced concrete; the modern theory of fluid mechanics as applied to the fields of hydraulics and aerodynamics; engineering thermodynamics, embodying the latest physical concepts of the fundamentals of heat engineering; the theory of electric, magnetic and dielectric circuits and their application to generalized networks and transient theory; the fundamental principles of general chemistry, chemical tables and industrial chemistry; the principles of light, acoustics and meteorological phenomena; an extensive handbook treatment of the properties of metallic and non-metallic materials with reference to features of manufacture and use; and a discussion of the elementary legal aspects of contractual relations with which all engineers should be familiar.

As regards format, a larger page permits the use of a larger type size and larger illustrations and diagrams than in the older type of handbook. The result is a much more readable page typographically.

The volume is well bound, opens easily at any page (a point not always attended to), has an adequate index, and can be recommended as one which every engineer, regardless of his specialty, will find a valuable reference book.

Aircraft Engines

Theory, Analysis, Design and Operation

By A. B. Domonoske and V. C. Finch. John Wiley and Sons, New York (Renouf Publishing Company, Montreal). 1936. 6 by 9¼ inches. 342 pages. $3.75. Cloth.

Reviewed by E. W. S.

The very ambitious title of this book is misleading, because upon glancing through one realizes at once that it contains nothing about the mechanical design of aircraft engines, but is devoted almost entirely to the consideration of what takes place within the cylinders.

There is a great tendency at the present time to encourage young engineers to specialize at an early stage in their careers and to teach them the theory of aircraft engines rather than the theory of heat engines. This book follows the modern tendency, and loses something thereby because of the necessity for condensing the theory into two chapters.

From Chapter IV onwards one finds very little ground for criticism and much material that is entirely new to text-books and of considerable value to the student and engineer.

Detonation and anti-detonants are dealt with in Chapter V, which represents a good résumé of present knowledge, and draws attention to the necessity for a new test engine for determining the knock rating of fuels to be used in air cooled aviation engines. Combustion processes in aircraft engines and thermal efficiency are treated effectively in the two subsequent chapters, whilst Chapter VIII gives an excellent description of the present practice for super-charging aircraft engines, including the current empirical method of estimating power obtainable at altitudes. This chapter on super-charging is timely because the very complicated output curves now published by the engine manufacturers are particularly difficult to understand for anybody who is not closely associated with present day methods of testing and recording results.

The final chapters, IX and X, deal with waste heat and cooling, and the testing of aircraft engines in a satisfactory manner.

The book is well produced, inexpensive, and gives an up-to-date account of the present position of the theory of heat engines as applied to the particular problem of the aircraft engine. It should be of value to all students of this subject and to aeronautical engineers.

Analysis and Design of Steel Structures

By A. H. Fuller and F. Kerekes. D. Van Nostrand Co. Inc., New York. 1936. 6¼ by 9¼ inches. 627 pages. $5.00. Cloth.

Reviewed by R. S. Eadie, M.E.I.C.*

A comprehensive development of the theories and methods employed in the design and detailing of steel and wood buildings and bridges is given in this book.

The fundamental theories required in the analysis of the stresses in beams and trusses are developed in the first three chapters. The use of these theories is demonstrated in the following three chapters, in which the design of the component parts of plate girders, roof trusses and mill buildings is gone into. Included in the chapter on mill buildings is a general description of the more common types in use.

Chapter VII deals with the analysis of stresses in bridge trusses due to moving loads. A number of locomotive wheel load tables and diagrams are given and their use discussed. Chapter VIII is a short discussion of the economic factors governing the selection and design of simple span bridges. Chapter IX describes step by step the preparation of the design and the detailing of simple span bridges. Included in this chapter are reproductions of a number of design and detail drawings of actual bridges.

The last three chapters are devoted to the development of the theory of statically indeterminate structures and of secondary stresses. Included with the above is an outline and comparison of the usual methods of distributing the stresses due to wind in multistorey buildings.

Two appendices contain the A.R.E.A. specification for steel railway bridges and the A.A.S.H.O. specification for highway bridges.

Although the authors state in the introduction that this book is intended as a text for undergraduate courses in structural design, it appeals to the reviewer more as a reference work for structural designers. The chapters dealing with the theory of design are too concise to be suitable as a text-book for undergraduates. This is particularly true of the chapters on indeterminate structures and secondary stresses.

The book is excellently printed and is well illustrated by a large number of photographs and diagrams.

**Designing Engineer, Dominion Bridge Company Limited, Lachine, Que.*

Principles of Heating, Ventilating and Air Conditioning

By Arthur M. Greene, Jr. John Wiley and Sons, New York (Renouf Publishing Company, Montreal), 1936. 6 by 9¼ inches, 446 pages. $4.50. Cloth.

Reviewed by E. A. Ryan, M.E.I.C.*

This is a valuable addition to the well known text books on the subject, particularly in its arrangement and conciseness. It will be found very useful, as was its object, as a text book and handbook both for students, engineers and architects in practice. It is replete with valuable technical and practical data necessary in the design of heating, ventilating and air conditioning systems and this is so arranged as to be quickly found and readily understood, even by those who may not have an advanced knowledge of the subject. It is well indexed, and the author has followed the recommendations of various societies in simplifying and listing basic theory and data. It should prove a valuable addition to any library, particularly that of the man engaged in work of which the science of heating and ventilating is a part.

**Consulting Engineer, Montreal.*

CORRESPONDENCE

The Editor,
The Engineering Journal,
Montreal.

Dear Sir:—

As an addendum to Mr. P. B. Motley's collection of timber bridge "primitives" contained in the October issue of The Engineering Journal, I am sending you a photograph of a rare specimen over which I passed with some trepidation in September, 1933. It crosses (or did cross) the Riviere a Mars, near Bagotville, P.Q. While one might conclude that

Bridge over Riviere a Mars, Bagotville, Que.

the spiralling of the end post was done to ease the approach curve, the post bends the wrong way for that commendable service. Nor is it clear as to whether the substantial shore leaning against the truss is to help it to stand up or to help it to fall down.

Yours very truly,

C. R. Young, M.E.I.C.

Department of Civil Engineering,
University of Toronto,
Toronto, Ont.
October 19th, 1936.

BRANCH NEWS

Border Cities Branch

Boyd Candlish, A.M.E.I.C., Secretary-Treasurer.
F. J. Ryder, Jr.E.I.C., Branch News Editor.

The Border Cities Branch reconvened after its summer holidays by holding a dinner meeting at the Prince Edward hotel on Monday evening, September 21st, 1936. J. F. Plow, A.M.E.I.C., assistant to the secretary of The Institute, was the guest for the evening. Sixteen members were present to hear Mr. Plow's discourse on the consolidation of the engineering profession in Canada.

The speaker first outlined the organization of the Canadian Society of Civil Engineers. In 1918 the name was changed to The Engineering Institute of Canada, and its scope was increased to embrace all branches of engineering. The aims of The Institute were outlined, and the reasons for the establishment of the professional associations.

The movement towards co-operation between The Institute and the Professional Associations was not of recent origin, and an historical resumé was given of the work of various committees in the past and of the present Committee on Consolidation which recently has recommended the revision of The Institute's By-laws. These revisions were to be discussed at the Plenary Meeting of Council held in October of this year.

Mr. Plow's talk was very well received, and a barrage of questions was thrown at him showing the interest he had aroused in the subject. After a lengthy questioning period, it was moved by C. G. R. Armstrong, A.M.E.I.C., that the speaker be given a hearty vote of thanks, which was approved unanimously. The Branch chairman, T. H. Jenkins, A.M.E.I.C., tendered the thanks of the meeting to Mr. Plow.

Hamilton Branch

A. Love, M.E.I.C., Secretary-Treasurer.
A. B. Dove, Jr.E.I.C., Branch News Editor.

The Hamilton Branch of The Institute met jointly with the Hamilton Construction Association at McMaster University, under chairmanship of W. Hollingworth, M.E.I.C., on October 2nd, 1936, to hear a most interesting talk, illustrated by motion pictures, on the "British Columbia Lumber Industry."

The British Columbia Lumber Industry

The speaker, Mr. A. Moore of Vancouver, B.C., who is manager of the publication "The British Columbia Lumberman," was ably introduced by Stanley Glover, A.M.E.I.C.

Before commencement of the motion pictures, Mr. Moore discussed various points which would be brought out on the screen. The three reels of film showed both methods of lumbering, i.e., the Swedish and "high rigged." In the latter method, 2- to 2¼-inch cables are strung between topped trees, as high as 300 feet, 2,600 to 2,800 feet apart. The moving pictures clearly demonstrated the high rigger's difficult feat in topping a 300-foot forest giant—and everyone heartily agreed that he earned his $15 per day. The scenes following showed the operations between tree and fished lumber.

In the Swedish system, 'smaller' logs are handled—although the film showed ten and eleven foot diameter logs being brought out. The system consists of a tractor and an arched tractor-driven trailer which carries the draglines by which logs are 'choked' for transportation through the woods to rail-head. This selective system, on the whole, dispenses with rigged topped lines, unless an area is reached in which the tractor cannot be used. To judge from the ground which the tractors traversed in the moving picture illustrating their use, the high rigging would not often be necessary.

Mr. Moore led a spirited discussion on the trade relations of British Columbia with the Empire. Frazer Valley sections logged sixty to seventy years ago, he said, were being relogged of 36-inch timber now. Reforestation is constantly going on, and the supply is inexhaustible, provided fire does not destroy the timber.

Mr. Hannaford moved a vote of thanks, after which the meeting adjourned for refreshments.

Proposed Programme of Meetings

W. J. W. Reid, A.M.E.I.C., chairman of the Meetings and Papers Committee, has an excellent line up of speakers for the coming months.

On October 20th, Professor R. W. Angus, M.E.I.C., of Toronto University, will lecture on the "Life and Inventions of James Watt." 1936 is the bi-centennial of the birth of this great inventor, and Professor Angus, as Professor of Mechanical Engineering, is the logical man to speak about the inventor and inventions which gave such a boost to mechanical engineering.

Another Toronto professor in the person of Professor E. A. Allcut, M.E.I.C., will be the speaker on November 10th. His subject will be "Heat Insulation Tests and Their Application." This subject is of such importance in building design that an invitation will be extended to the architects and builders' supply dealers to join with the Branch.

The appeal for Student papers has not met with a favourable response, so for this year the contest will be withdrawn. December will have a meeting about the second week but the speaker and subject are not definitely known yet.

On January 14th, a representative of the Johns-Manville Company will lecture on "Acoustics." This lecture will also be given to the Royal Canadian Institute in Toronto two days later.

An invitation has been received from the Ontario Section, American Society of Mechanical Engineers, to join with the Grand Valley Division of that Society in a joint meeting next May. Very cordial relations exist between the Grand Valley engineers and the Hamilton Branch, E.I.C., and it is most likely that the meeting will be held and it will be a good one.

London Branch

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

New Federal Government Building

On July 25th, 1936, by the courtesy of the architects and the contractors, the members of the Branch were conducted on a tour of inspection of the new million-dollar Federal building recently erected in this city. This is a palatial building of steel and concrete faced with cut stone, the entrances at street level being faced with polished black granite. The structure is very imposing and is a distinct asset to the city; it comprises eight storeys in height, surmounted by a penthouse.

All, or nearly all of the various government departments are to be housed in this building, post office, customs, income tax, public works, etc., which previously have been installed in various buildings in the downtown area.

The two lower floors are to be occupied by the Postal Department and the entrance halls and public spaces are embellished with marble trims and ornamental metalwork.

Great interest was taken by the members in the various modern machinery units, heating, air conditioning, water softening, etc., installed in the basement.

Votes of thanks were given to the architects and contractors, for the trouble they took to explain all the salient points, and these were suitably acknowledged.

Visit to Labatts Brewery

An adjournment was then made at the invitation by the management of Labatts well-known brewery to look over the large extensions which have been added to their plant during the last two or three years, and a good number of the party availed themselves of it.

Visit to Kellogg Factory

On September 19th a visit was paid to the Kellogg factory in this city, and as the works were in operation, the members and guests, together with their ladies, had the satisfaction of seeing how cornflakes and other toasted cereals were manufactured from the grain to the finished product. The making and filling also of the cartons excited much interest. A noticeable feature was the cleanliness of all the operations, the grain being carried by belts and chutes to and from machines and ovens from start to finish without being touched by anyone.

This tour of inspection was made possible by the courtesy of the management, and the party was personally conducted by members of the staff.

A substantial lunch was provided by the management which, needless to say, was much appreciated by the visitors. Votes of thanks were given and suitably acknowledged.

Visit of Assistant to the Secretary

On September 22nd the Branch had the pleasure of entertaining J. F. Plow, A.M.E.I.C., Assistant to the Secretary, from headquarters. At a dinner meeting held in the Hotel London Mr. Plow gave a condensed history of the past efforts towards consolidation of The Engineering Institute and the provincial organizations together with an account of the present standing of the work of the Committee.

Mr. Plow's talk was much appreciated and it was followed by lively discussion.

Moncton Branch

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

A special luncheon meeting of the Branch was held at the Riverdale Golf Club on August 31st, 1936, at which Dr. E. A. Cleveland, M.E.I.C., President of The Engineering Institute of Canada, was the speaker and guest of honour. G. L. Dickson, A.M.E.I.C., chairman of the Branch, presided, and in introducing Dr. Cleveland, expressed the particular pleasure of the members in welcoming one who was not only a native of New Brunswick but who had also been born within a few miles of Moncton itself.

In his opening remarks, Dr. Cleveland told of spending the morning visiting the old haunts, where, as a boy of fourteen, he had begun his engineering career by joining a railway location party. He dealt at considerable length with the question of consolidation and, while urging every co-operation with the committee that had the matter in hand, reminded his listeners that there was much of value in The Institute as now constituted, and in any scheme of reorganization care should be taken that nothing worth while was lost.

In moving and seconding a vote of thanks, C. S. G. Rogers, A.M.E.I.C., and T. H. Dickson, A.M.E.I.C., expressed appreciation of Dr. Cleveland. Professor H. W. McKiel, M.E.I.C., also referred to the speaker in complimentary terms.

Following the luncheon, Dr. Cleveland, accompanied by officers of the Branch, was taken for a motor tour of Moncton and the surrounding country.

Montreal Branch

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

AIR CONDITIONING

The first meeting of the Montreal Branch for the Fall Session was held on October 8th, 1936. D. W. McLenegan, assistant engineer of the Air Conditioning Department of the General Electric Company, Bloomfield, New Jersey, spoke on the technical and economic aspects of air conditioning. He said that as air conditioning progresses, new and better types of construction would have the effect of considerably lowering the cost of its installation.

A number of engineers were present, as were also members of the Province of Quebec Association of Architects, by invitation. At the close of the meeting light refreshments were served.

W. A. Newman, M.E.I.C., was in the chair.

THE INDUCTION MOTOR OF TO-DAY

E. W. Henderson, who is in charge of motor design for the English Electric Company of Canada, was the speaker at a meeting of the Branch held on October 15th. Mr. Henderson spoke on the design, characteristics and application of various types of induction motors in use in this country.

Professor C. V. Christie, M.E.I.C., acted as chairman.

JUNIOR SECTION

The first meeting of the Junior Section of the Montreal Branch was held on October 21st, with L. A. Duchastel, JR.E.I.C., chairman of the Section, in the chair.

Mr. Duchastel welcomed those present, and gave a brief review of Junior Section activities in Canada, the United States, and other countries.

E. R. Smallhorn, A.M.E.I.C., spoke to university students attending the meeting with regard to membership in The Institute.

The speaker of the evening was W. H. Laidley, a partner in the firm of Wainwright, Elder and McDougall, advocates and barristers, Montreal, who gave an instructive talk on "Incorporating Your Business."

Light refreshments were served at the close of the meeting.

GLASS CASTING FOR 200-INCH TELESCOPE BLANK

Dr. A. O. Gage, manager of the Aviation and Optical Division of the Corning Glass Works, addressed the Branch at its meeting on October 22nd, giving a detailed account of the equipment and methods used in casting a 200-inch blank for the telescope to be used in the new observatory which the Carnegie Technical Institute is building at Palamar, near Pasedena, Calif. He also gave a brief account of telescopes already in use.

Prior to the meeting an informal dinner was held at the Windsor hotel.

G. P. Cole, M.E.I.C., was in the chair.

Niagara Peninsula Branch

P. A. Dewey, A.M.E.I.C., Secretary-Treasurer.
C. G. Moon, A.M.E.I.C., Branch News Editor.

The October dinner meeting was held on the 14th at the Fox Head Inn, Niagara Falls.

Branch Chairman George H. Wood, A.M.E.I.C., presided and the speakers included Walter Jackson, M.E.I.C., who presented the very latest aspects on Consolidation; George E. Griffiths, A.M.E.I.C., in a description of the Vimy Pilgrimage, and Mr. G. C. Grubb, of the Canadian Industries Ltd., who told something of the history and manufacture of explosives. This was followed by three films depicting the use of modern methods in the explosive field of construction and mining.

While there are many varieties of explosives in present day use to meet different conditions, they may be classed roughly into three fields:—(1) Low velocity explosives such as the familiar black powder and ammoniac dynamite for dry work in heaving or moving quantities of loose material. (2) Medium velocity forcite or nitro-gelatin for denser underwater, or wet, work. (3) High velocity dynamite for a shattering effect in the breaking down of metalliferous materials and rock.

EXPLOSIVES—SOMETHING OF THEIR HISTORY, MANUFACTURE AND USE

While the Chinese are generally given credit for the first discovery of black blasting powder, the most authentic records indicate that it was really invented by Roger Bacon, the monk, in about 1250. The new product, however, was apparently put to no useful purpose for over three hundred years, because the first recorded commercial use of black powder was for mining in Saxony in 1613 and for road building in Switzerland in the latter part of the same century.

While black blasting powder still fills a useful purpose—especially in the construction and coal mining industries—by far the most important commercial explosives in Canada, and in the world today, are those with a nitroglycerine base. Sobrero, an Italian doctor, first made nitroglycerine in 1846, but it remained for Alfred Nobel, a Swedish engineer, who carried on most of his life's work in Scotland, to put Sobrero's invention to commercial use. Nobel may be truly called the "father of modern high explosives," for after perfecting the commercial production of nitroglycerine, he then invented dynamite and gelatin and their means of detonation—our modern blasting cap.

Since Nobel's time a great deal of chemical and research work has, of course, been done to improve and develop dynamites and gelatins of types which are best suited for the many different classes of today's commercial requirements. For instance, the kind of dynamite most suitable for a Nova Scotia or Ontario gypsum mine is probably not at all suitable for British Columbia logging operations, and the best type of gelatin for a particular gold mining operation is probably not at all the best type for a submarine blasting job. To best serve all classes of blasting operation in Canada today there are about a half hundred different kinds or sizes of nitroglycerine explosives now manufactured.

The proper formulating of these different explosives is the chemist's art, carefully guarded through process of manufacture by experience and supervision, and to produce them a great many different kinds of raw materials must be used. To name a few of the more important—glycerine, nitric acid, sulphuric acid, nitrate of ammonia, sulphur, nitrate of soda, wood pulp—and twenty or more others.

A modern high explosives plant covers a large area of land, and it is very much a self contained industrial unit. Due to the nature of the product, manufacturing operations are carried on in a great number of separate buildings and these are connected by and served by many miles of steam, air, electric, and water lines, as well as tram tracks and broad gauge tracks, an extensive power house and adequate machine shop facilities. Most large explosives works also provide dwelling houses for their employees, together with facilities for educational, religious and social activities.

Our present civilization could not be carried on without the use of modern high explosives—somewhere they enter into every industry. When you ride over smooth roads, look at a modern skyscraper, snap an electric switch, or enjoy the thousand and one conveniences of our civilization, remember that in the background in some important work explosives have helped to bring these wonders to you.

A. W. F. McQueen, A.M.E.I.C., introduced the speaker and vice-chairman L. C. McMurtry, A.M.E.I.C., proposed the vote of thanks.

Peterborough Branch

W. T. Fanjoy, A.M.E.I.C., Secretary-Treasurer.
E. J. Davies, A.M.E.I.C., Branch News Editor.

R.C.A.F. TRENTON STATION

The annual inspection visit of this Branch was made this year to the Royal Canadian Air Force Station at Trenton, on September 19th, 1936. The fifty-five members and friends assembled in the auditorium of the administration building, where they were welcomed by Wing Commander G. O. Johnston, A.M.E.I.C.

He outlined briefly the work that had been done to date and the projected future development. The work of the past five years has been retarded by lack of funds and also due to the fact that about six hundred unemployed men were quartered at this station, and all

Visit to Trenton Airport

work, excepting that requiring specialized skill, was done by these men. Although the progress was slow, those who were in charge are to be commended upon the results they attained.

The visitors, in conveniently small groups, were conducted around the station by the station officers, and the resident engineer. Starting from the auditorium, the route lead through the offices, quarters, class rooms, student work shops, store rooms, repair shops, seaplane hangar, water tower, buildings under construction and land plane hangars.

The auditorium is a modern room, consisting of main floor and gallery to seat three hundred persons. There is a projection room in which projection machines will later be installed. Unique features are the ventilating system and the indirect lighting system.

The seaplane hangar is built with the length parallel to the shore. The doors are placed in the length adjacent to the shore, and are so arranged that each or all may be raised vertically and then swung horizontally to give a clear vertical opening of 27 feet and so that the entire length is completely open without an interfering column along the length. This means that the entire roof is supported by cantilever trusses on two main columns in the centre of the hangar.

Fire sprinklers are set in the floor and the roof. The hangar is divided into sprinkler sections each working independently of the other. At the roof each section is separated from the other by means of a steel fire curtain, which hangs down 6 feet from the roof.

An observation platform surmounts the water tank, which is 125 feet high, and above that is a revolving beacon light. The stand pipe to the water tank is hollow, the inner portion being the shaft for the elevator which will take six persons. This shaft extends up through the water tank to the platform above.

An interesting feature of the landing field is the fact that 45 miles of drainage tile piping have been laid below the surface of this field. At the present time there are few planes at this station as the actual training of pilots is still being done at Camp Borden. Now that the relief project is over and the construction is again in the hands of contractors it is anticipated that the work will go forward much more quickly and much more flying will soon be done at this station.

When the complete party had assembled at the field hangars an exhibition of stunt flying was given by Flight Sergeant Marshall. The party then adjourned to the Officers Mess where they were entertained with refreshments by Wing Commander Johnston, Squadron Leader D. C. M. Hume, A.M.E.I.C., and J. J. MacNab, A.M.E.I.C., after which the party went to the Gilbert hotel at Trenton for supper.

Quebec Branch

Jules Joyal, M.E.I.C., Secretary-Treasurer.

La section de Québec de l'Institut des Ingénieurs du Canada a repris ses activités saisonnières et a tenu la première assemblée générale de ses membres, le 17 septembre dernier, à l'occasion de la visite officielle du président de l'Institut, monsieur E. A. Cleveland, M.E.I.C., qui fut notre hôte d'honneur à un déjeuner au Château Frontenac.

Présenté à l'auditoire par monsieur Alex. Larivière, président de la section de Québec, monsieur Cleveland nous fit part de ses vues sur le projet actuellement à l'étude pour amalgamer l'Institut des Ingénieurs du Canada avec les diverses Corporations Provinciales ou autres associations d'Ingénieurs Professionnels. Par son allocution notre président général a prouvé qu'il a une connaissance parfaite du problème et nous sommes assurés que des progrès marqués vers le règlement de cette question très controversée se réaliseront avant l'expiration de son terme d'office.

L'honorable Frs. J. Leduc, I.C., député de Laval et ministre de la voirie, était présent à cette réunion et nous fit l'honneur de nous dire quelques mots.

Monsieur A. R. Decary, M.E.I.C., fut invité à adresser quelques mots de remerciements à messieurs Cleveland et Leduc et la réunion prit fin.

A la table d'honneur l'on remarquait messieurs E. A. Cleveland, président général de l'Institut, Alex. Larivière, M.E.I.C., président de la section de Québec, l'honorable Frs. J. Leduc, ministre de la voirie, monsieur Lyon, secrétaire de la délégation française à la Conférence Mondiale de l'Energie, A. R. Décary, A. G. Sabourin, A.M.E.I.C., R. Wood, A.M.E.I.C., H. Cimon, M.E.I.C., A. B. Normandin, M.E.I.C., et T. C. Denis. Assistance totale: 34.

Toronto Branch

W. S. Wilson, M.E.I.C., Secretary-Treasurer.
D. D. Whitson, A.M.E.I.C., Branch News Editor.

The first meeting of the fall and winter sessions of the Toronto Branch of The Institute was held on October 2nd, 1936, at the Royal York hotel, in company with the Ontario Chapter of the American Society for Metals and the Ontario Section of the American Society of Mechanical Engineers. A very enjoyable dinner was held before the meeting, and it is hoped that more combined meetings will be held in the future.

Otto Holden, M.E.I.C., chairman of the Toronto Branch of The Institute, occupied the chair and introduced the speaker, Dr. Wm. B. White, Director of Acoustic Research, the American Steel and Wire Company. Dr. White delivered an able address on "Musical Sounds and their Engineering." With the aid of a projection oscilloscope and other apparatus, Dr. White showed a large and interested audience the nature of sound and how it is propagated. He pointed out that great advances had been made in recent years in the production of instruments for making musical sounds and especially predicted further advances in the near future. Dr. White suggested to his audience that modern instruments might be termed inefficient because they required so much skill on the part of the players and left the thought that instruments of the future would or should be improved in this respect.

Geology of Northern Ontario

The second meeting of the Toronto Branch was held on October 15th, 1936, in the customary quarters in Hart House, University of Toronto, with Otto Holden, M.E.I.C., presiding. A large turnout was well rewarded by a profusely illustrated address by H. C. Rickaby, B.A., Provincial Geologist for Ontario, on the "Geology of Northern Ontario." This is the first of a series of five addresses pertaining to Northern Ontario that are to be delivered to the Toronto Branch this fall. Mr. Rickaby showed graphically how fortunate Canada is in possessing such a large part of the known pre-Cambrian areas, which are such hospitable hosts for many kinds of ore. He predicted that not only would new areas be discovered, but that new finds in the older known areas would continue to be made, such as at Panour Porcupine Mines, etc., which would add to the importance of Northern Ontario for years to come as a source of new wealth.

Winnipeg Branch

J. F. Cunningham, A.M.E.I.C., Secretary-Treasurer.
H. L. Briggs, A.M.E.I.C., Branch News Editor.

Visit of President Cleveland

The Branch held a noon luncheon meeting at the Carlton Club to meet and to welcome President E. A. Cleveland, M.E.I.C., as he passed through Winnipeg on his return from the World Power Conference at Washington, D.C.

After the luncheon, President Cleveland spoke briefly on the subject of the consolidation of the engineering profession in Canada, urging that all engineers view the matter with an open mind and in the belief that an agreement as to the necessity of such a step will push into the background many of the existing controversial points. Each point can then be settled in some manner most satisfactory to all concerned.

The meeting was presided over by George E. Cole, M.E.I.C.

The Noranda Project

The first regular evening meeting of the Branch for the 1936-37 season was attended by one hundred and sixty members, students, and visitors.

Prior to showing the film "The Noranda Project," G. E. Cole, M.E.I.C., chairman of the Winnipeg Branch, outlined the magnitude of this well-known Canadian mine which in 1935 produced:

Copper........................	74,478,436 pounds
Gold..........................	268,333 ounces
Silver........................	544,559 ounces

The film showed the progress of the operations from when the ore was broken from the main ore bodies and taken through the crushing plant, the flotation process and the smelter, all at Noranda, and until pure copper rod bars are produced from the refineries at Montreal East. Copper wire drawing operations were also shown.

Professor A. E. MacDonald, A.M.E.I.C., moved the vote of thanks to Mr. Cole for his outline and running comments, and to the Noranda Mines Ltd. for the privilege of viewing their film.

HOW TO BECOME A MEMBER IN GOOD STANDING

NON-ACTIVE members may return to active status without filing an application on payment of 1937 fees. Full payment of any arrears of fees owing will be appreciated if the member is in a position to make it. However, if he is not, a $5.00 payment will be accepted and any remaining arrears cancelled.

RESIGNED members may return to active membership without payment of an entrance fee, regardless of the date of resignation, but must submit a record of their professional career up to date.

REMOVED members will be reinstated on payment of $5.00 reinstatement fee. Payment of annual fees for 1937 will be expected when due.

MEMBERS MAY TRANSFER to a higher grade by submitting an application for transfer. The present transfer fee, effective for a brief period only, is $5.00 from Student to Junior or Associate Member. Transfer from Junior to Associate Member or from Associate Member to Member, does not require any fee.

(The above arrangements have been approved by Council.)

Invention

A. E. MacRae, A.M.E.I.C.,
Consulting Engineer and Patent Solicitor, Ottawa, Ont.

Paper presented before the Science Association, National Research Council, Ottawa, April, 1935.

No statute in any country precisely defines "invention," although all patent statutes frequently use the term. Since the days of the Statute of Monopolies, which was passed in 1623 and is the fountainhead of the patent laws of the world, the courts of many countries have been concerned with defining the term as applied to particular sets of circumstances before them at the time. Yet even at this advanced stage there is no court decision which is capable of closely defining invention as applied to all sets of circumstances. Thus the best that can be done is to take into consideration some fairly well defined principles and apply them to the particular circumstances in hand in the light of the leading court decisions applicable thereto. It is generally conceded that there is more difficulty in accurately appraising invention in the chemical and related arts than in most others.

Invention is sometimes confused with discovery but there is a clear distinction. A discovery reveals something which was hidden or not previously recognized, while an invention produces something which did not previously exist. Newton discovered the law of gravity, he did not invent it. The identification of radium and of the other chemical elements with their inherent properties and characteristics may be regarded as a discovery but in itself does not constitute an invention. This does not mean, however, that no invention was made in the work which resulted in the discovery of the element. New methods and new types of apparatus may have been developed in the work leading to the discovery. The recognition of the fact of the circulation of blood, of the value of antisepsis or of any natural law principle is not an invention, although it may be a very far-reaching discovery. Natural laws and scientific principle evolved through discovery are among the tools used by the inventor.

Lord Justice Lindley said: "When Voltaire discovered the effect of an electric current from his battery on a frog's leg he made a great discovery but no patentable invention. Again, a man who discovers that a known machine can produce effects which no one before him knew could be produced by it may make a great and useful discovery, but if he does no more his discovery is not a patentable invention. A patentee must do something more. He must make some addition not only to knowledge but to previously known inventions, and must so use his knowledge and ingenuity as to produce either a new and useful thing or result or a new and useful method of producing an old thing or an old result. A patent for the mere use of an old contrivance without any additional ingenuity in overcoming fresh difficulties is bad and cannot be supported. If the new use involves no ingenuity but is in manner and purpose analogous to an old use, although not quite the same, there is no invention, no manner of new manufacture, within the meaning of the Statute of James I. On the other hand, a patent for a new use of an old contrivance is good and can be supported if the new use involved practical difficulties which the patentee has been the first to see and overcome by some ingenuity of his own. An improved thing produced by a new and ingenious application of an old contrivance to an old thing is a manner of new manufacture within the meaning of the Statute."

Invention resides in an idea conceived in the mind of the inventor and put into practice or useful form by him. Such a thing, while an invention in the broad sense, is not a patentable invention unless it meets other requirements. It must be new. It must not have previously existed as such and, in addition, its production must require the exercise of skill or ingenuity of a character which would not be expected of a person having ordinary skill and knowledge in the particular art and under similar circumstances. On this latter point, which is so important, let me quote the words of Mr. Justice Rinfret, of the Supreme Court of Canada, in a recent case: "Novelty and utility, without something more requiring the exercise of an inventive faculty, would not be sufficient to make it invention. The patentee must show an inventive step . . . No doubt mere smallness or simplicity will not prevent a patent being valid, but if you apply a known device in the ordinary way to an analogous use, without any novelty in the mode of applying it, you may get a useful article, you may get an article which, in a sense, is improved and novel but unless you show invention, that is to say, that in adapting the old device there were difficulties to overcome or there is ingenuity in the mode of making the adaptation, you do not show a valid subject matter of a patent."

He said in another case, "It is not enough for a man to say that an idea flowed through his brain. He must at least have reduced it to a definite and practical shape before he can be said to have invented a process."

Clearly there must be something special about the idea which may be regarded as invention but let me refer to other cases as to the extent of that particular element.

In an important case the Privy Council summarized the law on the question by quoting the words of Mr. Justice McLean, of the Exchequer, as follows:—

"There must be a substantial exercise of the inventive power or inventive genius, though it may in cases be very slight. Slight alterations or improvements may produce important results, and may disclose great ingenuity. Sometimes it is a combination that is the invention; if the invention requires independent thought, ingenuity and skill, producing in a distinctive form a more efficient result, converting a comparatively defective apparatus into a useful and efficient one, rejecting what is bad and useless in former attempts and retaining what is useful, and uniting them all into an apparatus which, taken as a whole, is novel, there is subject matter. A new combination of well-known devices, and the application thereof to a new and useful purpose, may require invention to produce it, and may be good subject matter for a patent."

In another case invention was defined in these words: "It is finding out something which has not been found out by other people."

Others have said, "The very simplicity of an invention may be the best proof of its value . . . Others knew what was needed but the inventor did it."

"We must be careful that we are not misled by the simplicity of an apparatus into a belief that no invention was needed to produce it. Experience has shown that not a few inventions, some of which have revolutionized the industries of this country, have been of so simple a character that when once they were made known it was difficult to understand how the idea had been so long in presenting itself, or not to believe that it must have been obvious to everyone."

It is now evident that the question of whether there is or is not invention is one of fact as well as of degree. Mere simplicity does not negative invention; indeed, it may support it. A small degree of ingenuity may be sufficient to make an invention patentable but mere novelty or usefulness is not sufficient. Thus, in considering a particular case, the problem is to determine whether the application of the new idea is such as naturally to suggest itself to one taking up the subject. This involves a determination of what the new idea actually is and sometimes this becomes quite an involved task which is somewhat outside the particular subject under discussion. However, it should be said that where there are new or improved results in efficiency or economy, or both, the case is one which may well embody invention.

Now to consider what may be regarded as expected skill.

Substitution of superior materials for others in a machine is but expected skill but if the substitution of one material for another in a composition or as a reagent in the operation of a process develops new properties in the composition or new or improved results in the operation of the process, it may amount to more than expected skill. The use of an alloy of copper and zinc instead of copper itself for the sheathing of ships was held to be an invention because of the improved results obtained. A process of welding aluminum by the use of the high temperature of oxygen-hydrogen blow pipe and a flux which had previously been used for soldering aluminum was held to be invention because of the unforeseen behaviour of the flux at the higher temperature.

The use of an old process, composition or machine for a new, but analogous, purpose involves but expected skill. Care must be taken, however, to accurately determine the analogy between the new and the old use. Are the same functions performed in the new as in the old use, and are the effects produced the same in both cases, are pertinent questions.

Changes in degree or size usually involve but expected skill although invention was found in the reduction of the diameter of the filament of the incandescent light from one-thirty-second of an inch to one-sixty-fourth of an inch because of the results obtained. The resistance was increased four times and the radiating surface reduced twofold, thus increasing eightfold the ratio of resistance to radiating surface and permitting the use of electricity of higher electromotive force and comparatively little current instead of the reverse.

It is expected skill to change a composition, a process or a machine by substituting an equivalent for any of its parts unless the new part develops new uses or properties of the article or performs another function by a different way of operation.

To change form or proportions without the production of a new mode of operation or new results is but expected skill but to change the proportions of a chemical combination or other composition of matter to produce a new product having new properties requires the exercise of more than expected skill.

To omit one or more parts with an omission of the function performed thereby is but expected skill unless the parts retained operate in a new way as a result of the omission.

Superior character of workmanship performed on an article, changes in strength or size of a machine for operation on larger materials or combining old articles or machines to provide something new without producing a new method or mode of operation, are not generally regarded as requiring the exercise of more than expected skill.

Despite these guiding principles, whether in a particular case there is invention or, in other words, the result of the exercise of more than expected skill, is a question of fact depending upon the special circumstances involved and has to be decided on the evidence of those having technical skill and knowledge which enables them to understand and appreciate the significance of the subject matter in hand.

The courts are frequently confronted with conflicting evidence on the part of so-called expert witnesses but generally exhibit skill in detecting the essential features upon which invention may be supported or denied.

It may be of interest to refer to the subject matter of a few Canadian cases in so far as they have a bearing on this question of invention. However, the question of novelty has much to do with the subject since it is very difficult to expel from the mind a knowledge of the state of the art and consider only the question of whether the alleged inventor actually exercised more than the skill which should be rightly expected from him. Nevertheless, theoretically that is what should be done, and having found invention to be present the question of novelty becomes one of anticipation. In other words, is the invention a new one?

The Exchequer Court found invention in a composition of matter used as a weed-killer and containing substantially 3 to 4½ pounds of sodium chlorate and 2 to 5 pounds of calcium chloride with water to make one gallon of solution, as well as in the method involved in its manufacture and use. In this case Mr. Justice McLean used the following words, quoted at some length since they indicate judicial reasoning. "Turning now to the question of invention. The law concerning chemical inventions, and I am treating this case as such, is the same as in any other invention. A chemical compound which has never been known or used, or published, in the sense required by the law of patents, for the accomplishment of a specific purpose is, I think, patentable, providing one may assume some degree of skill and ingenuity, or, perhaps I should say in a case of this kind, the exercise of intelligent research and experiment directed to a particular purpose or end. When two or more compounds are mixed or chemically combined, the product or method of producing the product, may or may not be patentable, because much, as in all other cases, depends upon the result obtained, and the properties of the product. 'There is no prevision in chemistry' is an observation attributed to Sir James Dewar. One cannot always predicate the results that may be obtained from chemical substances in combination, as in a combination of mechanical devices. The trained mechanical man can readily calculate the effect or result of the combination of certain mechanical devices, but that is not so in chemistry which is an experimental science, predictions are liable to failure without experiment, and results are obtained only by concentrated experiment and research. Where chemical action is involved analogy does not carry one far. The experimental chemist is perhaps therefore entitled to more favourable consideration than one working in the mechanical field, in the matter of invention. The discovery of a new principle, natural law, or a new chemical principle, cannot be patented unless it can be put to some new and useful use in the form of a described process, composition of matter, or apparatus. When that is done, there is then a patentable invention even though it embraces a discovery. The herbicidal preparation disclosed by Chipman, now known under the trade name of Altacide, is undoubtedly, I think, a new and useful herbicide compound. It is superior as a weed killer to arsenical compounds in the respect that it is non-poisonous to animals. It is superior to the sodium chlorate preparation because the fire hazard has been practically eliminated in Chipman. It is undoubtedly an effective weed killer. All these favourable features of Chipman were not, so far as I recall, seriously controverted. Chipman discloses a process or method of obtaining in commercial quantities, calcium chlorate, something previously known only to the laboratory. Then, Chipman has been well received by the interested public and has gone into very substantial use in Canada and the United States, production and sales expanding with the years. It meets other requirements, availability of raw materials, cheapness, capacity for concentration thus affecting favourably freight charges, all desirable in producing and marketing any herbicide. There can be no doubt, I think, but that Chipman accomplishes new and useful results, more than was inferrable from the prior art. But more than novelty and bare utility is required to constitute invention. Some evidence of ingenuity and skill is required by the Courts in order to constitute invention. There is, I think, in Chipman sufficient evidence of skill, research and experiment to hold that there is subject matter for a patent or patents as claimed here. To say that sodium chlorate as a weed destroyer was known, and that calcium chloride was known as an absorbent of moisture or as a hygroscopic agent, and therefore there was no invention in combining them together to overcome a specific difficulty, to avoid disadvantages in sodium chlorate as a herbicide, is not of substance. That contention is not supported by authority and it has been held time and again, that if a new combination of well known things bring about new and useful results, there is invention. The combination of substances disclosed by Chipman had not been done before for the purpose of a herbicide, and new results were produced by that combination. New properties and results may be produced by a change in the proportions of ingredients and that, I think, is true of this case. Chipman seems to have accomplished something more than might reasonably be expected of the hypothetical person skilled in the art, and all, I think, required of him is that he do more than is to be inferred from prior publications or known usages in that particular field, and this I think Chipman has done. Unless there has been anticipation, which I shall next deal with, I hold there is invention."

On the other hand, the Exchequer Court found no invention in a composition of matter for insulation purposes comprising comminuted wallboards having paper covers and hydrated gypsum cores so that the composition is a light, fluffy mixture of partially hydrated gypsum and fibres. The President of the Court in his reasons for judgment said: "The question for determination here is one of fact, and that is whether or not there is invention. It appears to me that the plaintiff's patent cannot be supported for want of subject matter. Thermofill has utility but, I think, only a comparative utility, a possible increase in utility over some other known insulating material. But utility is not an infallible test of originality. To support a valid useful manufacture, it must have involved somehow the application of the inventive mind; the invention must have required for its evolution some amount of ingenuity to constitute subject matter, or in other words invention. Fortunately the law does not authorize the granting of a monopoly for everything that is new and useful. The design of the patent law is to reward those who make some substantial discovery or invention which adds to our knowledge and makes a step in advance in the useful arts. If there is no novelty there can of course be no inventive ingenuity, but if there is novelty in the sense required in the law of patents, it must be the product of original thought or inventive skill. As stated in the cases, the inventive ingenuity necessary to support a valid patent may be found in the underlying idea, or in the practical application of that idea, or in both. It may happen that the idea or conception is a meritorious one, but that once suggested, its application is very simple. Again, it may be that the idea is an obvious one, but that ingenuity is required to put it into practice. Or, again, the idea itself may have merit and the method of carrying it into practice also require inventive ingenuity. In all these respects, I think, the alleged invention in this case fails. I cannot see how there can be invention in the idea of combining ground calcined gypsum with shredded paper stock, and blending them together, and after all that is the essential feature of the alleged invention. The state of knowledge concerning the principle of heat, cold, or sound insulation, the wide range of known materials possessing heat insulating properties or fire resisting properties, their respective insulating values singly or in combination, and the many known methods of production and application of these insulating materials, was too extensive in my judgment to hold that what the plaintiff's patentee disclosed in his specification was invention. The insulating properties of the different elements entering into the Thermofill was known; it must have been known that the union of calcined gypsum with shredded paper stock or other fibrous material, however united or applied, would make an insulating material; the crushing, grinding and mixing did not involve a new method or means requiring the exercise of the inventive ingenuity. No serious difficulty was experienced by Bolduf in grinding gypsum board from the very start. Any skilled mechanic could have produced a machine that would grind the board whenever required to do so. The dry bulk fill insulation was known and practised. The introduction of shredded paper, or its equivalent, into ground calcined gypsum was known and had been practised, for instance, by Govan. It seems to me that all the patent discloses, lay in the track of old processes, methods, and means of insulation, and it is to be assumed that the patentee had access to everything that was commonly known. I do not think that the specification discloses sufficient invention to justify a monopoly."

Both the Exchequer and the Supreme Court recently found invention in a casket handle defined as follows:

"A handle comprising a base member having an opening and provided with a pivot bar extended across the opening and a grip insertible into the opening and having a slot receiving the pivot bar, the slot defining a bendable finger in the grip, the finger co-operating with the base member at the lower edge of the opening, when the grip is raised, to secure a bending of the finger, a partial closing of the slot, and a permanent pivotal mounting of the grip on the pivot bar."

The Supreme Court in analysing the structure said: "It will therefore appear that the thing or combination which the inventor regarded as new, and for which he claimed 'an exclusive property and privilege' (Patent Act, s. 14), is a handle comprising a base member and a grip member. The base member must have an opening into which the grip is insertible. The base member is provided with a pivot bar extended across the opening. The grip has a slot receiving the pivot bar; and that slot defines a bendable finger.

"Such is what we would call the constructional part of the specification, and it must have been evident to persons having the technical skill and knowledge, to whom, after all, claims of this nature are primarily addressed—it must have been evident that, having regard to the state of the art as disclosed in the evidence, there was no novelty in the integers of the combination so far enumerated.

"But the claims proceed to say that the bendable finger co-operates 'with the base member at the lower edge of the opening, when the grip is raised, to secure a bending of the finger, a partial closing of the slot, and a permanent pivotal mounting of the grip on the pivot bar'; and there lies the gist of the invention. The article thus described is a construction which will permit the permanent assembly of the two parts of the handle by merely 'raising' the grip. The principle disclosed in the claims is the arrangement of the bendable finger in such a way

(*Continued on page 515*)

Preliminary Notice

of Applications for Admission and for Transfer

October 29th, 1936

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

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

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

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

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

The Council will consider the applications herein described in December, 1936.

R. J. Durley, Secretary.

---

*The professional requirements are as follows:—

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

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

Every candidate who has not graduated from a school of engineering recognized by the Council shall be required to pass an examination before a board of examiners appointed by the Council. The candidate shall be examined on the theory and practice of engineering, with special reference to the branch ofengineering 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 year.

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 equiva ent standard.

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

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

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

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

FOR ADMISSION

HALL—HENRY MONROE, of Toronto, Ont., Born at Vergennes, Vt., U.S.A., May 7th, 1882; Educ., B.A., Dartmouth College, Hanover, N.H., 1904; 1904-18, mill supt., Aluminum Co. of America, Massena, N.Y.; 1918-19, plant engr., Calco Chemical Co., Bound Brook, N.J.; 1919-24, gen. supt. and cons. engr., Geo. C. Moon Co., Garwood, N.J.; 1925-26, gen. mgr., Roy Sales Co., Boston, Mass.; 1926, American Copper Products Co., New York, N.Y., cons. engr.; 1926-28, mill supt., American Smelting and Refining Co., Baltimore, Md.; 1929-30, cons. engr., Macdonald Bros., Boston, Mass.; 1930 to date, mill supt. and wire rope engr., Canada Wire and Cable Co., Toronto, Ont.

References—H. Horsfall, W. G. Chace, F. W. Gray, S. C. Mifflen, W. C. Risley.

HORTON—EVERILL BLACKWELL, of 41 Humewood Drive, Toronto, Ont., Born at Toronto, Nov. 27th, 1906; Educ., B.A.Sc., Univ. of Toronto, 1931; Summer work 1928-29, operating ore crushing machy. and mtce., Kirkland Lake G.M. Co., motor car assembly, Durant Motors, Canada, aircraft rigging and repair, Ontario Air Service, surveying and dfting mining claims and townsites; 1931 (Jan.-Aug.), research, on development of elect'l. and mech'l. devices, Electrical Construction Co., Toronto; 1933-34, asst. engr., Trans-Canada Airways, Northern Ontario Group, Dept. of National Defence; May 1934 to Feb. 1935, not engaged in engrg. work; at present, general machinist in plant of Link-Bell Ltd., Toronto, Ont.

References: D. S. Laidlaw, H. L. Sherwood, A. W. F. McQueen, R. E. Smythe, E. A. Allcut, S. L. Grenzebach.

LASH—ALFRED WILLIAM, of St. Catharines, Ont., Born at Sheffield, England, Nov. 18th, 1898; Educ., M.Eng., Univ. of Sheffield, 1921. B.Com., Univ. of London. Assoc. Member, Inst. C.E.; 1916 (3 mos.), foundry and pattern shops;1917-18, mech'l. shops, incl. 15 mos. automobile repair work in France (War Service); 1919 (3 mos.), Ewden Valley reservoir constrn.; 1920-23, asst. to res. engr. and mgr., Llwyn, on reservoir constrn., City of Cardiff, constrn. of a large earth dam with usual ancillary works, road diversions, bridges, pipe lines, etc.; 1923-25, asst. res. engr. and mgr., Grwyne Fawr reservoir constrn. for Abertillery and District Water Board, concrete of large concrete dam; 1925-26, travelling in U.S.A. and Europe on a Sir Ernest Cassel Travelling Scholarship awarded by the Univ. of London; 1926-28, municipal waterworks engr., Canadian Fire Underwriters Assn.. Montreal, inspecting and reporting on municipal water supplies, fire depts., etc., in the Province of Quebec; 1928-36, asst. hydraulic engr., Power Corpn. of Canada Ltd., Montreal, engaged on various hydro-electrical projects including Back River, Seven Sisters, Upper Notch, etc., and reports on power and other projects; at present, hydraulic engr., Ontario Paper Co. Ltd., Thorold, Ont.

References: M. H. Jones, J. Stadler, J. S. H. Wurtele, L. C. Jacobs, J. F. Roberts.

McBRIDE—WILBERT GEORGE, of Montreal, Que., Born at Inglewood, Ont., Feb. 8th, 1879; Educ., B.Sc. (Mining), McGill Univ., 1902; Summers 1900-01, miner, Crows Nest Pass Coal Co., exploratory survey; 1902-03, surveyor, and 1903-07, chief engr., Copper Queen Mining Co.; 1907-09, supt., Sierra de Cobie Mines; 1909-16, gen. supt., Great Western Copper Co.; 1916-17, asst. gen. mgr., Detroit Copper Co.; 1917-27, gen. mgr., Old Dominion Co.; 1927 to date, professor of mining engineering, McGill University, Montreal, Que.

References: E. Brown, H. H. Vaughan, R. E. Jamieson, R. DeL. French, C. V. Christie.

SCHERMERHORN—HENRY LEWIS, of Napanee, Ont., Born in Richmond Township, Ont., May 2nd, 1895; Educ., 1919-21, Queen's Univ.; With the Dept. of Highways of Ontario as follows: 1919-21, rodman, 1921-27, asst. to res. engr., 1927 to date, district engr. of municipal roads, Prov. of Ontario, Napanee, Ont.

References: R. M. Smith, A. A. Smith, W. P. Wilgar, A. K. Hay, J. B. Wilkinson.

SCOTT—CLARENCE WHITING HARMER, of 299 Argyle Road, Walkerville, Ont., Born at Napanee, Ont., Aug. 21st, 1899; Educ., B.Sc., Queen's Univ., 1927; 1918-19, meter inspr., service mtce. and elect'l. installn., Belleville District, H.E.P.C. of Ontario; With Dept. Prov. Highways of Ontario as follows: 1919-20, rodman, 1920-23, rodman, levelman, transitman, office dfting .under res. engr. at Napanee, Ont.; 1923-26, inspr. of macadam, grading, ditching, culvert and bridge constrn., concrete, coffer damming and crib work; 1934-35, inspr'man. on highway location survey party, Dept. of Northern Development; 1926-1934, and 1935 to date, with the Canadian Bridge Co. Ltd., Walkerville, Ont., making ,checking and estimating shop details, layouts, etc., for all kinds of steel structures, including various kinds of bldgs., fixed bridges, movable bridges and elect'l. transmission structures.

References: D. T. Alexander, F. H. Kester, R. C. Leslie, L. T. Rutledge, R. M. Smith.

STEAD—HARRY G., of 810 Princess Avenue, London, Ont., Born at Wilton Grove, Ont., Jan. 26th, 1908; Educ., Night School at London Technical School, studies up to Senior Matric. in Maths. and Physics; With E. Leonard & Sons Ltd., London, Ont., as follows: 1923-27, ap'tice mech'l. dftsman., 1927-31, mech'l. dftsman., 1927-31, mech'l. dftsman, and 1931 to date, chief dftsman.

References: I. Leonard, A. H. Morgan, H. A. McKay, D. S. Scrymgeour, E. V. Buchanan.

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

MACDONALD—ALBERT EDWARD, of Winnipeg, Man., Born at Halifax, N.S., Feb. 20th, 1900; Educ., B.Sc., N.S. Tech. Coll., 1920. M.Sc. (Civil), McGill Univ. 1922; R.P.E. of Man.; 1917-18 (summers), dftsman., concrete inspr. and instr'man., bridge dept., Halifax Ocean Terminals; 1918-19, and 1919-20, instructor in mech. drawing and descriptive geometry, Dalhousie Univ., Halifax; 1920-21, lecturer in civil engr., Univ. of Alberta; 1923 to date, Dept. of Civil Engrg., Univ. of Manitoba, 1923-30, asst. professor, 1930-36, associate professor, and at present, professor of civil engrg. and head of the dept.; During summers engaged on various engineering works including—1922-23, struct'l. engr. on design of reinforced concrete terminal grain elevators, C. D. Howe & Co., Port Arthur; 1929-30, struct'l. engr. on reinforced concrete bldgs., for Cowin & Co. Ltd., Winnipeg; 1928, concrete expert on constrn. of 7,000,000-bushel grain elevator at Port Arthur; 1935, designed and supervised constrn. of underpinning for 5-storey apartment bldg. in Winnipeg; also retained as expert witness in a number of legal actions. (*St. 1919, Jr. 1922, A.M. 1932.*)

References: E. P. Fetherstonhaugh, J. N. Finlayson, C. D. Howe, H. B. Henderson, A. W. Fosness, E. V. Caton, E. Brown, F. R. Faulkner.

REID—JOHN HERBERT, of Port-of-Spain, Trinidad, B.W.I., Born at Seattle, Wash., Aug. 27th, 1890; Educ., B.Sc. (E.E.), McGill Univ , 1916; 1915-19, overseas Infantry, R.F.C. and R.A.F. 1910-12, elec. constrn., City of Grand Forks, B.C.; 1912-13, elec. mtce., Granby Mining, Smelting and Power Co., Grand Forks; With the Can. Gen. Elec. Co. Ltd., Peterborough, Ont., as follows: 1919-20, student course, 1920-21, asst. designing engr., A.C. generator section, 1921-22, asst. constrn. engr.; 1921-28, asst. professor of elect'l. engrg., Nova Scotia Technical College, Halifax, N.S.; Summer work included inspection of transmission line bldg., operation of 4 hydro electric power stations of N.S. Power Commn., adjustments of armature windings of 13,000-volt alternators for N.S. and N.B. Power Commns. for Can. Gen. Elec. Co.; 1928 to date, gen. supt., Trinidad Electric Co., Pôrt-of-Spain, Trinidad.

In charge of steam turbine and Diesel power station, light and power distribution system, street railway, and refrigeration plant, for Port-of-Spain. (*Jr. 1919, A.M. 1924.*)
References: F. R. Faulkner, G. H. Burchill, J. H. Winfield, C. H. Wright, W. M. Cruthers.

FOR TRANSFER FROM THE CLASS OF JUNIOR

ALLISON—JESSE GRAHAM, of 1038 Main St., Vancouver, B.C., Born at Cincinnati, Ohio, May 18th, 1903; Educ., B.Sc. (E.E.), Univ. of So. California, 1927; 1927-30, asst. estimator (constrn.), and 1930-33, estimator and purchasing agent, H. C. Johnston Co. Ltd., Montreal, Que.; 1933-35, real estate and investments; 1935-36, mgr. of tire agency (Commercial Tires Ltd., Montreal). (*St. 1924, Jr. 1931.*)
References: H. C. Johnston, B. R. Perry, W. S. Atwood, F. Peden, W. M. Reid.

FOR TRANSFER FROM THE CLASS OF STUDENT

BERRY—MELVILLE DOUGLAS, of 31 Stanhope Ave., Toronto, Ont., Born Rush Lake, Sask., June 7th, 1908; Educ., B.Sc. (E.E.), 1931; 1929, General Engrg. Co., Hudson Bay Mining and Smelting; 1930-33, Canadian Westinghouse Co., ap'tice. and test course; 1933-34, operated small repair shop (elect'l.) in Hamilton; 1934-35, design and shop work, Hamilton Dynamo and Motor, Hamilton; 1935-36, dftsman., Leland Electric Co., Dayton, Ohio; Jan. 1936 to date, engr. responsible for mech'l. and elect'l. design, and asst. production, Leland Electric Canada Ltd., Toronto, Ont. (*St. 1928.*)
References: J. R. Dunbar, E. P. Fetherstonhaugh, W. F. McLaren.

COLEMAN—SHELDON W., of Ottawa, Ont., Born at Montpelier, Vt., U.S.A., June 13th, 1906; Educ., B.Sc. (Civil), McGill Univ., 1928. Air Pilotage, Seaplane, Instructors' and Instrument Flying Courses, R.C.A.F.; 1926, instr'man., transmission line constrn., Green Mountain Light and Power Co.; 1927-28 (June-Oct. in each year), road constrn. design, Vermont State Highway Dept.; 1928-29, asst. struct'l. steel designer, John S. Metcalf Co.; With the R.C.A.F. as follows: 1931-32, Officer i/c School of Technical Training, Camp Borden, also Flying Instructor at Camp Borden; 1932-34, Adjutant, Maritime (Mounted Police) Operations; 1934-35, Operations Officer No. 4 (FB) Squadron; Nov. 1935 to date, Adjutant (Flight. Lieut.), No. 8 (GP) Squadron, at Winnipeg, Man. (*St. 1925.*)
References: E. W. Stedman, A. Ferrier, F. C. Higgins, H. Rolph, E. Brown, J. E. Genet.

FISHER—CHARLES BODDY, of 4566 Oxford Ave., Montreal, Que., Born at Wiesville, Alta., Aug. 8th, 1908; Educ., B.A.Sc., Univ. of Toronto, 1930. M.Eng., McGill Univ., 1933; Summers: 1925, ap'tice, Alberta Govt. Telephones. 1926, rodman, Alberta Highways Branch. 1927, rodman, and 1928, instr'man., C.N.R.; With the Northern Electric Co. Ltd., Montreal, as follows: 1928-29, shop inspr.; 1930-33, development engr., special products; 1934-35, development engr., radio receivers, and 1935 to date, engr. in charge, radio receivers, engrg. dept. (*St. 1927.*)
References: H. J. Vennes, J. S. Cameron, W. H. Eastlake, N. L. Morgan, E. S. Kelsey.

LEIGHTNER—DONALD BENJAMIN, of 95 Spadina Ave., Hamilton, Ont., Born at Jansen, Sask., April 10th, 1908; Educ., B.Sc. (E.E.), Univ. of Man., 1931; 1931-33, student ap'tice. course, Canadian Westinghouse Co., Hamilton, Ont.; 1929-30, drawing office, Can. Gen. Elec. Co. Ltd., Peterborough, Ont.; 1933 to date, engrg. dept., Canadian Westinghouse Company, 1933-35, transformer design, and 1935 to date, induction motor design. (*St. 1929.*)
References: D. W. Callander, J. C. Nash, W. F. McLaren, J. R. Dunbar, G. W. Arnold, W. L. Miller.

MACPHERSON—JOHN MILES, of North Devon, N.B., Born at North Devon, Aug. 23rd, 1903; Educ., B.Sc. (C.E.), Univ. of N.B., 1933; Three years ap'ticeship as machinist and three years practice in shop work; 1931, 1935, and at present, instr'man., N.B. Highway Dept., North Devon, N.B. (*St. 1934.*)
References: J. Stephens, E. O. Turner, C. G. Grant, A. F. Baird, D. W. Burpee.

Invention (*continued*)

that, in the words of the inventor at the trial, it will 'hook-up automatically' by the mere upward lift of the grip. That is an interpretation of the claims to which, in our view, the respondent is entitled upon a fair reading of the whole of the specification. In the light of that specification, the words 'the finger co-operating' in the claims may reasonably be construed as meaning: 'capable of co-operating.' In that sense and contrary to what was urged by the appellant, the invention does not consist solely in a mode of attachment or in a method of locking the parts, to which, when the finger is once bent or when the closing of the slot is once permanently secured, the claims no longer apply. The invention is not precisely the method of locking. It is rather the particular construction whereby that method is made possible, the arrangement whereby the bendable finger will close by the mere raising of the grip and will procure 'a permanent pivotal mounting of the grip' on the base member. No other two such parts had ever been constructed before. It was a combination which appeared to the learned President of the Exchequer Court 'quite novel and ingenious indeed'; and we agree with his decision."

It will be observed that the structure was a very simple one yet the Courts found in it an idea which was sufficiently ingenious to take it out of the realm of expected skill.

In conclusion, invention can best be defined by saying that it is the result of the exercise of something more than the skill which may rightly be expected of the normally intelligent worker of the art in question. The average inventor is naturally enthusiastic about what he has done and his enthusiasm tends to magnify the importance of what he has accomplished. Careful analysis of his work and the results achieved is, therefore, necessary in determining whether or not he has exercised more than the skill which rightly may be expected of him. That is what the courts did in the casket case to which reference has just been made. Moreover, the original analysis of the construction was such that the description of the invention conveyed the inventive idea which the courts found. Had that not been so, the decision might have been otherwise. Personal experience indicates that the tendency of the scientific worker is to fail to consider the results of his work from the point of view of invention with the result that he does not always secure the rewards and recognition which otherwise might be his.

The Hydro-Electric Scheme of the Galloway Water Power Company

The catchment area of this project is 400 square miles, the altitude varying from 2,764 feet to sea level, and the average rainfall varying with the locality from 80 inches to 40 inches per annum. The first part of the scheme included a power station at Glenlee, which is supplied from a reservoir at Clatteringshaws with a capacity of 1,250,000,000 cubic feet, through a 3½-mile tunnel and pipe line. After passing through the turbines, this water is discharged into the River Ken, a short distance below St. John's Town of Dalry. From this point, the combined waters of the Ken and the Clatteringshaws' reservoir flow into Loch Ken, which was converted into a regulating reservoir by the construction of a barrage at Glenlochar, and thence into the River Dee. Seven miles below Glenlochar, a dam was erected across the mouth of a gorge to form another reservoir, and from this point water is supplied to Tongland station through a short tunnel and pipe line. It is finally discharged into the river a short distance above tidal level.

The second part of the scheme, which is now approaching completion, includes the erection of a dam across the northern end of Loch Doon, thus raising the level of this sheet of water by 27 feet and converting it into a reservoir with a capacity of 2,900,000,000 cubic feet. It will be fed, in addition to the streams which already run into it, by the head waters of the Deugh and by Bow Burn. To enable this to be done, Bow Burn has been dammed and led to the Deugh, while a tunnel has been built from the Deugh to Drumjohn, where the stream known as Carsphairn Lane is crossed. At this point a syphon pipe has been constructed, from which a tunnel leads to Loch Doon. At the foot of the syphon there is an outlet to Carsphairn Lane, with valve control, so that the impounded water can be directed to the lower stretches of the Water of Deugh. It will thus be possible for water from the Deugh and Bow Burn, as well as from its own catchment area, to be stored in Loch Doon during the wet season and utilized during dry periods, when the streams are low, to maintain the necessary flow down Carsphairn Lane.

At points three miles and four miles, respectively, below the village of Carsphairn, dams have been formed across the Waters of Deugh and Ken, so as to provide a single reservoir with a daily storage capacity of 40,000,000 cubic feet. The water from this reservoir will be taken through an open channel, at one end of which it will be joined by the Blackwater Burn and then delivered to Kendoon power station through a closed pressure aqueduct. This station is served by a catchment area of 152 square miles, and contains 21,000 kw. of plant, which will operate under an average head of 150 feet. A mile and a half below Kendoon the Ken has again been dammed to provide a reservoir for the station at Carsfad, which is supplied through a short canal and pipe line. This station will have a capacity of 12,000 kw., and will operate under an average head of 64 feet. Two miles lower down the river there is a dam above Allangibbon Bridge, which impounds water for the station at Earlstoun, also with a capacity of 12,000 kw., the water running thence into the River Ken through a short tail race. This water is finally utilized in the station at Tongland in the way described in a previous article. The capacity and head of the Earlstoun station are practically identical with those at Carsfad. It will be seen that, like the first, the second portion of the scheme provides for a large seasonal storage reservoir, combined with three smaller working reservoirs. Full use is therefore made of the available water.

—*Engineering.*

EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada
2050 Mansfield Street, Montreal

Situations Vacant

SALES ENGINEER with good training in shop and office for the Vancouver sales department of a prominent engineering specialty house. Must have executive ability and be willing to shoulder responsibility. Apply to Box No. 1399-V.

YOUNG ENGINEER, preferably mechanical with two or three years experience for plant and production work. Single man preferred. Good prospects. Location Montreal. Apply to Box No. 1404-V.

Situations Wanted

INDUSTRIAL ENGINEER AND SUPT. Age 31, A.M.E.I.C., with combined electrical, mechanical and steel industry experience. Experience includes design and testing of all types of industrial electrical equipment, supervision of production and cost reduction, heat treating of steel, time study application in several plants. At present supt. of modern factory. Apply to Box No. 132-W.

ELECTRICAL ENGINEER, B.Sc., E.E. Age 30. Completed C.G.E. Test Course; five years experience with power company utility work—substation and power house (steam) operation and maintenance, transmission and distribution line operation, maintenance and design. Industrial or utility work desired. Location immaterial. Available on short notice. Apply to Box No. 266-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

ENGINEER, A.M.E.I.C. Age 30. Single. Employed. Civil and mining experience, capable of designing and superintending construction of timber, concrete and steel structures, rock crushing and ore plants. Would consider position with mining or engineering company designing and building mills. Apply to Box No. 431-W.

MECHANICAL ENGINEER, B.Sc. Age 31. Married. Last ten years includes:—Mechanical structural and reinforced concrete design in pulp and paper mills, industrial plants, hydro-electric, mine, sewers and sewage disposal plant construction. My experience also includes shop production, steam plant combustion, fuel analysing, inspecting, supervising and instrument work on industrial construction. Permanent position preferred. Apply to Box No. 521-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aero-photographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

ELECTRICAL ENGINEER, B.Sc. '28; M. Eng. '35. Two years student apprenticeship at Can. Westinghouse Co., including test and electrical machine design. Also about two years experience in operating dept. of large electrical power organization. Available on short notice. Apply to Box No. 660-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.Sc. Elec. '29, B.Sc. Civil '33. Jr.E.I.C. Age 29. Experience includes four months with Can. Gen. Elec. Co., approximately three years in engineering office of large electrical manufacturing company in Montreal, the last six months of which was spent as commercial engineer. For the last year and a half employed in electrical repair shop. Best of references. Apply to Box No. 693-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

Situations Wanted

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.Sc. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No 728-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER, M.Sc., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering. Read, write and talk French. Married. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

Employment Service Bureau

This bureau is maintained by The Engineering Institute of Canada for the benefit of members and organizations employing technically trained men.

An enquiry addressed to 2050 Mansfield Street, Montreal, will bring full information concerning the services offered. Details can also be obtained from Branch secretaries who are located in the larger centres throughout Canada.

Brief announcements of men available and positions vacant will be published without charge in The Engineering Journal and the Bulletin. Replies addressed in care of the required box number will be forwarded to the advertiser without delay.

An additional service also offered those who are unemployed or wish to change their positions, is the opportunity of placing their names and records on file at 2050 Mansfield Street for consideration by employers wishing to employ engineers. This is of great assistance as many employers will not advertise or wish to locate a suitable man on short notice. If desired the information contained in these records can be kept confidential.

Forms for registration purposes may be obtained from The Institute Headquarters or Branch secretaries.

RADIO AND ELECTRICAL ENGINEER, B.Sc., '31, Jr.E.I.C. Single. Age 29. One year and a half actual field experience in power and lighting equipment. Extensive work in telephone and radio layouts in switchboard and installation depts. Particularly interested and experienced in sales and traffic work in telephone and radio company. At present supervisor over sales and service of radio and electrical company. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, B.Sc. '29, A.M.E.I.C. Married. One year building construction. One year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

PLANT ENGINEER or SUPERINTENDENT, capable of supervising all phases of industrial plant operation, graduate electrical, eleven years diversified industrial experience including test course, four years on large Quebec industrial development, on construction and operation, also six years with prominent consulting firm supervising electrical and mechanical engineering projects. Age 31, single. Apply to Box No. 795-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

Situations Wanted

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 32, married. Two years in pulp mills draughting and designing additions, maintenance and plant layout. Three and a half years in the Toronto Building Department, checking and designing for steel, reinforced concrete and ordinary structures. One and a half years as transitman and draughtsman on road location and maintenance work. Available at once. Location immaterial. Apply to Box No. 899-W.

CIVIL ENGINEER, B.Sc., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements Available at once. Apply to Box No. 950-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. B.Sc. (Man. '23), A.M.E.I.C. Married. Ten years specialized experience in the practical use of magnetic, electrical and mechanical instruments for the prospecting, surveying and mapping of mineral, oil and gas lands. Five years experience with telegraph, telephone and radio equipment. Capable of giving instruction in theory and practice in these lines and in college physics. Available on short notice. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.Sc.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

ENGINEER, with twenty years experience in industrial, pulp and paper mill, and general engineering and design. Age 41. Last five years chief engineer of paper mill making newsprint specialties and toilet tissues. Apply to Box No. 1246-W.

ELECTRICAL ENGINEER, B.Sc. '34 (Univ. of N.B.), S.E.I.C. Age 21, single. Desires any kind of electrical work. Will consider any location. Apply to Box No. 1262-W.

ENGINEER AND DRAUGHTSMAN, Jr.E.I.C., age 33, married. Diplomas from Mtl Tech. Inst. in R.C. and Structural Design. 11½ years experience in civil engineering, draughting and instrument work. This includes 7 years with M.L.H. & P. Cons. as field engineer on construction and maintenance of gas mains. Present location Montreal. Available at once. Apply to Box No. 1326-W.

CIVIL ENGINEER, M.E.I.C. Married. Age 38. Twenty years experience in organization, design and estimating, and cost accounting. Active service in France. Apply to Box No. 1367-W.

ENGINEER SUPERINTENDENT, A.M.E.I.C., R.P.E., Que. and Alta. Age 47. Married. Twenty years experience as engineer and superintendent in charge of hydro-electric, industrial, railroad, and irrigation construction. Specialized in rock excavation and suction dredging. Intimate knowledge of costs, estimating and organizing. Available immediately. Apply to Box No. 1411-W.

1935 GRADUATE IN CIVIL ENGINEERING, B.Sc. (Queen's Univ.), S.E.I.C. Experience includes eleven months summer work as county engineer's assistant in charge of the surveying party, and two months as surveyor's assistant during construction of concrete formwork and installation of machinery. Keenly interested in graphical analysis, draughting, design, organization and report writing. Now available for any location. Apply to Box No. 1415-W.

CIVIL AND ELECTRICAL ENGINEER, Univ. of Man. '35 and '36. S.E.I.C. Experience in irrigation and mapping. Available at once. Location immaterial. Box No. 1418-W.

CIVIL ENGINEER, B.Sc. 1910, A.M.E.I.C. Married. Twenty-six years experience on heavy construction work, both field and office; rails, roads, power house, hotels, bridges, etc. Location immaterial. Available at once. Apply to Box No. 1470-W.

SALES ENGINEER, M.E.I.C. Age 50. Married. Several years in combustion and general machinery lines. Estimating and layout work (mechanical and electrical). Speaking French fluently. Executive ability. Apply to Box No. 1482-W.

TRANSIT FOR SALE

Transit—Troughton and Simms, London. Horizontal circle, 4½ inches in diameter, with reading by two verniers to one minute. Vertical circle 4 inches in diameter, reading by two verniers to single minutes. Telescope 9 inches. Four levelling screws. Magnifying glasses for all verniers. Compass needle 1¾ inches. Instrument in mahogany case with carrying handle. Tripod with telescopic legs. Sacrifice price $35.00.

THE ENGINEERING JOURNAL

THE JOURNAL OF THE ENGINEERING INSTITUTE OF CANADA

Published monthly at 2050 Mansfield Street, Montreal, by The Engineering Institute of Canada, Incorporated in 1887 as The Canadian Society of Civil Engineers.

Entered at the Post Office, Montreal, as Second Class Matter.

"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."

December, 1936 — Volume XIX, No. 12

CONTENTS

Price 50 cents a copy, $3.00 a year, in Canada, British Possessions, United States and Mexico. $4.50 a year in Foreign Countries.
To Members and Affiliates, 25 cents a copy, $2.00 a year.

Published Monthly at 2050 Mansfield St., Montreal

THE ENGINEERING INSTITUTE OF CANADA

Incorporated in 1887 as The Canadian Society of Civil Engineers

BRANCHES:

Halifax Branch, Halifax, N.S.
Cape Breton Branch, Sydney, Cape Breton.
Moncton, Branch, Moncton, N.B.
Saint John Branch, Saint John, N.B.
Saguenay Branch, Kenogami, Que.
Quebec Branch, Quebec, Que.
St. Maurice Valley Branch, Three Rivers, Que.
Montreal Branch, Montreal, Que.
Ottawa Branch, Ottawa, Ont.
Kingston Branch, Kingston, Ont.
Peterborough Branch, Peterborough, Ont.
Toronto Branch, Toronto, Ont.
Hamilton Branch, Hamilton, Ont.
Niagara Peninsula Branch, Niagara Falls, Ont.
London Branch, London, Ont.
Border Cities Branch, Windsor, Ont.
Sault Ste. Marie Branch, Sault Ste. Marie, Ont.
Lakehead Branch, Port Arthur, Ont.
Winnipeg Branch, Winnipeg, Man.
Saskatchewan Branch, Regina, Sask.
Lethbridge Branch, Lethbridge, Alta.
Edmonton Branch, Edmonton, Alta.
Calgary Branch, Calgary, Alta.
Vancouver Branch, Vancouver, B.C.
Victoria Branch, Victoria, B.C.

Members of Council 1936

PRESIDENT

E. A. CLEVELAND, Vancouver, B.C.

VICE-PRESIDENTS

*E. V. CATON, Winnipeg, Man.
†R. L. DOBBIN, Peterborough, Ont.
†H. W. McKIEL, Sackville, N.B.
†A. B. NORMANDIN, Quebec, Que.
*P. L. PRATLEY, Montreal, Que.

PAST-PRESIDENTS

F. A. GABY, Toronto, Ont.
O. O. LEFEBVRE, Montreal, Que.
F. P. SHEARWOOD, Montreal, Que.

COUNCILLORS

*C. G. R. ARMSTRONG, Windsor, Ont.
†Y. C. BARRINGTON, Sydney Mines, N.S.
*C. B. BROWN, Montreal, Que.
†G. S. BROWN, Lethbridge, Alta.
*G. H. BURBIDGE, Port Arthur, Ont.
†H. CIMON, Quebec, Que.
*A. COUSINEAU, Montreal, Que.
†A. B. CREALOCK, Toronto, Ont.
†T. H. DICKSON, Moncton, N.B.
†A. FRIGON, Montreal, Que.
†A. B. GATES, Peterborough, Ont.
*For 1936

*L. F. GOODWIN, Kingston, Ont.
*B. GRANDMONT, Three Rivers, Que.
†A. K. HAY, Ottawa, Ont.
‡F. S. B. HEWARD, Montreal, Que.
*G. H. KIRBY, Riverbend, Que.
*H. S. JOHNSTON, Halifax, N.S.
†T. C. MAIN, Winnipeg, Man.
†E. P. MUNTZ, Hamilton, Ont.
†E. P. MURPHY, Port Colborne, Ont.
†H. J. McLEAN, Calgary, Alta.
‡F. NEWELL, Montreal, Que.
†For 1936-37

†E. A. RYAN, Montreal, Que.
†F. SMALLWOOD, Sault Ste Marie, Ont.
*R. E. SMYTHE, Toronto, Ont.
*E. W. STEDMAN, Ottawa, Ont.
†H. L. SWAN, Victoria, B.C.
*J. A. VANCE, Woodstock, Ont.
*G. A. VANDERVOORT, Saint John, N.B.
*H. R. WEBB, Edmonton, Alta.
*A. S. WOOTTON, Vancouver, B.C.
*S. YOUNG, Regina, Sask.
‡For 1936-37-38

TREASURER

J. B. CHALLIES, Montreal, Que.

SECRETARY

R. J. DURLEY, Montreal, Que.

OFFICERS OF BRANCHES

HALIFAX
Chairman, C. S. BENNETT
Vice-Chair., C. SCRYMGEOUR
Sec.-Treas., R. R. MURRAY, Wm. Stairs Son & Morrow, Ltd., Halifax, N.S.
Executive, J. R. KAYE, I. P. MACNAB, J. D. FRASER, J. F. F. MACKENZIE, W. H. NOONAN, J. W. McLEOD, J. B. HAYES
(Ex-Officio) H. FELLOWS, H. S. JOHNSTON

CAPE BRETON
Chairman, M. R. CHAPPELL
Sec.-Treas., S. C. MIFFLEN, 60 Whitney Ave., Sydney, N.S.
Executive, C. M. ANSON, S. G. NAISH, I. W. BUCKLEY, W. S. WILSON
(Ex-Officio) W. E. BOWN, Y. C. BARRINGTON

SAINT JOHN
Chairman, J. R. FREEMAN
Vice-Chair., G. H. THURBER
Sec.-Treas., F. A. PATRIQUEN, P.O. Box 24, Saint John, N.B.
Executive, T. C. MACNABB, T. MOFFAT, S. HOGG
(Ex-Officio) V. S. CHESNUT, G. A. VANDERVOORT

MONCTON
Chairman, G. L. DICKSON
Vice-Chair., E. B. MARTIN
Sec.-Treas., V. C. BLACKETT, Engrg. Dept., C.N.R., Moncton, N.B.
Executive, F. O. CONDON, C. S. G. ROGERS, R. H. EMMERSON, F. L. WEST, A. S. GUNN, G. C. TORRENS
(Ex-Officio) T. H. DICKSON, H. B. TITUS, H. W. McKIEL

SAGUENAY
Chairman, S. J. FISHER
Vice-Chair., F. L. LAWTON
Sec.-Treas., G. H. KIRBY, P.O. Box 22, Riverbend, Que.
Executive, G. F. LAYNE, H. PELLETIER, G. E. LAMOTHE, C. MILLER
(Ex-Officio) J. SHANLY, L. R. BEATH

QUEBEC
Hon. Chair., A. R. DECARY
Chairman, ALEX. LARIVIERE
Vice-Chair., J. T. F. KING
Sec.-Treas., J. JOYAL, Quebec Public Service Comm., Court House, Quebec, Que.
Executive, R. WOOD, L. P. METHE, M. BOURGET, A. O. DUFRESNE, J. G. O'DONNELL, A. ROBERGE
(Ex-Officio) A. B. NORMANDIN, HECTOR CIMON

ST. MAURICE VALLEY
Chairman, B. GRANDMONT
Vice-Chair., J. E. FLEURY
Sec.-Treas., J. A. HAMEL, 642 Notre Dame St., Three Rivers, Que.
Executive, F. W. BRADSHAW, C. L. ARCAND, H. J. WARD

MONTREAL
Chairman, J. B. D'AETH
Vice-Chair., H. MASSUE
Sec.-Treas., C. K. McLEOD, 1440 St. Catherine St. W., Montreal, Que.
Executive, R. H. FINDLAY, C. C. LINDSAY, B. R. PERRY, T. C. THOMPSON, J. A. LALONDE, J. A. E. GOHIER
(Ex-Officio) F. S. B. HEWARD, A. COUSINEAU, C. B. BROWN, P. L. PRATLEY, O. O. LEFEBVRE, E. A. RYAN, F. NEWELL, A. FRIGON, F. P. SHEARWOOD

OTTAWA
Chairman, E. VIENS
Sec.-Treas., F. C. C. LYNCH, Dept. of Mines, Victoria Memorial Museum, Ottawa, Ont.
Executive, E. M. DENNIS, T. A. McELHANNEY, N. B. MACROSTIE, G. R. TURNER, B. F. HAANEL
(Ex-Officio) E. W. STEDMAN, R. W. BOYLE, A. K. HAY

PETERBOROUGH
Chairman, H. R. SILLS
Sec.-Treas., W. T. FANJOY, 627 Homewood Ave., Peterborough, Ont.
Executive, V. R. CURRIE, A. L. KILLALY, E. J. DAVIES, W. M. CRUTHERS
(Ex-Officio) A. L. DICKIESON, A. B. GATES, R. L. DOBBIN

KINGSTON
Chairman, Lt.-Col. N. C. SHERMAN
Vice-Chair., Major H. H. LAWSON
Sec.-Treas., Major L. F. GRANT, Royal Military College, Kingston, Ont.
Executive, A. JACKSON, R. F. LEGGET, J. B. WILKINSON
(Ex-Officio) L. F. GOODWIN, R. A. LOW

TORONTO
Chairman, O. HOLDEN
Vice-Chair., A. U. SANDERSON
Sec.-Treas., W. S. WILSON, Mining Bldg., University of Toronto, Toronto, Ont.
Executive, W. P. DOBSON, N. MACNICOL, W. E. P. DUNCAN, A. M. REID, D. D. WHITSON, C. E. SISSON
(Ex-Officio) W. E. BONN, A. B. CREALOCK, R. E. SMYTHE, F. A. GABY

HAMILTON
Chairman, W. HOLLINGWORTH
Vice-Chair., E. G. MACKAY
Sec.-Treas., A. LOVE, 40 Paisley Ave. S., Hamilton, Ont.
Executive, W. J. W. REID, A. R. HANNAFORD, V. S. THOMPSON, D. W. CALLANDER
(Ex-Officio) E. P. MUNTZ

LONDON
Chairman, JAS. FERGUSON
Vice-Chair., A. O. WOLFF
Sec.-Treas., D. S. SCRYMGEOUR, London Structural Steel Co. Ltd., London, Ont.
Executive, E. V. BUCHANAN, W. C. MILLER, J. R. ROSTRON, H. A. McKAY, W. M. VEITCH
(Ex-Officio) S. W. ARCHIBALD, S. G. JOHRE, J. A. VANCE

NIAGARA PENINSULA
Chairman, G. H. WOOD
Vice-Chair., L. C. McMURTRY
Sec.-Treas., P. A. DEWEY, 1224 Ontario Ave., Niagara Falls, Ont.
Executive, S. HAIRSINE, W. D. BRACKEN, M. H. JONES, C. S. BOYD, R. A. BRADLEY, C. G. MOON, A. W. F. McQUEEN
(Ex-Officio) P. E. BUSS, E. P. MURPHY

BORDER CITIES
Chairman, T. H. JENKINS
Vice-Chair., C. F. DAVISON
Sec.-Treas., BOYD CANDLISH, 170 Rankin Blvd., Sandwich, Ont.
Executive, E. M. KREBSER, D. T. ALEXANDER, C. G. WALTON
(Ex-Officio) C. G. R. ARMSTRONG, H. J. COULTER

SAULT STE. MARIE
Chairman, J. L. LANG
Vice-Chair., W. SEYMOUR
Sec.-Treas., N. C. COWIE, 15 Hearst St., Sault Ste. Marie, Ont.
Executive, E. M. MACQUARRIE, T. FOULKES, C. W. HOLMAN, H. W. SUTCLIFFE
(Ex-Officio) F. SMALLWOOD

LAKEHEAD
Chairman, F. C. GRAHAM
Vice-Chair., G. R. DUNCAN
Sec.-Treas., G. R. McLENNAN, 80 North High St., Port Arthur, Ont.
Executive: H. G. O'LEARY, J. M. FLEMING, K. A. DUNPHY, E. A. KELLY, E. L. GOODALL, W. J. BISHOP
(Ex-Officio) G. H. BURBIDGE, R. J. ASKIN

WINNIPEG
Chairman, G. E. COLE
Vice-Chair., A. E. MACDONALD
Sec.-Treas., H. L. BRIGGS, 609 Ingersoll St., Winnipeg, Man.
Executive, F. W. ALEXANDER, A. CAMPBELL, W. D. HURST, R. W. McKINNON, W. F. RIDDELL
(Ex-Officio) E. V. CATON, F. V. SEIBERT, T. C. MAIN

SASKATCHEWAN
Chairman, W. E. LOVELL
Vice-Chair., STEWART YOUNG
Sec.-Treas., J. J. WHITE, City Hall, Regina, Sask.
Executive, A. R. GREIG, J. W. D. FARRELL, J. McD. PATTON, H. S. CARPENTER, H. J. BYRD, S. R. MUIRHEAD
(Ex-Officio) A. P. LINTON

LETHBRIDGE
Chairman, P. M. SAUDER
Vice-Chair., R. F. P. BOWMAN
Sec.-Treas., E. A. LAWRENCE, 207-7th St. S., Lethbridge, Alta.
Executive, J. M. CAMPBELL, J. B. DEHART, W. MELDRUM
(Ex-Officio) W. L. McKENZIE, G. S. BROWN, C. S. CLENDENING

EDMONTON
Chairman, E. STANSFIELD
Vice-Chair., A. RITCHIE
Sec.-Treas., M. L. GALE, 9914-111 St., Edmonton Alta.
Executive, J. D. BAKER, W. E. CORNISH, C. E. GARNETT, A. J. GAYFER, E. NELSON
(Ex-Officio) F. K. BEACH, H. R. WEBB

CALGARY
Chairman, JOHN DOW
Vice-Chair., H. W. TOOKER
Sec.-Treas., JAS. McMILLAN, 506 Insurance Exchange Bldg., Calgary, Alta.
Executive, J. J. HANNA, W. T. McFARLANE, H. J. McEWEN
(Ex-Officio) J. HADDIN, F. M. STEEL, H. J. McLEAN

VANCOUVER
Chairman, JAS. ROBERTSON
Vice-Chair., H. N. MACPHERSON
Sec.-Treas., T. V. BERRY, 3007-36th Ave. W., Vancouver, B.C.
Executive, E. C. THRUPP, P. SANDWELL, G. L. BOOKER, J. P. MACKENZIE, P. H. BUCHAN, C. P. HAMILTON, F. O. MILLS
(Ex-Officio) G. M. GILBERT, E. A. CLEVELAND, A. S. WOOTTON

VICTORIA
Chairman, I. C. BARLTROP
Vice-Chair., J. C. MACDONALD
Sec.-Treas., KENNETH REID, 1336 Carnsew St., Victoria, B.C.
Executive, G. M. DUNCAN, G. M. IRWIN, G. M. TRIPP, C. D. SCHULTZ
(Ex-Officio) D. MACBRIDE, H. L. SWAN

THE ENGINEERING JOURNAL

The Institute as a body is not responsible either for the statements made or for the opinions expressed in the following pages.

Volume XIX — Montreal, December, 1936 — Number 12

Hydro-Electric Practice in Canada

T. H. Hogg, D.Eng., M.E.I.C.,
Chief Hydraulic Engineer, Hydro-Electric Power Commission of Ontario, Toronto, Ontario.

Presented before the Niagara Falls Meeting of the American Society of Mechanical Engineers, on September 17th to 19th, 1936, and reprinted by permission of the American Society of Mechanical Engineers.

SUMMARY.—A review of present-day practice as compared with that of 1924, indicating marked progress in generating, transmission and protective equipment. Interesting features are the repair of eroded runners, the development of welded construction, the simplification of switchgear, and greater reliability in continuous service.

The writer of a paper presented at the World Power Conference at London in 1924, dealing with water power development in Canada, made this assertion:

> "It may be stated, with a fair degree of assurance, that the future holds no prospect of revolutionary advances in the art such as have taken place in the last twenty years."

That period had seen a gradual increase in unit capacity of turbines, an improvement in their efficiency, an extension in realization of high efficiency over a greater percentage of the full capacity of the unit, perfection of the means of supporting revolving weights, and development of effective means of controlling long water columns.

Reference was made to the position at that time of the propeller type runner, undoubtedly a revolutionary advance in water power development, which was, in 1924, just beginning to find its place. European and American practice had diverged somewhat in the development and application of this type of equipment, and to this reference is made later.

A field inviting investigation at that time was the cause and nature of pitting of turbine runners. The extent to which this proceeded in comparatively brief periods in many installations and the perfect freedom from it in others presented problems of great scientific and economic interest. Decided advances have been made toward a solution of the problems presented by the phenomena of pitting.

Reviewing changes that have taken place since 1924, we find improvements have been made in governing equipment, in draft tube design and in simplification of the layout of the hydraulic plant, but, in general, it may be said that the prediction of the improbability of revolutionary advances in the art, as far as hydraulic plant is concerned, has been confirmed.

This is not so, however, in the broader field of hydro-electric practice. In generation, transformation and transmission of electric power, notable changes have taken place. It is significant, however, that these changes do not apply so strikingly to generating and transforming equipment as to switching, control and protective equipment. True, there has been advance in generator design and changes in practice regarding transformer equipment, but these are comparable to the advances made in the turbine, draft tube and plant layout.

Statistical

In common with many other countries, Canada has experienced a rapid growth in water power development. Developed water power, which at the beginning of the century aggregated less than a quarter of a million horse-power, through a fairly rapid growth reached a total of 3,590,000 h.p. by 1924. The rate of growth thereafter for eight years was at the extremely rapid rate of 440,000 h.p. per year, so that the total developed power exceeded 6,125,000 h.p. at the end of 1930. It was hardly to be expected that the rapid growth which took place under the impetus of the business expansion subsequent to 1924 would continue until the present, but, in spite of the adverse economic conditions of recent years, there has been a great increase in developed power, until at the end of 1935 it amounted to 7,909,000 h.p.

It is quite true that a portion of the increase since 1930 is accounted for by the completion of developments planned in the years preceding 1930. In view of this, a more significant gauge of the growth of the industry is provided by the number of kilowatts generated by central electric stations. It must be kept in mind that central electric stations include only those electric stations which generate power for distribution, and therefore do not include hydraulic and hydro-electric stations generating power for specific industrial establishments. As ninety-eight per cent of the output of central electric stations in Canada is generated in hydro-electric plants, and as the great majority of hydraulic plants are included in central stations, the energy generated in central stations year by year is a very reasonable gauge of the growth in importance of the hydro-electric industry. The output of central electric stations in Canada amounted to 9,315,277,000 kilowatt hours in 1924, and to 18,093,802,000 in 1929, after which a decline took place until 1932, when the output amounted to 16,052,057,000; but a subsequent steady increase carried it to 23,410,000,000 kilowatt hours in 1935. Developed hydraulic horsepower and output of central electric stations year by year since 1924 are shown in Fig. 1.

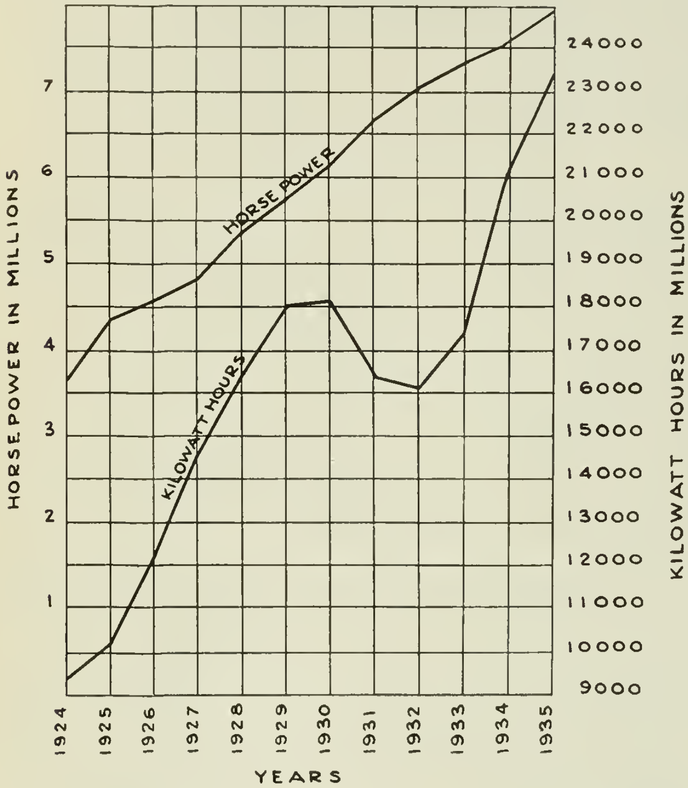


Fig. 1—Installed Hydraulic Horse Power and Energy Generated in Central Electric Stations 1924-1935.

Power Supply for Mining Industries

An outstanding feature in the use of hydro-electric power is the growth in amount and special provisions for meeting the requirements of mining and related industries. To appreciate the significance of this, it is necessary to consider recent developments in mining in the Dominion.

The remarkable growth of the industry is shown by a consideration of the value of mineral production, which fifty years ago had a value of only $10,200,000.00, but has grown in recent years as indicated in the table following:

1896....	$ 22,474,256.00
1906....	79,286,697.00
1916....	177,201,534.00
1926....	240,437,123.00
1935....	310,162,455.00

The value of production was as high in 1929 as in 1935, after which there was a slight decline, from which the industry has now recovered. In considering these figures it must be kept in mind that, while gold has risen in price, nickel has remained stationary, and all other products, metallic and non-metallic, bring lower prices than when the record of 1929 was made. Copper, lead and zinc are now selling at very low prices, lead and zinc remaining close to their minimum value. The present high production thus indicates a greatly increased gross tonnage from the mines, a greater use of power, and wider employment of machinery.

To meet the power requirements of the industry, numerous isolated developments have been necessitated by mines located far from existing sources of power supply and at points to which transportation of equipment is difficult and costly. This latter feature is not new in the mining industry, but in Ontario and Quebec, lacking as they do coal deposits, it precludes the use of fuel-produced power for mining and milling operations. Diesel power is utilized in some places in these provinces, and for preliminary operations in a new field local fuel is used, but one of the earliest concerns of the mine manager now is to locate a dependable source of electric power. Probably ninety per cent of the mines in Ontario and Quebec use electric power for all purposes. Furthermore, electric equipment is used more extensively for domestic purposes in the communities in the mining districts than in other parts of these provinces.

Hydraulic Turbines

The prediction referred to above that we had, in 1924, probably reached the ultimate in efficiency of Francis type turbine runners has been confirmed. No claims have been made for greater efficiency than was obtained at that time in a number of notable developments in Canada and elsewhere. In March 1925, extensive and careful tests were made on unit No. 7 at the Queenston development at Niagara Falls. This unit has a rated capacity of 58,000 h.p. under a head of 294 feet, and a specific speed of 38. The turbine efficiency realized is believed to be as high as, or higher than, has been obtained in any other installation, and, what is more important from an operating standpoint, unusually high efficiency was realized over a very great range of output. The maximum turbine efficiency was 93.8 per cent, and the efficiency was greater than 90 per cent for 48 per cent of the range in capacity of the turbine.

The Abitibi Canyon development is fairly comparable with the Queenston development and, as far as the layout and size of the units are concerned, is quite similar to it. The turbines are rated at 66,000 h.p. under a head of 237 feet, and have a specific speed of 41.5. Tests were made on four of the units at this development in January, 1936, by the same method as was used at Queenston. The maximum turbine efficiency realized was 93.6 per cent, nearly the same as at Queenston, and the range of high efficiency was also practically the same.

Thus, over a period of eleven years no improvement is observed in the efficiency results for large Francis type runners of moderate specific speed, mainly because the ultimate had been so closely approximated at the beginning of that period. To-day's turbine, however, is in many respects a better machine, due to improvements in mechanical design and manufacturing methods. One illustration of this may be cited. In two installations of large size in which turbine gate leakage was measured, this amounted to less than three-tenths per cent of full gate discharge in the one case, and less than one-tenth per cent in the other case. Formerly, a turbine gate leakage of one per cent was not considered excessive.

Turbine practice has advanced, however, in the use of high specific speed runners, particularly in the extension of the application of these to higher powers and to higher heads than was the case ten years ago. Reference has been made from time to time in technical publications to the difference in European and American practice in the use of the high speed runner. In Europe, few installations use the fixed blade propeller type runner, the field being practically monopolized by the Kaplan runner. In the United States, while the fixed blade runner is used more frequently, there are also many Kaplan runners in service, some of very large size. But in Canada the field is almost entirely taken up by the fixed blade runner. A few Kaplan runners are used, but these are of small size.

If one is to search for the reason for this preference for the fixed blade runner in Canada, in spite of its inferiority to the Kaplan runner in maintenance of high efficiency over a great range of capacity, he will find several explanations.

The fixed blade runner presumably is more rugged than the Kaplan runner, as the latter has numerous parts moving relatively to each other. Moreover, the fixed blade runner usually has as high, and, in some instances, higher maximum efficiency than the Kaplan runner. If, then, the lower efficiency of the fixed blade runner at part loads is not a detriment, its mechanical advantages and high maximum efficiency may prompt its choice. As most of the installations in Canada form parts of large systems, it is often quite feasible to operate individual units always at high efficiency, the plant load being varied, as a unit is taken from, or put on, the line, by such amounts that all units operating do so at high efficiency. The operation of the Chats Falls plant on the Ottawa river illustrates what may be done in this regard. This plant, operating in the Niagara System of the Hydro-Electric Power Commission, is equipped with fixed blade runners rated at 28,000 h.p. under a head of 53 feet at 125 r.p.m. A study of actual operating results at this plant over several periods, each one week in length, showed an overall plant efficiency as high as 83 per cent. Manifestly, the turbines were operated at all times close to the point of maximum turbine efficiency to obtain so high a result as this for the whole plant.

In other instances in which high speed runners have been used, the governing condition has not been high efficiency, but rather reliability. The single unit in the Ear Falls plant on the English river in Ontario supplies mining load, and has been called upon for continuous service since it went into operation in December, 1929. In the intervening six years, the unit has been shut down only four times, for a few hours each time, for inspection and cleaning.

Welding of Turbine Runners

Considerable progress has been made in the last ten years in the art of welding in connection with the restoration of pitted parts of turbines. The corrosion and erosion of runner blades, throat rings, seal rings and draft tube sections have been experienced on high powered, as well as on high speed, turbines, and this has, in many cases, proceeded to such an extent that replacement at considerable expense has been necessary. However, through careful investigation along scientific lines by special experts, welding processes now make it possible to save affected parts and restore them to efficient operating condition. Thus, for low maintenance expenditure, costly machines can be restored, instead of being replaced, and kept in service with little outage.

Cast steel and forged steel can be welded with little difficulty and, since rust-resisting materials have been applied, surfaces treated in this manner stand up very satisfactorily in service on turbine parts where pitting, due to cavitation, is unavoidable.

Successful maintenance work is now carried out on cast iron runners and cast iron throat rings with a welding process, which can easily be applied while such parts are assembled with the whole machine. Pitted cast iron parts are now filled with Monel metal, where previously a cheaper grade of welding steel was used. Several years of experience has proved that Monel metal is a good substitute to build up corroded parts on turbines.

Welding practice in connection with maintenance of hydraulic turbines is still in a state of flux and new processes, having certain advantages or special fields of application, are frequently being proposed and used. Among these might be mentioned the metal spraying process and atomic hydrogen process. Naturally, the product of any of these new methods, although giving promise of success, must be subjected to a testing period in service before the method may be accepted as worthy of approval.

Governors

Mechanical drives for governor flyballs have been almost entirely superseded by electric drives. The latter, as at first installed, were not free from defects and disadvantages; in fact, various devices were proposed and used to overcome the defects and assure greater reliability.

A separate set of transformers connected to the generator leads supplying power directly to the governor drive give direct connection between the unit and the governing mechanism, even when interruption occurred which separated the unit from the system. This type of drive is advantageous with high speed flyballs, and finds frequent application at the present time.

A further advance was made by the addition of slip rings on the pilot exciter when available, from which a power supply was drawn for the governor drive. This method, although possessing advantages over those preceding it, was affected by disturbances in the main electrical system which were not related to speed changes in the unit, that which the governing system is designed to control.

Apparently a power supply, quite independent of the main system, is desirable. The necessity for this prompted the development of a permanent magnet generator, directly connected to the main generator shaft, but independent of the main electrical system. The governor flyballs, being driven by power from this separate generating unit, are affected only by speed changes in the main generator shaft, and tend to operate the governor mechanism only as the speed of the unit departs from normal. Satisfactory results are being experienced in an installation of this type, replacing the earlier pilot exciter drive at the Alexander development.

Generators

The use of rolled sections, instead of castings, in the fabrication of the frame and rotor of hydro-electric generators has become virtually standard practice. Improvement in welding technique and the development in rolled shapes have resulted in reduced weights, while the umbrella type of unit has tended to reduce power house superstructure volume.

A tendency to reduce the size of the power house superstructure is noted in several plants where the upstream wall is moved in much closer to the units than in the case of, say, the Queenston development. This tendency is seen in the Alexander and Chats Falls developments and the Rapide Blanc and La Gabelle plants in Quebec.

Beyond this, improvements in generator designs are noted mainly in details and in the excitation system. Advantage is being taken of experience to improve insulation, to prevent coil movement in slots under varying operating temperatures, and to brace the windings more securely to withstand short-circuit stresses.

The excitation system of large generators has undergone radical changes in the last ten years. The growth of interconnections and the generally longer transmission systems carrying large and important blocks of power have resulted in stability of operation becoming an important problem. One of the first measures adopted to improve stability was the so-called "high-speed" or "rapid-response" excitation system coupled with low values of armature reactance. While other measures are now considered of greater benefit in the relief of the problem, notably the extremely rapid clearance of faults, the generator excitation system quite commonly includes a pilot-exciter and high-speed voltage regulator.

The tendency to increase generator voltages noted in other countries is not so marked in Canada, partly because only a relatively small number of new developments have been undertaken in recent years and partly because hydro-electric development in Canada almost invariably involves more or less long-distance transmission. When a step-up transformation is involved in any case, there is not the urge to increase generator voltages as is the case when generated voltage distribution is involved.

The grounding of generator neutrals is a live subject in present-day practice. In a number of cases, where distribution at generator voltage is not present, generators are being operated with ungrounded neutrals. Damage occasioned by ground faults is thereby minimized, with no apparent countervailing disadvantages. When distribution at generator voltage is present, the protection of the windings against lightning damage is receiving more attention.

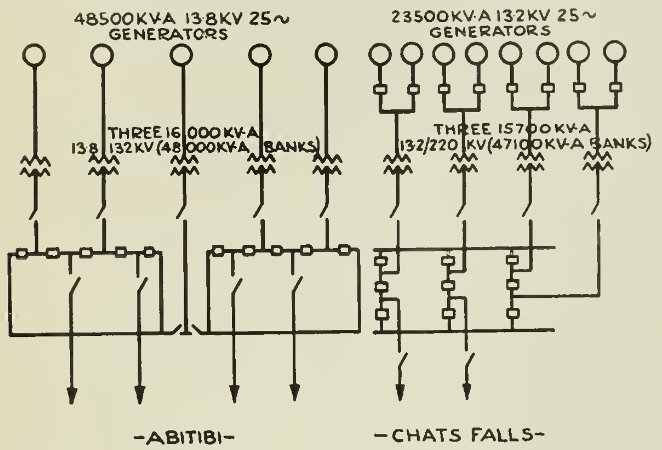


Fig. 2—Single Line Diagrams of Main Electrical Connections.

Transformers

The principal trends in transformer designs may be traced to the knowledge gained in recent years, as a result of extensive research in the field and in the laboratory into the problems of lightning protection, so that equipment as now designed is virtually lightning proof. The shielded transformer and the so-called "surge-proof" unit are products of this development.

As in the case of generators, refinements in design of transformers are being dictated by operating experience. The oil-insulated water-cooled unit continues to be used most frequently in hydro-electric installations, though the self-cooled unit supplemented in some cases by air blast finds favour where temperatures below 40 degrees F. are likely to be experienced. The forced-oil cooling system is practically unknown in Canadian practice.

Single-phase units are by far the most common, though several installations of three-phase units have been made where economical physical dimensions have apparently been the only limit to capacity.

Application of tap-changing devices has become almost universal practice. In the majority of cases these devices operate only with the transformer de-energized, but "on-load" tap-changing equipment has been developed to the point where standard equipment can be offered to meet almost any problem.

Connections and Switching

The present tendency in station connections and switching facilities is definitely towards simplification and the elimination of duplication, as contrasted with the much earlier practice of double-bus arrangements and other more complicated diagrams.

This trend was no doubt initiated as development of more remote sites made necessary higher transmission voltages and, consequently, more expensive switching equipment. The generally smaller number of generating units per plant, the lesser need to provide emergency connections for single generating units as systems expand, and the increasing cost of switching equipment as vastly increased circuit interrupting speeds are demanded by modern interconnections, are all factors tending to maintain this trend.

Allied with this simplification of connections, however, has been an expansion of the automatic relay protection afforded the component parts of the electrical equipment. Generator differential or split-phase protection, bus differential and transformer differential are among the types of protection applied.

In many plants, for example at Chats Falls, Beauharnois and Abitibi Canyon, one or more generators and an associated transformer bank of the same total capacity are treated as a unit. Generator breakers, if used at all, are provided only between the unit and the transformer bank, while the high-voltage diagram may be of the "ring" type or the "1.5" breaker arrangement, both as shown in Fig. 2.

In the case of the Alexander development, high-tension oil-circuit breakers are entirely eliminated. The transformer bank capacity is arranged to equal that of one transmission line and forms an integral part thereof. This capacity must, however, be greater than that of the generating units connected to it, as, when a transmission line trips out, the station output must pass through the remaining lines and banks. The cost of this excess transformer capacity has necessarily to be weighed against the saving in high voltage switching equipment. A line diagram is shown in Fig. 3.

Where generator voltage switching equipment is used, the metal-clad type has found general favour, due to its compactness and its freedom from interference and outage. Such switching is invariably installed within the generating station, as the space requirements are small, though transformers and high-voltage switching have been almost invariably moved outdoors.

The developments in oil-circuit breakers in all voltage classes has been towards higher speeds of operation. These developments originate in various means of controlling the behaviour of the arc, and much progress has been made in breakers rated at 60,000 volts and above. Standard equipment in these voltage classes is rated to clear the circuit in 8 to 10 cycles on a 60-cycle system, while special high-speed equipment is available operating in 3 to 4 cycles.

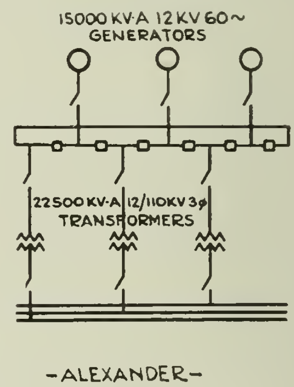


Fig. 3—Single Line Diagram of Main Electrical Connections.

Undoubtedly the trend away from massive oil-filled circuit breakers, so noticeable in European practice, is making itself felt in Canada. Up to the present, however, no noteworthy installations of apparatus incorporating radically new principles have been made. The tendency to curtail sharply the use of high-voltage oil-circuit breakers has, however, been largely responsible for a considerable improvement in the design and construction of no-load disconnecting and air-break switches. Such switches are quite frequently used to break transformer bank exciting current and the charging current of up to fifty miles of 132-kv., 25-cycle line, applications where previously oil-filled switches would have been considered almost essential. They are also successfully operating outdoors in temperatures ranging as low as 60 degrees F.

Control and Automatic Relay Protection

The recent developments in miniature type control switching and switchboard apparatus has brought about a radical change in the size and general design of all electrical control rooms. A compact main control board is provided, upon which are mounted miniature switches and the essential operating instruments. Control is by means of 24- to 48-volt control circuits to sub-control panels located adjacent to the main apparatus. Graphic instruments, relays and other equipment are mounted on these sub-panels.

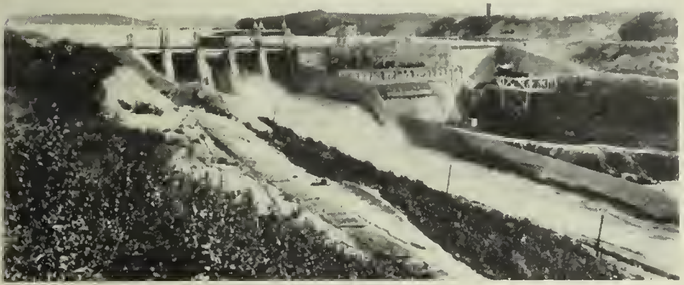


Fig. 4—Highwater Channel and Dam, Abitibi Canyon Development.

This design reduces the space occupied by the essential features of the control system, thus greatly facilitating plant operation and reducing costs. As an example, the control room of the Chats Falls development, designed in 1930 to provide for the ultimate installation of ten units, occupies a space of 40 feet by 18 feet, the main control board including operating instruments, being only 12 feet long. By contrast the control room in the earlier Queenston development designed in 1920, also a ten-unit plant, is 70 feet by 74 feet, the main control board totalling 51 feet in length.

Control room lighting has been the subject of extensive investigation in recent years, in fact generally higher levels of illumination are found throughout the more modern plants. Air-conditioned and sound-proofed control rooms, virtually isolated from the generator floor, are becoming common practice, some form of control pedestal usually being provided adjacent to the unit, an operator on the generator floor performing the more simple operations of starting and shutting down the unit.

With the continued growth of transmission systems, the tendency toward higher voltage and consequently more heavily loaded lines, interconnections between generating plants and the generally higher grade of service the consumer has been educated to expect, the problems of load control, frequency regulation and the removal of disturbances by means of automatic relays have become more exacting.

Automatic frequency regulation and the corresponding automatic regulation of tie-line loading is gradually finding a place in Canadian practice, though more extensively applied in other countries.

Extremely rapid clearance of line and station disturbances, while retaining proper selectivity, is the object of modern relay applications. It is expected that practically complete solution of stability problems in high-voltage long-distance 25-cycle transmission will be effected by the combination of these relays with the high speed breakers discussed above.

Relays for this service usually operate on the impedance or reactance principle, the mechanical designs having been improved to the point where one cycle operation has been obtained. The application of pilot type relaying, where the action of the distant end relays may be controlled by impulses of carrier frequency transmitted over the power circuits, is growing to meet the needs of more complicated system connections. Pilot type control appears to offer a satisfactory solution to such problems as "branched" or tapped lines, for which no other high-speed types have been found to be entirely suitable.

In general, the necessary potentials for the operation of these relay types are obtained from two-winding transformers. The potentiometer type of potential source, utilizing capacitance principles, is, however, finding increasing service in a number of ways; for example, in re-synchronizing high-voltage lines at main receiving stations following an automatic trip-out.

In summary, the electrical side of hydro-electric development is growing in complexity as the demand for power increases. As the number of generating stations operating in parallel increases, either normally or under stress of emergency conditions, so the associated transmission systems become more complicated. To counteract this tendency, the development itself is being designed to effect the maximum possible simplicity.

Designs incorporate in general the minimum number of units (single-unit plants are not uncommon), the most simple electrical connections, with the control removed from human hands in so far as possible by the application of automatic devices. As these trends of themselves tend to promote economical development of available sites, it is to be expected they will continue.

Fig. 5—Interior of Power House, Abitibi Canyon Development.

Conclusion

Interconnection of plants and their separate transmission systems, resulting in the building up of large distribution networks in the more populous parts of the country, had a profound influence upon the design and operation of hydro-electric development ten to twenty years ago. Some of the problems of speed regulation and of pressure regulation in long conduits were partially solved by this tendency, more efficient use of limited water supplies was effected, and development of certain sites made economically advantageous. The design of plants to meet the requirements of industry in remote parts of the country has brought about a return to many of the earlier problems of design. Many of the plants so built are quite isolated from all others and must therefore be designed for continuous and reliable service, frequently under very adverse conditions. Reference has been made already to one plant in Northern Ontario, where continuous service has been given for six years with no opportunity for interruptions for maintenance. Moreover, load variations were such as to make much more severe demands on the governing system than would be the case in plants giving ordinary central station service.

Extensions of transmission systems into many mining districts are taking place, the same tendency toward interconnection of isolated plants and systems being observed as took place in industrial districts some years ago. Large areas in Northern Ontario and Quebec, dependent mainly on mining activity, are now covered by an extensive transmission network.

Cost and Performance Data for House Insulation

With Reference to a Group of Fourteen Houses in the Saguenay District

F. L. Lawton, M.E.I.C.,
Electrical Engineer, Saguenay Power Company, Limited, Arvida, Que.

Paper presented before the Saguenay Branch of The Engineering Institute of Canada, August 22nd, 1936.

SUMMARY.—Discusses three different forms of insulation as used in a group of electrically heated six-room houses in Northern Quebec, comparing the actual heat expenditures during the winter 1935-1936 with the computed values. The results are compared with those previously reported for a group of somewhat similar houses less completely insulated.

The purpose of this paper is the presentation of cost and performance data secured on several forms of house insulation in houses built during 1935 at Isle Maligne in the Saguenay District.

Fourteen one-and-a-half or two storey houses of first-class construction were built, the average gross volume being 17,444 cubic feet. Their construction was to some extent experimental in that different forms of heat insulation and interior finishes were used. Careful cost records were kept for each, with the exception of one brick veneer. All have white pine or spruce siding over building paper over sheathing on studding. Interior finish varies—some are finished in ½-inch insulating board with and without a spruce sheathing, some with metal lath and plaster, and one in plasterboard and plaster.

All the houses have full-size basements of concrete. They have storm sash and storm doors. All are completely weatherstripped with a high-grade cloth-lined metal weatherstrip.

Eight of the houses were heated electrically, on a meter-rate basis, and careful records were kept with the co-operation of the tenants. The eight houses have pipeless hot-air furnaces, with the electric heating equipment of heavy wire resistance heaters mounted between the furnace and the jacket separating hot and cold air passages. The heaters were operated from an air-temperature-actuated thermostat controlling a magnetic contactor in the supply circuit to the heaters.

In addition to the electric-heating energy requirements, all domestic usage for cooking, lighting, hot water, etc., was separately metered.

Details of House Construction

The eight electrically-heated houses forming the group on which the major part of this study is based are one-and-a-half storey, with the following average pertinent data:—

Average gross volume (exterior) ....17,894 cubic feet
Average net volume (interior)...........12,998 cubic feet
Ratio net volume to gross volume..................0.726
Net area (first and second floor).........1,027 square feet

All the houses are of first-class frame construction with the exception of one brick veneer and have full-sized basements of concrete. Wall construction consists of white pine or spruce siding over a high-grade building paper over T & G sheathing on 2-inch by 4-inch studding, except for the brick veneer house, where the brick veneer and air space replaced the siding. Different types of heat insulation were used, as noted hereafter, and in the manner shown by the various illustrations. Some of the houses have an interior finish of ½-inch insulating board with and without a T & G spruce sheathing on the studding. Others have a metal lath and plaster for interior finish and one has plasterboard and plaster. Roofs consist of slate-coated asphalt shingles (320 pounds per square) laid over a good-quality building paper on 1-inch T & G sheathing on 2-inch by 6-inch rafters. All houses have double-hung window sash with spiral balances throughout. All windows and doors are completely weatherstripped with a high-grade cloth-lined metal weatherstrip and are provided with storm sash and storm doors.

Figure 1 is a photograph showing two typical houses with sectional elevation similar to Fig. 2. Location of the heat insulation is plainly shown. A general idea of floor layouts and size is afforded by Fig. 3.

Forms of Insulation

Three forms of insulation were used, as follows:—

Form A—A filler-type insulation of flaked, dry and fluffy gypsum and fibrous material.

Fig. 1—Two Typical Houses.

Form B—A foil-type insulation in which the low conductivity of air has been combined with the low radiating power of bright aluminum foil in a foil-air-cell structure designed to minimize convection currents.

Form C—A fibrous form of material made from rock in which the felted material is wrapped on chip-board centres, the "bat" being 15 inches by 18 inches by 2¼ inches.

Form A insulation was used in two of the electrically-heated houses. Wall spaces between studs, 3⅝ inches thick, were completely filled; ceilings were insulated to a thickness of 6 inches and first floors 4 inches. The manner in which the insulation was installed is shown by Fig. 4.

Form B insulation was used in three of the electrically-heated houses. Walls were insulated with two curtains of foil forming three air spaces, first floors similarly and ceilings with three curtains of foil forming four air spaces. Chinks and small crevices, etc., were filled with form C insulation. Application of the form B insulation was as shown by Figs. 5 and 6 for frame and brick-veneer construction, respectively.

Form C insulation was utilized in three of the electrically-heated houses, only one thickness of 2¼ inches being employed. Figure 7 illustrates the manner in which this form of insulation was applied.

All the electrically-heated houses in the insulation test had insulated floors, except one.

Construction Features

The advantages and disadvantages of the three forms of insulation may be briefly set forth as below:—

Form of Insulation	Advantages	Disadvantages
A	Fireproof; vermin-proof; easy to handle as it can be poured; filler type, tending to fill out spaces; cuts off air spaces and prevents rapid spread of fires.	Heavy; settles somewhat; slightly hygroscopic; dusts through cracks; considerable heat storage.
B	Light weight; fireproof: vermin-proof; non-hygroscopic; easy to handle; non-dusting; minimum heat storage.	Fragile and easily damaged during construction. Some other form of insulation such as C needed in restricted spaces, as around window frames, etc.
C	Moderately light weight; vermin-proof; easy to handle; non-dusting; fireproof.	Slightly hygroscopic.

Experience in building the fourteen houses at Isle Maligne and several field experiments indicate that it is difficult to use form A insulation with standard metal laths without a sheathing. This difficulty is, of course, overcome when a plasterboard base is used. Form A insulation is not

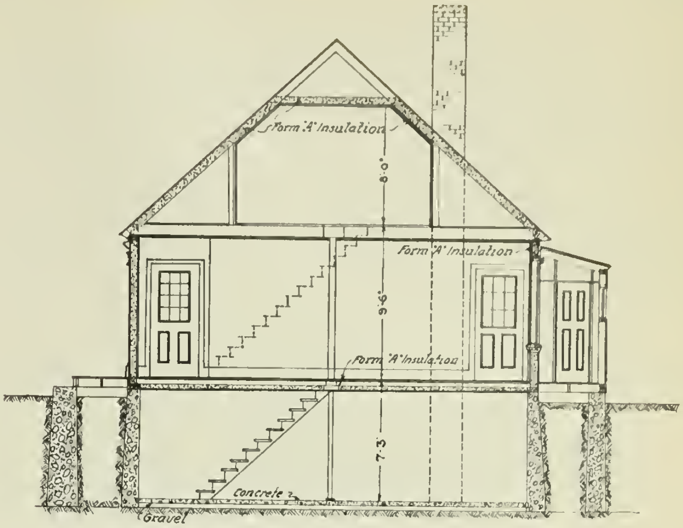


Fig. 2—Sectional Elevation of Typical House.

suitable for use with insulating boards laid directly on studding.

Either of forms B or C, but particularly B, is adaptable to use with insulating boards laid directly against studding as inside finish.

Computation of Probable Results

In order to determine the probable heating requirements of the eight houses in the insulation test, use was made of the latest data on heat transmission coefficients for the various materials used.

The over-all coefficient of heat transmission for simple wall, floor, etc., is found from the formula

$$U = \frac{1}{\frac{1}{F_i} + \frac{x}{k} + \frac{1}{F_o}}$$

Where U = thermal transmittance or over-all coefficient of heat transmission expressed in B.t.u. transmitted in one hour per square foot of wall, floor, etc., for a difference in temperature of 1 degree F. between inside and outside air.

k = thermal conductivity expressed in B.t.u. transmitted per hour per square foot of a homogeneous material 1 inch thick for a difference in temperature of 1 degree F. between the two surfaces of the material.

F_i, F_o = film or surface conductances expressed in B.t.u. transmitted by radiation, conduction and convection from a surface to the air surrounding it, or vice versa, per hour per square foot of surface for a difference in temperature

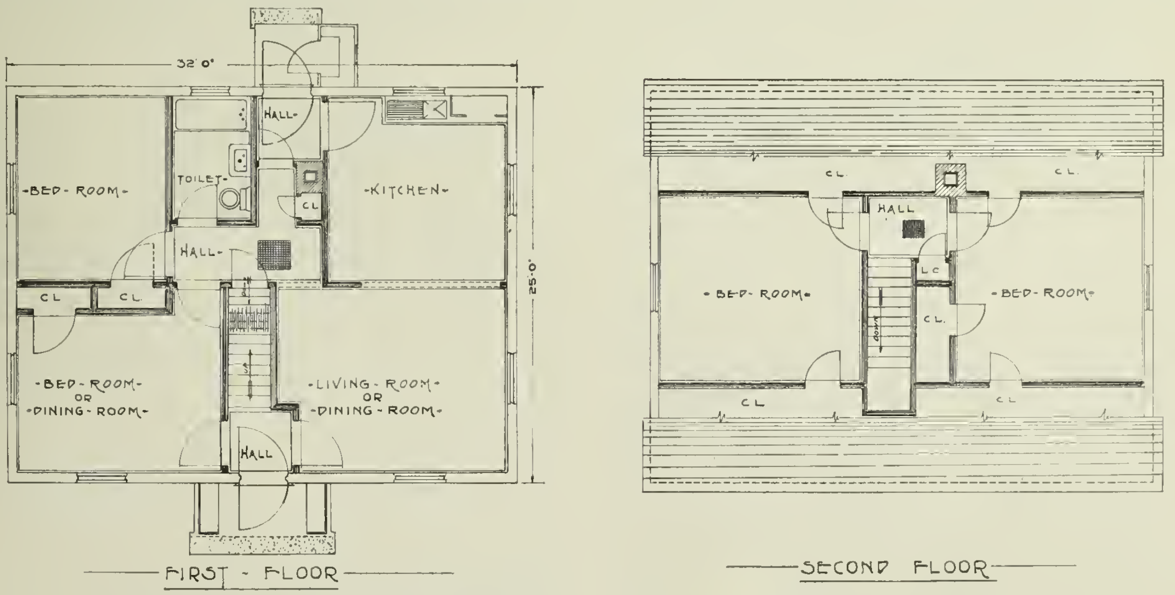


Fig. 3—Floor Layout of Typical House.

of 1 degree F. between the surface and the surrounding air, inside and outside surfaces respectively.

x = thickness of homogeneous material in inches.

In the case of a composite wall, floor, etc., U is found from the formula

$$U = \frac{1}{\frac{1}{F_i} + \frac{x_1}{k_1} + \frac{x_2}{k_2} + \cdots\cdots\cdots\cdots \frac{1}{F_o}}$$

the symbols having the meaning previously indicated, with the subscripts denoting the different materials.

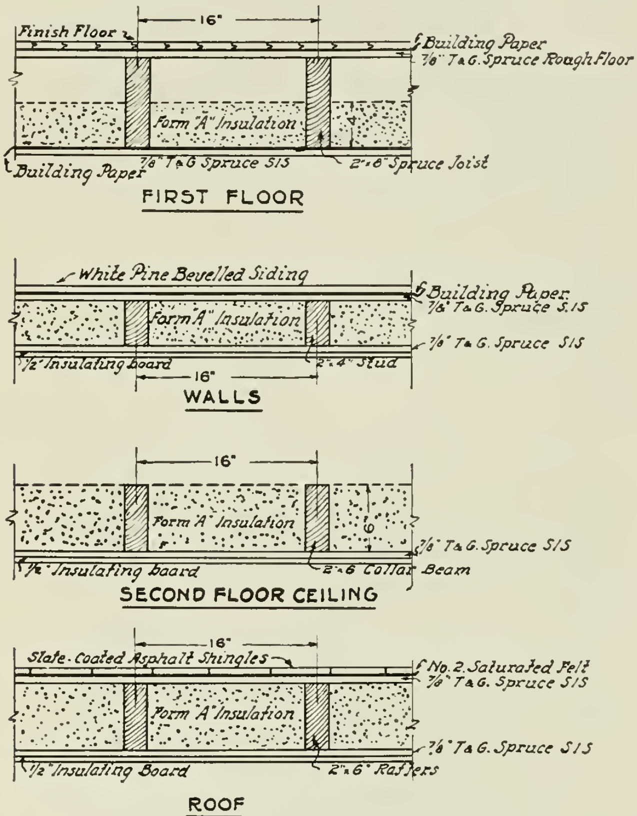


Fig. 4—Method of Installing Form A Insulation.

The over-all coefficients of heat transmission for the various wall, floor, ceiling and roof sections used for the houses were computed in line with the foregoing, using the current American Society of Heating and Ventilating Engineers values of conductivity and conductances.

General data for computation of heat losses from the houses in the insulation test are given by Table I. Estimated and actual heat losses for a typical house in the insulation test are given by Table II.

The measure of resistance to heat loss through a wall or other section is afforded by $R = \frac{1}{U}$, where U has the meaning previously explained.

The resistances to heat loss for the walls, ceilings, etc., of the different houses having the same form of insulation were multiplied by the respective areas for walls, ceilings, etc., and the sum of the products divided by the total area, thus giving a composite heat resistance value for the particular form of insulation. No allowance was made for windows and doors as losses at these points are substantially the same for all houses. In this study, it was assumed that those interior finishes most suitable for the particular forms of insulation were used, as plasterboard and plaster for A and insulating board for B and C, also that floors were uninsulated. The comparison follows:—

Form of Insulation	Relative Composite Heat Resistance (Calculated)
A	93.4 per cent
B	90.9 per cent
C	100.0 per cent

Cost of Insulation

During construction careful detailed cost records were kept for all items entering into the insulation of each house. From these records, average costs were determined as below:—

Form of Insulation	Cost per sq. ft. (Actual)	Relative Cost (Actual)
A	$0.0984	110.8 per cent
B	0.0975	109.8 per cent
C	0.0888	100.0 per cent

The above figures cover labour and material only, with the assumption of most suitable interior finish and uninsulated floors, as previously noted.

Combining the foregoing values, the actual relative cost for the same computed resistance becomes:—

Form of Insulation	Actual Relative Cost for Same Calculated Heating Performance
A	118.6 per cent
B	120.8 per cent
C	100.0 per cent

Actual comparative costs of insulation and comparative performance, with interior finish and insulated floors as actually used, were:—

Form of Insulation	Actual Relative Cost	Actual Relative Energy Requirements for Heating
A	135.87 per cent	79.4 per cent
B	99.01 per cent	92.7 per cent
C	100.00 per cent	100.00 per cent

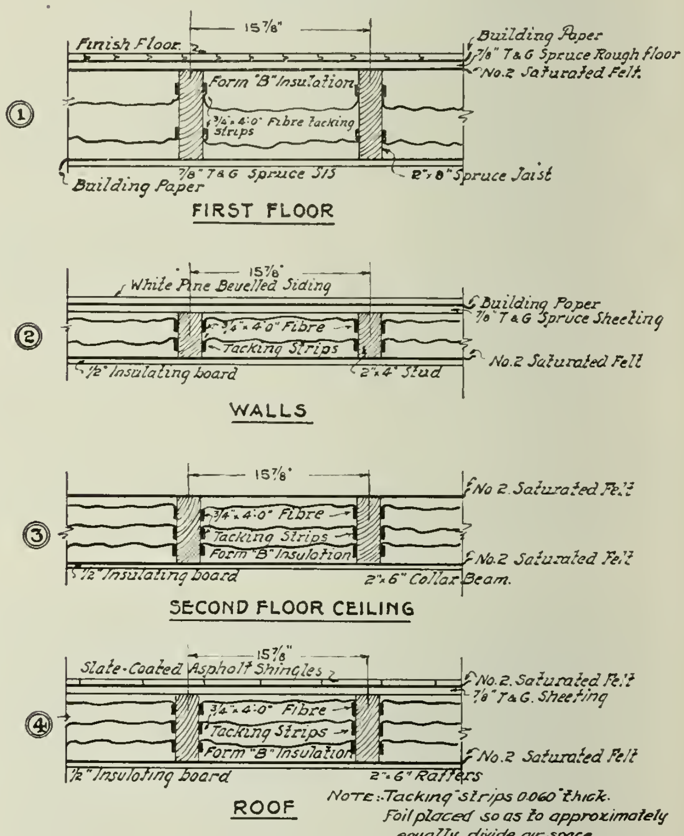


Fig. 5—Method of Installing Form B Insulation with Frame Construction.

From these figures, the true relative cost of the different forms of insulation, for the same heating performance, based on actual observations, is:—

Form of Insulation	Actual Relative Cost for Same Actual Heating Performance*
A	107.9 per cent
B	91.8 per cent
C	100.0 per cent

*Relative values are based on values for Form C insulation taken as 100 per cent. Therefore, if actual relative cost of Form A insulation is 135.87 per cent and the actual relative energy requirement for heating is 79.4 per cent, with Form A insulation, then the actual relative cost for the same actual heating performance is $1.3587 \times 0.794 = 1.079$ or 107.9 per cent, on the reasonable assumption relative cost is inversely proportional to relative energy requirement for heating.

The comparison between estimated performance and actual performance on a cost basis shows:—

Form of Insulation	Actual Relative Cost for Same Calculated Heating Performance	Actual Relative Cost for Same Actual Heating Performance
A	118.6 per cent	107.9 per cent
B	120.8 per cent	91.8 per cent
C	100.0 per cent	100.0 per cent

That is to say, the Form A insulation was estimated to cost 18.6 per cent more than the Form C for the same heating performance but actually cost 7.9 per cent more. On the other hand, the Form B insulation was estimated to cost 20.8 per cent more but actually cost 8.2 per cent less than the Form C insulation.

The average cost of insulation plus any extra sheathing chargeable to insulation was 4.41 per cent of the total cost of a house with uninsulated floor.

The average cost of complete weatherstripping was 1.47 per cent of the total cost of a house.

Effect of Ventilation

Heat losses were carefully computed for the fourteen houses. From these losses, it was estimated that one additional air change per hour over and above air entering by leakage and infiltration would increase the heat losses by 42.2 per cent.

Actual Performance of Houses in Insulation Test

To determine the actual performance of the houses in the test, they were heated electrically, on a meter-rate basis, and careful records were kept with the co-operation of the tenants. In addition to the electric-heating energy requirements, all domestic usage for cooking, lighting, hot water, etc., was separately metered. It was assumed that all energy metered by the domestic-usage meter in excess of 1,100 kw.h. per month is useful in heating. This value of 1,100 kw.h. per month was adopted because of agreement with actual observations in connection with the group of houses referred to under the heading "Actual Results Experienced Elsewhere."

The houses in the insulation test are heated by pipeless hot-air furnaces, with electric-heating equipment of heavy wire resistance heaters mounted between the furnace and the jacket separating hot and cold air passages. The electric-heating equipment is operated from an air-temperature-actuated thermostat controlling a magnetic contactor in the supply circuit to the heater.

A record was kept of the thermostat settings and temperatures during the test. Tenants regulated temperatures to suit, with no restrictions except that of keeping records.

Readings of the kw.h. meters recording energy usage for heating and domestic service were made at regular intervals. Tenants paid for the electrical energy used at a rate somewhat less than the equivalent fuel-heating cost using coal.

The houses in the insulation test, which extended over the four-and-half months period January 1st, 1936, to May 15th, 1936, had an average energy requirement for heating of 0.0942 kw.h. per 1,000 cubic feet of gross volume per degree-day below 70 degrees F. These houses have an average gross volume of 17,894 cubic feet.

The period mentioned above was taken because the houses were only completed and ready for occupancy in December 1935.

There are several possible bases of comparison for the different forms of insulation, as regards performance. One is the mean of results obtained on the bases of degree-days below 70 degrees F. and degree-days below 65 degrees F., it being observed from temperature records kept for the individual houses that the average operating temperature in the houses was between 65 and 70 degrees F. This basis of comparison further assumes all energy input to a house other than the 1,100 kw.h. per month domestic usage is useful in heating.

A comparison of the actual average and estimated results gives the following:—

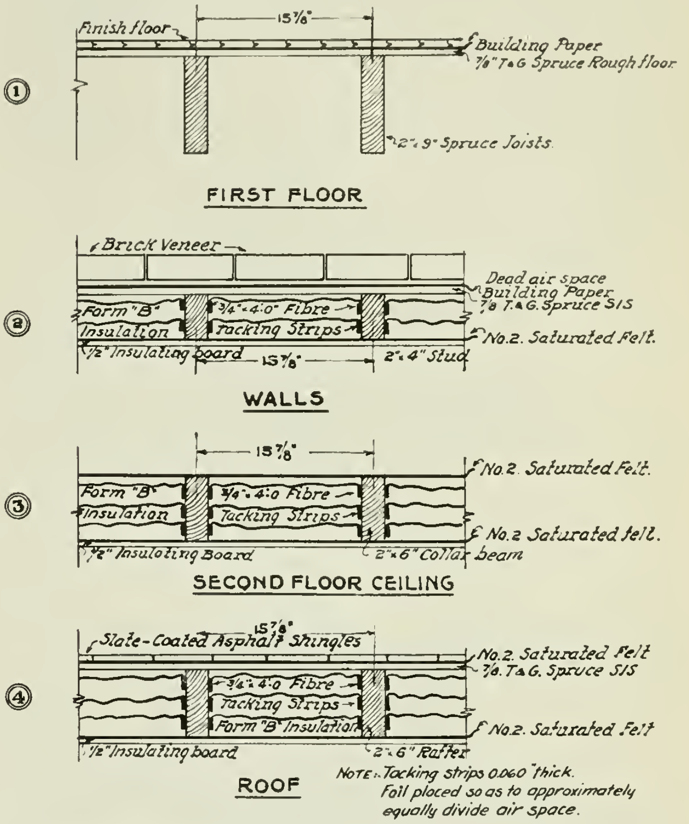


Fig. 6—Method of Installing Form B Insulation with Brick Veneer Construction.

Actual average ratio kw.h./M. cu. ft. gross volume/degree-day with Form A insulation to kw.h./M. cu. ft. gross volume/degree-day with Form C insulation $= 0.794$

do $\dfrac{\text{Form B insulation}}{\text{Form C insulation}} = 0.927$

Calculated ratio, etc., $\dfrac{\text{Form A insulation}}{\text{Form C insulation}} = 1.009$

do $\dfrac{\text{Form B insulation}}{\text{Form C insulation}} = 1.125$

It will be noted that reference has been made to calculated ratios of kilowatt hours per 1,000 cubic feet gross volume per degree-day, and, further, that these are higher than the actual average ratios. As a result of a careful analysis, it was concluded that both the Form A insulation and the Form B insulation were proving better than anticipated. However, this was, in the case of Form A insulation, because the conductivity k chosen was that which applies to a density of 24 pounds per cubic foot whereas the initial density was probably less with correspondingly lower value of k. The apparent better performance of Form A insulation will likely disappear in the course of a few years due to settlement resulting in increased density and unprotected spots.

Actual Results Experienced Elsewhere

In order to establish a criterion or benchmark by which the heating performance of the insulated houses could be measured, a careful analysis was made of the performance of a group of houses similar to the insulated houses, having pipeless hot-air heating systems, and an average gross volume of 15,071 cubic feet. These houses are wood-frame construction, detached type, of average to better-than-average construction and located in the same district. They are all insulated in some measure, the insulation varying from complete insulation of walls and ceilings with shavings to insulation of ceilings only with shavings or sawdust up to 5 or 6 inches. One house has 6 inches of rockwool placed pneumatically under insulating board over ceiling joists. The performance referred to was that obtained in a three-year investigation of electric house heating on the same basis as that used in the insulation test.*

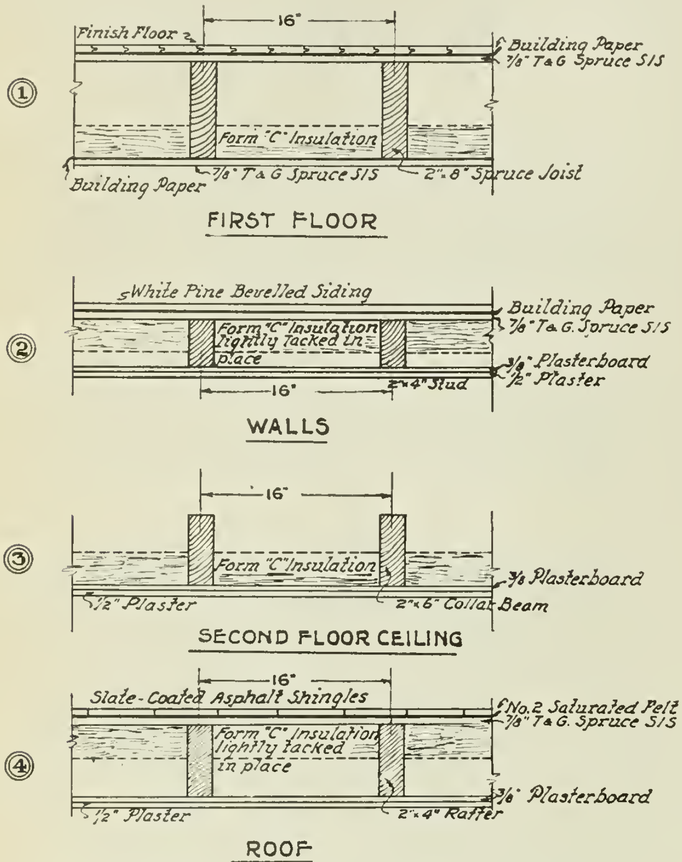


Fig. 7—Method of Installing Form C Insulation.

It was found that the average energy requirements for electrically heating this group of houses, similar to the insulated houses, was 0.1550 kw.h. per 1,000 cubic feet gross volume per degree-day below 70 degrees F.

Comparison of Results Obtained With Insulated Houses and Those Elsewhere

The insulated houses required 0.0942 kw.h. per 1,000 cubic feet gross volume per degree-day below 70 degrees F. whereas similar houses elsewhere of average to better-than-average construction, partially or completely insulated with shavings or sawdust, required 0.1550. That is, the houses elsewhere required 64.54 per cent more energy for heating. Expressed another way, the insulated houses showed a saving in heat requirements of 39.23 per cent over the houses elsewhere.

Temperature and Humidity Throughout Houses in Insulation Test

Careful observations in two houses in the insulation test indicated that the temperature distribution horizontally, at the breathing line 5 feet above floor level, and vertically was very good.

Relative humidities were found to be somewhat above the best value. In other words, some condensation was experienced at windows and exterior doors in moderately cold weather. However, it should be remarked that the tenants, as a whole, did not employ much ventilation.

The interesting feature of these observations is that good humidity values can be secured in houses of the size mentioned by weatherstripping the house and using good construction. It is generally considered that it is necessary to introduce water vapour by means of some humidifying device but these observations indicate it can be secured by natural means.

There is undoubtedly some point at which ventilation and natural humidity have the optimum relationship insofar as the health of the occupants in a house is concerned but this point is by no means clearly defined.

Conclusions

The following conclusions have been drawn from the investigation:—

Form A insulation is not particularly suitable for use with standard metal laths and plaster without an inside sheathing. A plasterboard base is desirable. Moreover, Form A insulation is not suitable for use with insulating boards laid directly on studding.

Form B insulation is very adaptable to use with insulating boards laid directly on studding.

Form B and C insulations possess greater stability of insulation value than Form A.

Although the Form A insulation was estimated to cost 18.6 per cent more than the Form C for the same heating performance, it actually cost only 7.9 per cent more.

Although the Form B insulation was estimated to cost 20.8 per cent more than the Form C, it actually cost 8.2 per cent less for the same heating performance.

The average cost of insulation plus any extra sheathing chargeable to insulation was 4.41 per cent of the total cost of a house with uninsulated floor.

The average cost of complete weatherstripping was 1.47 per cent of the total cost of a house.

The effect of one air change per hour over and above air entering by leakage and infiltration was an estimated increase in heating requirements of 42.2 per cent.

Partially-insulated houses similar to the insulated houses, and of average and better-than-average construction, required 64.54 per cent more energy for heating.

The thorough insulation and weatherstripping of the insulated houses resulted in a saving of 39.23 per cent over the heating requirements of similar houses, partially insulated and of average and better-than-average construction.

With the insulation and weatherstripping employed, very satisfactory temperature distribution was secured throughout the houses.

With complete weatherstripping, in houses of about 17,500 cubic feet gross volume, it is possible to secure relative humidities exceeding the best value for freedom from condensation at windows and doors in cold weather.

It is probable that good relative humidities can be secured in moderate sized houses by entirely natural means, by weatherstripping the house and controlling the amount of ventilation.

* 1. Heat Economy and Comfort in the Home as Influenced by Heating Methods and Building Construction, F. L. Lawton, Engineering Journal, pp. 482-493, Nov., 1934.
2. Advance Reports of Canadian Electrical Association for 1933, pp. 18-57.
3. Proceedings of Canadian Electrical Association for 1933, pp. 49-65.
4. Advance Reports of Canadian Electrical Association for 1934, pp. 20-40.
5. Proceedings of Canadian Electrical Association for 1934, pp 50-72.
6. Proceedings of Canadian Electrical Association for 1935, pp. 67-71.

Table I

General Data for Computation of Heat Losses From Houses in Insulation Test

1. Lowest outside temperature — −40 degrees F.
2. Base temperature (Item 1 plus 10° F.) — −30 degrees F.
3. Direction of prevailing wind — Northwest
4. Inside temperature — 70 degrees F.
5. Temperature difference (Item 4-Item 2) — 100 degrees F.
6. Average wind velocity — 15 m.p.h.
7. Construction details—As specified for individual houses. Doors and windows fitted with cloth-lined metal weatherstrip. All doors have storm doors and windows have storm sash. Doors have thin panels.
8. Transmission coefficients—As shown for individual houses. Same coefficient used for both windows and doors, viz. $U=0.45$ B.t.u./hr./sq.ft./° F. temp. difference.
9. Infiltration coefficients—For doors—infiltration taken as 34.1 c.f. per foot crack per hour or equivalent loss of 0.614 B.t.u./hr./° F. temperature difference between inside and outside air/foot of crack. For windows 23.6 c.f. or 0.425 B.t.u./hr./° F. temperature difference/foot of crack.

Table II

Estimated Heat Losses for Typical House in Insulation Test

Form B insulation: See Fig. 5

For Detail 1... $U=\dfrac{1}{\dfrac{1}{1.65}+\dfrac{0.781}{1.10}+\dfrac{0.781}{0.80}+\dfrac{1}{0.15}+\dfrac{0.781}{0.80}+\dfrac{1}{1.65}}=0.0948$

For Detail 2.. $U=\dfrac{1}{\dfrac{1}{6.00}+\dfrac{0.45}{0.80}+\dfrac{0.781}{0.80}+\dfrac{1}{0.15}+\dfrac{0.5}{0.33}+\dfrac{1}{1.65}}=0.0953$

For Detail 3.... $U=\dfrac{1}{\dfrac{1}{1.65}+\dfrac{1}{0.11}+\dfrac{0.5}{0.33}+\dfrac{1}{1.65}}=0.0846$

For Detail 4..... $U=\dfrac{1}{\dfrac{1}{6.00}+\dfrac{1}{6.50}+\dfrac{0.781}{0.80}+\dfrac{1}{0.11}+\dfrac{0.5}{0.33}+\dfrac{1}{1.65}}=0.0799$

Section	Exposure	Net Area in Sq. Ft. or Crack-Length in Ft.	Coefficient	Temp. Diff. °F.	B.t.u. Loss per Hour
Front Wall......	W	208.0	0.0953	100	1,982
Windows.......	W	65.0	0.45	100	2,925
Window crack*.	W	66.0	0.425	100	1,402
Door..........	W	21.0	0.45	100	945
Door crack*....	W	20.0	0.614	100	614
Wall...........	N	312.0	0.0953	100	2,973
Windows.......	N	43.8	0.45	100	1,971
Window crack*.	N	47.0	0.425	100	1,000
Rear wall......	E	254.0	0.0953	100	2,420
Windows.......	E	21.0	0.45	100	945
Window crack*.	E	28.0	0.425	100	595
Door..........	E	19.3	0.45	100	869
Door crack*.....	E	19.3	0.614	100	593

Table II (Continued)

Wall...........	S	312.0	0.0953	100	2,980
Window........	S	43.8	0.45	100	1,971
Window crack*.	S	47.0	0.425	100	1,000
Ceiling.........	—	248.0	0.0745†	100	1,848
Roof...........	—	700.0	0.0799	100	5,593
Floor..........	—	744.0	0.0948	38	2,680
Total........					35,306

Equivalent kw... 10.33

One air change per hour for ventilation = 12,680 c.f./hr. or 12,680 × 100 × 0.018 = 22,824 B.t.u./hr.

Total loss with one air change per hour for ventilation = 58,130 B.t.u./hr.

Equivalent kw... 17.02

*Only one-half total crack length used because air entering on one side must leave by the opposite.

†Combined coefficient for second-floor ceiling and roof.

Gross volume........ 17,866 cu. ft.

Degree-days below 70° F. during 24 hours with average outside temperature of − 30° F....... 100

Estimated kw.h. equivalent of losses for 24 hours assuming no ventilation other than infiltration = 10.33 × 24........ = 247.92

Estimated kw.h./M. cu. ft. gross volume/degree-day below 70° F. $= \dfrac{247.92}{17.866 \times 100}$ .... = 0.1388

Estimated kw.h. equivalent of losses for 24 hours, assuming one air change per hour over and above infiltration = 17.02 × 24........ = 408.48

Estimated kw.h./M. cu. ft. gross volume/degree-day below 70° F. $= \dfrac{408.48}{17.866 \times 100}$ .... = 0.2286

Actual Heat Losses

Degree-days below 70° F. during test period Jan. 1 to May 15, 1936........ 6,793

Actual kw.h. energy requirements for heating (all energy input to heating equipment plus all domestic usage in excess of 1,100 kw.h. per month)........ 10,605

Actual kw.h./M. cu. ft. gross volume/degree-day below 70° F. $= \dfrac{10,605}{17.866 \times 6793}$ .... = 0.0874

Actual kw.h. energy requirements for heating, taking all energy input to heating equipment and for domestic service (including energy input to hot water tank) as useful in heating........ = 15,555

Actual kw.h./M. cu. ft. gross volume/degree-day below 70° F. $= \dfrac{15,555}{17.866 \times 6793}$ (on above basis). = 0.1282

Note:—It should be noted that heat input to the house from occupants and from sunshine were not taken into account. Hence, actual energy requirements differ from estimated values to the extent noted in addition to any inaccuracies in methods of computation.

The Induction Motor of To-day

E. W. Henderson,
English Electric Company of Canada Limited, St. Catharines, Ontario.

Paper presented before the Montreal Branch of The Engineering Institute of Canada, October 15th. 1936.

SUMMARY.—Notes on various types and applications, such as those requiring limitation of starting current, large torque, frequent reversals, variable speed, special braking, or operation over a fraction of a revolution. Reference is made to the standardization of frame sizes and ratings effected by NEMA.

For those not familiar with the induction motor, it may be described briefly as being made of two main parts: a primary part, usually stationary and hence called the "stator," and a secondary part, usually the rotating element and known as the "rotor." The primary takes power from the source of supply, magnetically induces electrical pressures in the secondary circuits, which in turn set up current in these secondary circuits when the latter are closed. The reaction of the magnetic fields of the primary and the currents of the secondary produces the torque or turning effort of the motor.

There are two main divisions of induction motors, dependent on the type of rotor used. These are known as (*a*) squirrel cage and (*b*) slip ring or wound rotor type motors. In the squirrel cage type the secondary winding consists of bars located in slots on the outer surface of the rotor magnetic core, all of these bars making electrical contact with rings disposed one at each end of, and near to the core. In the wound rotor type a winding somewhat similar to that of the primary is located in slots on the periphery of the rotor core, this winding terminating at slip-rings, usually three in number, so that these secondary circuits may be connected to apparatus external to the motor itself.

On account of the natural simplicity and ruggedness of construction of the squirrel cage type, it has grown to be the most universally used of all alternating current motors. Inherently both types are much alike as far as their operating characteristics are concerned, the main difference between the two being that with the wound rotor type the starting current, starting torque and running speed for a given load may be controlled over wide limits by apparatus external to the motor. Hence the wound rotor type is used principally for such services as hoists, cranes, elevators, for adjustable speed and for control of the starting current in the larger sizes.

The squirrel cage type is generally known as a constant speed motor, although the speed varies slightly with the load, the variation between its actual speed and its synchronous speed being known as the "slip." This slip will depend on the resistance of the rotor squirrel cage winding for a fixed voltage and frequency applied to the stator.

Control of Starting Current

The main objection to the squirrel cage type of motor has been its inherent large starting current. Many devices have been used to overcome this, such as the use of compensators or starting transformers, star-delta starters, clutch devices, automatic and manually operated switches mounted on the rotor to give the machine the starting characteristics of the slip ring motor and convert it later into a virtual squirrel cage, cutting or dividing the end rings (Osnos) (Ziehlke), conductor circuits arranged in opposition in starting and in addition for running (Georges), use of double cage rotors (Boucherot), use of reactance automatically cut out when motor is up to speed (Zani). Another interesting proposal of Boucherot was the use of a double stator and double rotor, each stator having its own core and winding. One stator was fixed in position in the frame structure, the other could be rotated in the frame and means were provided, in the nature of a lever or wheel, whereby this movable stator could be adjusted in position. The rotor cores were mounted rigidly on a common shaft, and axially displaced to correspond to the spacing of the stator cores. Copper bars, common to both cores, were connected to low resistance copper rings at their ends; and in the central space between the rotor cores and connected to the bars was a high resistance ring. To start the motor, the stator cores and winding were displaced 180 electrical degrees; the currents induced in the bars were, therefore, opposed, but by virtue of the high resistance ring in the centre of the rotor a path for the rotor currents in each rotor core was provided. The motor thus started as a high resistance squirrel cage rotor. When up to speed the movable stator core was shifted to bring the currents in the two rotors in phase. The action of the central ring was thus cut out and the current flowed the full length of the rotor bars. The motor operated under load as a low-resistance-rotor type. A variation of this scheme was to provide double stators and rotors as above, but instead of displacing one of the stators mechanically, a phase displacement transformer was provided, and the voltages applied to the stators had a 180-degree phase relation in starting, and an in-phase relation when running.

Various methods of limiting the starting current, combined with high starting torque and low slip, are to be found in motors invented by Hunt, Kierstead, Punga, Morelli, Mavor, and others. These have not found much favour in America on account of their complexities and cost and also because here one has become accustomed to the use of much larger squirrel cage motors than are allowed on the transmission systems of Europe. For these reasons current-limiting devices in common use to-day are usually of the following types:

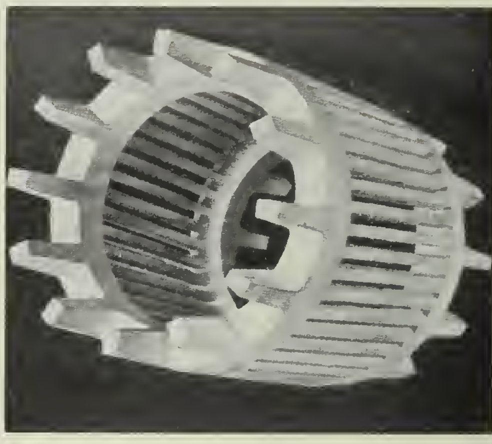


Fig. 1—Cast Rotor for Squirrel Cage Type Induction Motor showing Rotor Bars and End Rings.

(1) Resistance in a wound rotor circuit.
(2) Use of reduced voltage starters, such as compensators and transformers.
(3) Application of external, and usually variable, resistance or reactance in the stator circuit.
(4) Use of double-cage, deep bar, L-shaped bar rotors, or other high reactance current limiting device in the rotor circuit.
(5) High resistance rotors of the squirrel cage type.

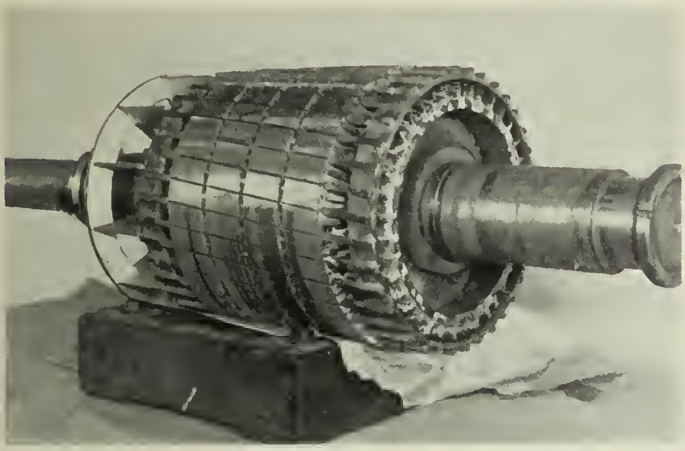


Fig. 2—Double Cage Rotor for 75 h.p. Motor Fan Removed to show both Squirrel Cage Windings.

Types of Squirrel Cage Motors

Squirrel cage inductions motors, by virtue of their design characteristics, are sub-divided into the following classes, which is in accordance with that of the National Electric Manufacturers' Association (NEMA):

Class A—Normal torque, normal starting current, squirrel cage motors. This is the standard, low-slip motor in universal use. The starting equipment must be of a type to reduce the line voltage and thus limit the starting current to a reasonable figure. The slip is low, varying from approximately 2 to 4 per cent.

Class B—Normal torque, low starting current, squirrel cage motors. These are motors in which the starting current is limited by action of the motor itself—generally through an automatic variable reactance in the rotor circuit as provided by a double-cage or deep-bar rotor. Motors of this type are designed to have starting currents within prescribed limits and require no starting equipment other than some type of switch or contactor which throws the motor directly on the supply line. The starting torque varies with the base speed from 100 to approximately 180 per cent of full load torque. The slip is the same as for Class A.

Class C—High torque, low starting current, squirrel cage motors. Same as Class B except that the starting torque is higher, varying from 180 to 350 per cent of full load torque.

Class D—High torque, low starting current, high slip squirrel cage motors. In this type the starting current is limited largely by the high resistance of the rotor. The starting equipment may be as for Class B, but the slip under full load may be as high as 25 per cent.

Class E—Low starting torque, normal starting current, squirrel cage motors. Starting equipment for larger motors same as for Class A; in small sizes same as for Class B. Starting torque approximates full load torque. Slip is low.

Class F—Low starting torque, low starting current, squirrel cage motors. Torque lower than for Class B, but otherwise approximately the same.

Special Types of Induction Motors

Other than the simple slip-ring and squirrel cage motors there are, today, several types which are more complicated, have higher first cost, require higher maintenance cost and are, therefore, rather limited in application. These types are designed to offset some of the inherent characteristics of the simpler motors. A few typical ones are:

(1) Asynchronous-synchronous motors, with direct current exciter. These motors start up as slip-ring induction motors but when up to speed the rotor winding is excited with direct current and the motor runs as a synchronous motor. Advantages: constant speed under load, unity or leading power factor as desired.

(2) Unity power factor motors of the type in which the primary winding is on the rotor. The rotor carries in the upper part of its slots a second winding connected to a commutator in a manner similiar to that of a direct current armature. Brushes from the commutator are connected to the secondary winding which in this case is stationary. Advantages: self-contained, unity power factor motor: practically constant speed.

(3) Capacitor motors which have usually an additional winding on the stator to which condensers are connected of such a value as to give a high power factor, usually less than unity, averaging about 95 per cent.

(4) Motors equipped as in (2) but designed for adjustable brush setting to give the characteristics of adjustable speed, combined with practically constant speed under variable load for any one setting.

Special Applications of Squirrel Cage Motors

As regards use, no motor, in recent years has been put to such diversified applications as the simple squirrel cage type induction motor. Invariably the characteristics desired are obtained at the expense of others, but inasmuch

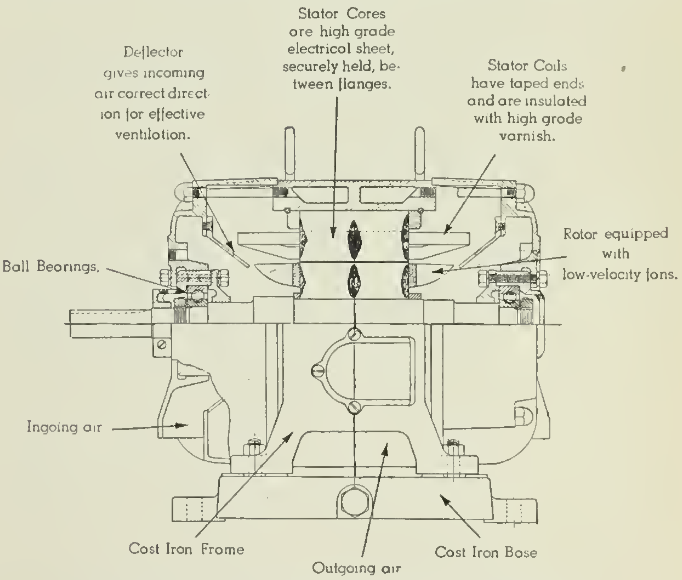


Fig. 3—5 h.p. Squirrel Cage Induction Motor.

as the end justifies the means, these applications are sound. Some of these applications include the following:

(1) Torque motors, either continuously or intermittently rated, which are designed to operate over a fraction of a revolution or make but few revolutions. Examples include: (*a*) motor operated brakes in which the motor stands stalled as long as the brake is open; (*b*) motor operated clutches for machine tools; (*c*)

motor operated valves, screw-downs, etc.; (*d*) motor operated clamping devices for machine tools.

(2) Torque motors in which the rotor revolves continuously and which are used to maintain a given tension such as employed on spoolers in the process of wire drawing. As the reel builds up it is evident that to maintain a constant tension on the wire the torque of the motor must increase. This increase in torque must be accompanied with a reduced speed to meet the demands of a constant drawing speed. The speed-torque characteristics of an induction motor can be adjusted to meet this condition.

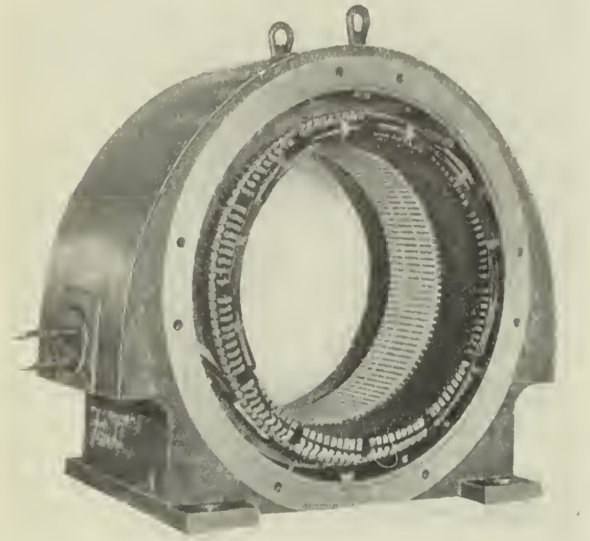


Fig. 4—Fabricated Protected Type Stator Complete with Stator Winding for 175 h.p. Squirrel Cage Induction Motor.

(3) High torque motors, which are variations of Class D mentioned above, such as for:

- (*a*) Elevators, cranes, hoists, skips, etc., where large starting torque is required and where the inherent large slip is not a disadvantage.
- (*b*) Slow-moving shears, presses, drop-hammers, etc., equipped with fly wheels where the high slip is necessary to allow the fly wheel to deliver energy and smooth out the power demand.
- (*c*) Theatre lifts, door and window openers, machine-tool shifts, etc., where abnormally high torque is demanded for a short period.

(4) Medium or semi-high torque motors, such as—

- (*a*) Punch press motors, having an average slip of approximately nine per cent and where this slip is necessary to allow the fly wheel to deliver part of its stored energy.
- (*b*) Numerous reversing motors used on such machines as tappers, threaders, and similar reversing jobs. Such machines have been capable of reversing 30 to 60 times a minute.
- (*c*) Run-out table motors for plugging to standstill or reverse where favourable torque characteristics at slips greater than unity are desirable.
- (*d*) Specially constructed low-inertia-rotor motors for the larger frame, especially designed for reversing service such as those recently applied to steel mill automatic catcher tables and which will withstand up to 40 reversals per minute.

(5) Overfluxed motors to give abnormally high outputs under conditions where a very high load may come on the motor for a short time and which must be carried over; e.g., certain types of crushers, centrifugal babbit pots and in other applications where production must be maintained under occasional adverse conditions.

Adjustable Speed Induction Motors

As mentioned earlier in this article, the induction motor is inherently a constant speed motor. To meet the demand for an adjustable speed induction motor recourse is had to the (*a*) slip-ring type, (*b*) squirrel cage multi-speed type, (*c*) commutator brush-shifting type, (*d*) simple squirrel cage motors supplied by variable frequency control.

The disadvantage of (*a*) is that the speed varies with the load, so that, in order to keep a given speed, adjustment in control must be made as the load varies. In (*b*) squirrel cage rotors are used and the stator may have one, two or more windings; with provision made in the control for giving the motor a number of fixed speeds, e.g., 1,800, 1,200, 900, 600, etc. Such multi-speed motors are made in three classifications; constant-torque, constant-horsepower, and variable-torque. They may be adapted for many of the special applications cited above. One of the most recent applications is that of a two-speed punch-press motor for forming the turret tops of automobiles. The two speeds are necessary to accommodate the draw of the different metals. Commutator brush-shifting types (*c*) have the advantages of constant speed under load. Their disadvantages are increased first cost and maintenance. Controlling the speed of a squirrel cage motor by varying the frequency of the supply voltage (*d*) is a method much used in steel mills for run-out tables and similiar conveyor systems. By its use the speed of all the motors of the system can be controlled as a unit and the speed of all

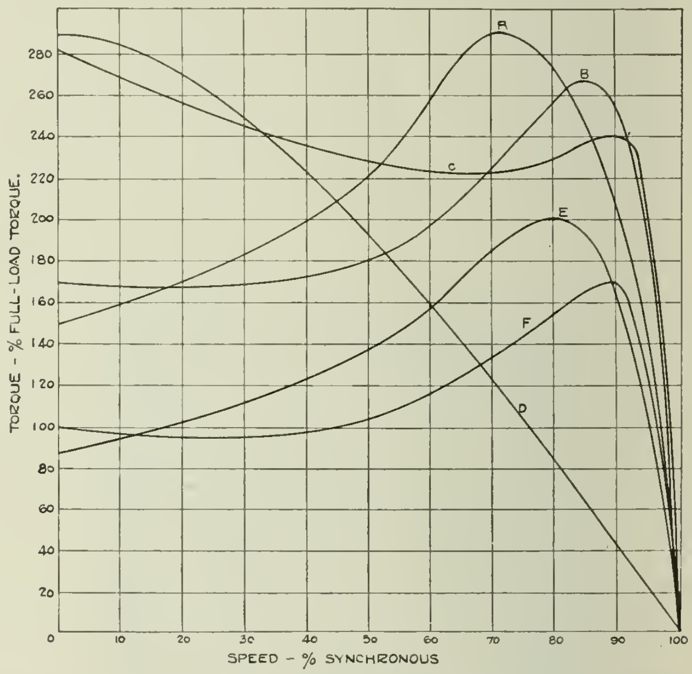


Fig. 5—Typical Torque Curves for the Various Classes of Squirrel Cage Motors Indicated in the Text. The Letter on the Curve Corresponds to the Class.

raised or lowered in unison. The variable frequency is ordinarily obtained from an alternator driven by an adjustable speed d.c. motor.

Mechanical Forms of Induction Motors

From the mechanical standpoint, the trend in today's motor is towards better protection. The use of "fan-cooled" and "protected" type motors is overreaching the "open" type. "Fully enclosed" motors have been used for years, but with the disadvantage of high first cost, due to necessarily large frames and dimensions. In both the protected and fan-cooled types, the frame size is the same as for the standard open motor. In the protected type the circulated cooling air, taken from the space immediately surrounding the motor, comes in contact with the internal windings. In the fan-cooled type the windings are entirely enclosed and shut off from contamination by the surrounding air, although the latter is used to cool the motor by blowing it across or through the frame and brackets. "Pipe-ventilated" motors are protected motors to which clean air is piped from beyond that adjacent to the motor. "Explosion-proof" motors or motors for hazardous locations are fully enclosed or fan-cooled types, especially designed with regard to the length of machine fits, lead outlet, shaft clearances, etc. "Water-cooled" squirrel cage motors have been applied recently for furnace motors and to motors driving coilers and pinch-rolls on the receiving end of high speed continuous steel strip mills. These motors are totally enclosed, the water being circulated usually through the frame only, but occasionally through the brackets as well, in order to keep the bearings within normal temperature rise.

Geared units have found much favour lately. Induction motors for slow speeds are necessarily large and costly. The directly-connected geared unit conserves space and offers a wide choice of driven speeds. Geared units for run-out tables have recently been applied on a large order for a Russian steel plant.

D.C. Braking of Induction Motors

Something new in the application of squirrel cage motors has been the braking of these motors by means of d.c. current. The use of d.c. offers many advantages, chief of which are reduced heating, flexibility or adjustability of the braking time, and reduced necessary size of motor. The first application of this principle on a large scale was on the run-out table motors at the Otis Steel Company in Cleveland about five years ago. D.c. braking was applied at the same time to the coiler motors. A few years later the run-out tables of the new Ford steel mill were installed with d.c. braking and last year the new Bethlehem Steel Mill at Lackawana on the outskirts of Buffalo was so equipped. The advantages of a controlled and positive stop is a big feature in such drives. Rapid acceleration and retardation of these tables has made possible delivery speeds of 600 to 1,600 feet per minute, with coilers operating at speeds of 800 to 2,000 feet per minute; yet with such speeds stopping by d.c. braking is accomplished within two seconds. D.c. braking has been applied with considerable success to induction motors used for hoists or cranes.

Selsyn Motors

In a somewhat different field are induction motors used for indicating and control, such as Selsyn motors. In such cases the control is through interconnected secondaries. An application of this type was made recently on the high speed printing presses of the New York Times.* The drive of the press sections consisted of 35 h.p. 1,250 r.p.m. 300 volts, d.c. motors coupled to 240-pound-foot, 208-volt, 60-cycle, Selsyn units, thus holding speeds of the press units with that of the folder unit. Other applications have been made in the U.S. Navy for control of steering mechanisms from different stations.

NEMA Motors

There have come to the Canadian market in the last few years induction motors known as NEMA. The word "NEMA" comes from the significant letters of National Electric Manufacturers Association of the United States. This Association is an outgrowth formed by the merger of the Associated Manufacturers of Electrical Supplies and the Electric Power Club. It takes the place in industry of these two named organizations and of the Electrical Manufacturers Council, the oldest of which was organized in 1908. NEMA standards and practices represent the result of many years' research and investigation by the organization itself, its predecessors, their sections and committees. This standardization has resulted in greater uniformity in engineering and manufacturing practice and in improved quality of electrical apparatus.

One of the standards effected by NEMA was that of ratings and frame sizes of induction motors. The frame sizes were first set up with regard to standardized dimensions and ratings were later assigned to these frames. The advantages to the user of NEMA is that like ratings are in frames with identical mounting dimensions, so that, irrespective of where the motor is bought, it will always conform to the same principal dimensions. The accomplishment of this standardization has been costly for the manufacturers, but the accomplishment also is an indication of what excellent work can be done by co-operation. The ratings and dimensions were set up by a committee whose personnel represented practically every responsible manufacturer of electrical motors in the United States. As a former member of this technical committee, the author can speak with enthusiasm of the engineering co-operation which made this standardization possible.

*See Electrical World, December 22, 1934.

THE

ENGINEERING JOURNAL

THE JOURNAL OF
THE ENGINEERING INSTITUTE
OF CANADA

VOLUME XIX DECEMBER 1936 No. 12

The Fifty-first Annual General Meeting

Notice is hereby given that in accordance with the By-laws, the Annual General Meeting of The Engineering Institute of Canada for 1937 will begin at Headquarters at eight o'clock p.m., on Thursday, January 21st, 1937, for the transaction of the prescribed business, and will be adjourned to reconvene in the York Room of the Windsor Hotel, Montreal, at ten o'clock a.m., on Friday, January 29th, 1937, continuing on Saturday, the 30th.

The principal business before the Annual General Meeting will be the consideration of the proposals for the amendment of The Institute By-laws put forward by the Committee on Consolidation with a view of obtaining co-operation with the several Provincial Associations of Professional Engineers.

In view of the Semicentennial Celebrations which will be held in June 1937, the usual General Professional Meeting will not be held in conjunction with the Annual General Meeting this year.

Sir Charles Parsons and Steam

The first of a series of lectures designed to commemorate the life work of Sir Charles Parsons has just been delivered at Newcastle-upon-Tyne by the distinguished secretary of The Royal Society. These lectures, together with a Parsons Memorial Medal, have been founded as the result of a national movement organized by The Royal Society with the co-operation of the leading British technical institutions.

The selection of Sir Frank Smith as the first lecturer was very appropriate, for his long experience in directing scientific and industrial research well qualifies him to speak on the achievements of a remarkable man, whose main characteristic was a passion for experiment and investigation. It was this enthusiasm, coupled with inventive genius and a sound knowledge of manufacturing processes and workshop practice, that enabled Sir Charles Parsons to develop the possibilities of the steam turbine at a time when many eminent authorities took the view that there was no future for the steam engine as it then was. In his later work on marine propulsion, and in the advances he made in the construction of the searchlight reflector and the astronomical telescope, Sir Charles showed the same striking qualities.

His engineering training was not of the conventional type. He was the youngest son of the Earl of Rosse, perhaps the most eminent astronomical engineer of his day, whose best-known achievement had been the construction in his own workshops, of a great six-foot reflecting telescope. Thus Charles was brought up in the atmosphere of experimental and mechanical activity which filled the workshops and laboratories of Birr Castle, Lord Rosse's seat in Ireland. No doubt he derived from his father that interest in astronomy which led him, many years later, to embark so successfully on the manufacture of optical glass and astronomical equipment. When he was nineteen, after a year at Trinity College, Dublin, Charles went to Cambridge, where as yet there was no engineering school. He left the university in 1877, having distinguished himself in mathematics and physics.

For the first Memorial Lecture,* the speaker selected the title which stands at the head of this article. It indicates the line of endeavour for which Sir Charles was best known. At his death in 1931, his name was chiefly associated with the rapid development of the steam turbine which had been going on during the preceding thirty years. A long period had been spent in experiment and improvement. His first patents for the steam turbine were taken out in 1884, and in the same year his first commercial turbo-generator set was built at Gateshead. Before Sir Charles' death more than twenty-eight million brake horse power of steam turbines had been constructed at the Parsons Works and at those of the company's licensees in Europe and North America.

In the field of marine propulsion Sir Charles startled the engineering world with the "Turbinia," a small vessel 100 feet long and 44 tons displacement. The first trials of this boat in 1894 were not very successful, largely due to difficulties arising from cavitation, a phenomenon not well understood at that time, but which Sir Charles at once began to study. New machinery was designed, improved performance resulted, and at the Naval Review in 1897 the boat was shown in the Solent running at the then record speed of 34½ knots. Soon afterwards the Admiralty adopted turbine machinery for destroyers and in 1905 turbines were fitted in the battleship "Dreadnought," an event which marked the practical abandonment of reciprocating steam engines for warships. Over forty-four million horse power of marine steam turbines have now been built by the Parsons Company, and its seventy licensees.

Many of his early productions have been preserved as museum pieces, in fact, the whole after end of the "Turbinia" with its machinery is in the South Kensington Museum. This year a Parsons Exhibition is being held in Newcastle-upon-Tyne under the auspices of the North-East Coast Institution of Engineers and Shipbuilders. It contains a large number of exhibits illustrative of his early work, including various types of experimental turbine blading, models and drawings of marine turbines and generator sets, the experimental tank and apparatus used for investigating cavitation, and examples of his optical work on reflectors and telescopes.

Sir Charles was the recipient of many honours. He was created a K.C.B. in 1911. He was a vice-president of The Royal Society, president of The British Association, and British vice-president of the Second World Power Conference held in Berlin in 1930. Those who knew him best were most impressed by his power of concentration, his courage, his persistence in face of difficulties and apparent failure, his resourcefulness, and his extensive knowledge of mechanical appliances and operations.

* Published in "The Engineer" of Nov. 13th and Nov. 20th, 1936.

The Proposals of the Committee on Consolidation

On another page of this issue will be found a series of proposals for the amendment of the By-laws of The Institute, which, if put into effect, will make a fundamental change in its constitution, by establishing for the first time a definite basis on which the Provincial Associations of Professional Engineers and The Institute can co-operate. These proposals have been drawn up by The Institute's Committee on Consolidation, and are now presented in the form in which they will be discussed at the Annual General Meeting to be held in Montreal on January 29th and 30th, 1937.

It is encouraging to note that in the proposals now presented the Committee on Consolidation has embodied nearly all of the modifications and additions suggested at the Plenary Meeting of Council, so that, with the exception of one item, the two bodies are in agreement on this matter. The one clause on which there is a difference of opinion will no doubt receive special attention at the Annual General Meeting, where there will be an opportunity to reconcile the conflicting views.

The proceedings of the Seventh Plenary Meeting of Council, held on October 16th and 17th, 1936, were marked by keen interest on the part of all present. The list of delegates included representatives of the Dominion Council of Professional Engineers, Past-Presidents of The Institute, and past-chairmen of the various Institute committees which, during the past ten years, have considered the organization and future of The Institute There were also present representatives of several councillors who were unable to attend.

The sessions lasted some eighteen hours; everyone was able to speak freely, and the debate dealt with every aspect of the consolidation question. The report of the sittings, published in this issue of The Journal, is greatly condensed, but is sufficient to show how thoroughly the ground was covered. All members who wish to form a worth-while opinion on the points at issue will do well to study that report in conjunction with the proposals themselves.

The final decision, upon which the future of The Institute depends, will be made by letter ballot of the corporate members of The Institute following the discussion of the proposals at the Annual General Meeting of 1937.

1. F. P. Shearwood, M.E.I.C.
2. Dr. O. O. Lefebvre, M.E.I.C.
3. A. J. Grant, M.E.I.C.
4. Dr. E. A. Cleveland, M.E.I.C.
5. G. J. Desbarats, Hon. M.E.I.C.
6. Professor H. W. McKiel, M.E.I.C.
7. P. L. Pratley, M.E.I.C.
8. R. L. Dobbin, M.E.I.C.
9. H. J. McLean, A.M.E.I.C.
10. Professor H. R. Webb, A.M.E.I.C.
11. Stewart Young, M.E.I.C.
12. G. S. Brown, A.M.E.I.C.
13. F. S. B. Heward, A.M.E.I.C.
14. Dr. L. F. Goodwin, M.E.I.C.
15. A. B. Crealock, M.E.I.C.
16. G. H. Burbidge, M.E.I.C.
17. R. J. Durley, M.E.I.C.
18. J. L. Busfield, M.E.I.C.
19. F. Smallwood, M.E.I.C.
20. A. K. Hay, A.M.E.I.C.
21. H. Cimon, M.E.I.C.
22. G. McL. Pitts, A.M.E.I.C.
23. G. A. Vandervoort, A.M.E.I.C.
24. G. H. Kirby, A.M.E.I.C.
25. J. A. Vance, A.M.E.I.C.
26. E. P. Murphy, A.M.E.I.C.
27. T. H. Dickson, A.M.E.I.C.
28. Colonel R. E. Smythe, M.E.I.C.
29. James Robertson, M.E.I.C.
30. H. L. Swan, M.E.I.C.
31. C. C. Kirby, M.E.I.C.
32. C. G. R. Armstrong, A.M.E.I.C.
33. A. B. Gates, A.M.E.I.C.
34. F. Newell, M.E.I.C.
35. Major A. J. Taunton, M.E.I.C.
36. E. A. Ryan, M.E.I.C.

The Seventh Plenary Meeting of Council.

Semicentennial Committee

A. Cousineau, A.M.E.I.C.
R. L. Dobbin, M.E.I.C.
J. M. Fairbairn, A.M.E.I.C.
R. H. Findlay, M.E.I.C.
F. S. B. Heward, A.M.E.I.C.
J. L. Busfield, M.E.I.C., Chairman

OTTAWA BRANCH
Alan K. Hay, A.M.E.I.C.

QUEBEC BRANCH
H. Cimon, M.E.I.C.

TORONTO BRANCH
C. E. Sisson, M.E.I.C.

VISITORS

Among the prominent visitors who are expected at the Semicentennial are His Excellency the Governor General, Lord Tweedsmuir; Sir Alexander Gibb, President-Elect, The Institution of Civil Engineers; Mr. Johnstone Wright, Vice President, The Institution of Electrical Engineers, and Chief Engineer, Central Electricity Board, London; Mr. E. C. Hill, President-Elect, The American Society of Civil Engineers. Announcement will be made regarding representatives of other societies in due course.

GOVERNMENT HOUSE
OTTAWA

October 17th 1936

Dear Mr Busfield,

I am desired by His Excellency to thank you for your letter of the 15th instant, and to say how very pleased he is to accept the invitation to be the guest of honour and speaker at a banquet to be held in the Rose Room of the Windsor Hotel, Montreal, on either June 15th or 16th, 1937 As I am sure you will understand, it is quite impossible to say what the Governor-General's plans will be so far ahead as June next, and consequently I must ask you to consider His Excellency's acceptance of the invitation as provisional for the time being.

Her Excellency is now in England, and I fear it is not possible to advise you, at present, whether she will be able to attend the banquet or not.

Yours sincerely,

Secretary to the Governor-General.

J.L.Busfield Esq.,M.E.I.C.,
The Engineering Institute of Canada,
1440 St. Catherine St. West,
MONTREAL.

TECHNICAL PAPERS

C. J. Mackenzie, M.E.I.C., Dean of Engineering, University of Saskatchewan, and B. A. Evans, will give a paper describing the design and construction of a highway bridge across the North Saskatchewan River at Ceepee, Saskatchewan.

The bridge, a reinforced structure, consists of approach girders and three bow-string arches of long span. The paper will deal with unusual design features involved in such long spans of this type, and give results of interesting extensometer and other records obtained during and after construction. A discussion of construction methods including cold weather experiences will also be given.

Dean Mackenzie has been associated with this work as Consulting Engineer, and Mr. Evans as Senior Engineer in charge for the Department of Public Works of Canada.

A study of standard and increment methods of measuring stream flow will be presented by H. J. McLean, A.M.E.I.C., Production Superintendent of the Calgary Power Co. Limited, and O. H. Hoover, M.E.I.C., Engineer-in-Charge of the Dominion Water Power and Hydrometric Bureau, Calgary. This paper will deal with unique methods developed for the efficient apportionment of load to machines in various hydro-electric plants of a system, and the hourly calculation of total water available at each plant.

SYMPOSIUM ON THE BURNING OF CANADIAN COALS

Announcement will be made in due course of the authors and subjects forming this symposium, which will be a valuable contribution to the meeting.

WANTED — A SLOGAN

Typifying the engineer in the community. A slogan to be used as a motif or theme for the Semicentennial. We must look upwards and forwards as well as backwards.

Please submit your suggestions to the Secretary, or to the Chairman of the Committee. There will be no reward for the successful submission except the satisfaction of contributing to the success of the meeting.

The Seventh Plenary Meeting of Council

The Seventh Plenary Meeting of the Council of The Institute was convened at Headquarters on Friday, October 16th, at ten o'clock a.m., with President E. A. Cleveland in the chair, and the following members of Council present:

Past-Presidents A. R. Decary, A. J. Grant, O. O. Lefebvre, F. P. Shearwood and H. H. Vaughan; Vice-Presidents R. L. Dobbin (Province of Ontario), H. W. McKiel (Maritime Provinces), P. L. Pratley (Province of Quebec); Councillors C. G. R. Armstrong (Border Cities), G. S. Brown (Lethbridge), G. H. Burbidge (Lakehead), H. Cimon (Quebec), A. B. Crealock (Toronto), T. H. Dickson (Moncton), A. B. Gates (Peterborough), L. F. Goodwin (Kingston), A. K. Hay (Ottawa), F. S. B. Heward (Montreal), G. H. Kirby (Saguenay), E. P. Murphy (Niagara Peninsula), H. J. McLean (Calgary), F. Newell (Montreal), E. A. Ryan (Montreal), F. Smallwood (Sault Ste. Marie), R. E. Smythe (Toronto), H. L. Swan (Victoria), J. A. Vance (London), G. A. Vandervoort (Saint John), H. R. Webb (Edmonton), and S. Young (Saskatchewan); Treasurer J. B. Challies, and by special invitation President-Elect G. J. Desbarats. There were also present Mr. James Robertson, representing Councillor A. S. Wootton of Vancouver, and Major A. J. Taunton representing Vice-President E. V. Caton and Councillor T. C. Main of Winnipeg. There were also present by special invitation —Mr. J. L. Busfield, chairman of the former Committee on Development; Mr. C. C. Kirby, President of the Dominion Council of Professional Engineers, and Mr. Gordon McL. Pitts, chairman of the Committee on Consolidation.

Expressions of regret at being unable to attend were received from a number of Past-Presidents and Councillors, and from Professor H. E. T. Haultain, M.E.I.C., chairman of the former Committee on Society Affairs.

Announcement was made of the death on September 23rd, 1936, of Past-President R. A. Ross, M.E.I.C., and a resolution of condolence was unanimously passed.

Acceptances having been received from all nominees, and all being in good standing, it was resolved that the list of nominees for officers of The Institute for 1937, as submitted by the Nominating Committee, and appearing in the November 1936 issue of The Engineering Journal, be approved.

P. L. Pratley, M.E.I.C., the Chairman of the Finance Committee, presented a summary of the revenue and expenditures of The Institute for the first nine months of 1936, which showed that The Institute had been able to operate on a slightly higher basis than was anticipated in the budget prepared in February.

The activities of the Committee engaged in arranging the Semicentennial celebrations were outlined by the chairman, J. L. Busfield, M.E.I.C.

Preliminary announcements had been sent to about seventy engineering societies throughout the world, and about twenty-five of the major societies had been asked to send delegates. Adequate publicity has been arranged for; a special number of The Journal is to be issued with historical reviews of the fifty years of engineering activity in Canada; a programme of technical papers is under way, as are also arrangements for a round table conference of Branch delegates, and a Plenary Meeting of Council. The financing of these activities is being arranged for. Plans as submitted by the chairman were approved.

It was decided that the formal annual general meeting of The Institute for the appointment of scrutineers, etc. should be held at Montreal on Thursday evening, January 21st, 1937, to be adjourned to Friday and Saturday, January 29th and 30th.

A proposed By-law submitted by the Peterborough Branch, which provided for the election by the Branch of Honorary Branch Affiliates, was approved.

Council accepted with sincere appreciation the gift from Sir Alexander Gibb, M.E.I.C., of a mezzotint engraving of a portrait of Thomas Telford by Raeburn.

The meeting adjourned at one o'clock to reconvene at two o'clock p.m.

October 16th—Afternoon Session

The afternoon meeting convened at two o'clock p.m.

Consolidation

Mr. C. C. Kirby, President of the Dominion Council of Professional Engineers, said that he believed the desires of the majority of engineers in Canada were:—

(*a*) closer co-operation between the Provincial Associations;

(*b*) some form of alliance with a national body organized so as to avoid the present duplication of fees; and

(*c*) the national body to be representative of the whole engineering profession.

The idea of creating a new body to implement (*a*) and (*c*) was acceptable in some provinces, but unacceptable in others, because The Institute with its history of service to the profession was available. The provinces themselves were not unanimous on the registration movement, and some engineers now members of The Institute were not required by the nature of their employment to become registered. The idea that the associations should also maintain permanently their own Dominion Council had proved unacceptable to some associations. The present proposals of the Committee on Consolidation appeared a practical compromise between all these views.

The principal features of the present proposals were the recognition by The Institute of membership in the Associations as a qualification for membership, the establishment of a standing committee to be known as the Committee on Association Affairs, representation of the Associations on The Institute Council, the abandonment of the present grade of Associate Member in The Institute; Associations which co-operate with The Institute would be known as Component Associations. In a province where a Component Association exists, membership in that Association would in future be essential for admission to The Institute.

The President observed that it was now the duty of Council to consider the proposals prepared by the Committee on Consolidation, and to express an opinion regarding these for transmission to the proposers for consideration, but not necessarily for acceptance. The proposals when put in final form by the proposers are then to be communicated to the membership, discussed at the Annual General Meeting, and submitted to the membership for decision by ballot.

On the request of the President, the Secretary read the following:

(1) A letter dated September 21st, 1936, from the Committee on Consolidation, submitting certain proposals for the amendment of existing by-laws, dated September 21st, 1936, and considered by the committee to be essential for co-operation between The Institute and the Provincial Professional Associations.

(2) A letter signed by sixty-five corporate members under date of September 21st, 1936, submitting to the Council the same proposals in accordance with Section 75 of the By-laws of The Institute, and authorizing the Committee

on Consolidation to act for the proposers in considering Council's opinion thereon.

(3) A letter dated September 21st, 1936, signed by twenty-four corporate members of The Institute, transmitting the same set of proposals and giving a similar authorization to the Committee on Consolidation, but excepting from that authorization Subsection 7 (*b*), in regard to which the Committee on Consolidation is not authorized to accept any change.

(4) Letters from Past-President Julian C. Smith and from Past-President C. H. Mitchell expressing general approval of the proposals, but hoping, in regard to Subsection 7 (*b*), that provision would be made for engineers who are not compelled under the respective Acts to join Component Associations.

(5) A resolution from the Toronto Branch in favour of amending Subsection 7 (*b*) by the insertion of the words "who is required by law to be a member of such Association" after the word "Association" in line two.

(6) A telegram from Councillor H. S. Johnston, supporting the same amendment to 7 (*b*), but stating that the Committee's proposals did not go far enough to satisfy Nova Scotia.

(7) A letter from the Kingston Branch urging that the class of Associate Member be retained; that members of the Component Associations be admitted to The Institute as Associate Members unless considered by Council qualified as Members; and supporting the amendment of Subsection 7 (*b*) by the insertion of the words "who is required by law to be a member of such Association."

(8) A resolution passed by the Ontario Association of Professional Engineers on October 3rd, 1936 as follows:—

> "THAT the Council of the Ontario Association feels that the Dominion Council, as at present constituted, fulfills the needs of the Ontario Association better than the proposed co-operation movement. However, the Council agrees that if the majority of the Professional Associations feel that this co-operation scheme is preferable and so indicate by subsequent action, then the Ontario Association will give it further consideration."

(9) Mr. Pitts read a letter from the Consolidation Committee of the Niagara Peninsula Branch of The Institute under date of October 9th, 1936, generally approving of the committee's proposals, suggesting some changes, but approving Subsection 7 (*b*) as proposed by his committee.

(10) The Secretary read a letter from the Secretary-Treasurer of the Lethbridge Branch dated October 9th, 1936, suggesting certain minor changes, and urging that Section 12 should be revised so as to reduce the number of councillors.

(11) The Secretary read a letter from the Registrar of the Professional Association in British Columbia, dated October 9th, 1936, giving the views of the Council of that Association, and enclosing two schemes for the revision of The Institute by-laws, referred to as "B.C. Revision No. 1," and "B.C. Revision No. 2." The letter stated that the Council of that Association "does not feel hopeful that the revisions of the Committee on Consolidation will meet with the approval of the engineers in British Columbia," and suggested that the Committee on Consolidation was moving too quickly in the matter. The Council of the B.C. Association was unable to accept the committee's revisions. It was felt that if The Institute Council would now accept B.C. Revision No. 1, this might lead to acceptance later of the more extended B.C. Revision No. 2.

The two revisions, B.C. Revision No. 1 and B.C. Revision No. 2, which accompanied Mr. Wheatley's letter, were not then read, but at the request of the President Mr. Robertson undertook to bring forward the suggestions in these revisions at the appropriate points in the course of the discussion.

Colonel Smythe stated that a resolution had been passed by the Executive of the Toronto Branch to the effect that the Council of The Institute as at present constituted, is unwieldy and unnecessarily expensive and should be reduced to a workable number.

Mr. Pratley urged that Council should consider what would actually be accomplished if the present proposals were put into effect. They only disclosed minor objectives, such as facilitating the youth movement; and avoiding unnecessary duplication of administrative costs and fees. The objectives present, but not evident, were the professionalization and regimentation of engineering. In his opinion a professional engineer was one who dealt directly with his clients, and was personally responsible for the work he turned out; apparently this definition was not generally accepted by the Associations. Some held that all were professional engineers who did engineering work. This appeared to be the meaning of the word as used by the Committee on Consolidation. A further objection to the proposals was the surrender to other bodies not wholly within The Institute of the autonomy of The Institute and the right to choose its members. He felt that the proposals were based on a misconception of the purpose of The Institute. His objection was not to consolidation, but to the scheme now proposed. He believed that there would be chaos as a result of putting the present proposals into effect.

Major Taunton said that in Manitoba it was felt that in the province there should be only one engineering organization. The Professional Association must therefore assume the provincial functions of The Institute, but The Institute must be the national centralized co-ordinating body. This would result if the Manitoba proposals were put into effect. These proposals were a definite plan that it was considered must be followed so as to obtain a single organization embracing all the engineers in the province.

The plan provided for a group membership of the Association in The Institute, which meant giving full corporate membership in The Institute to every corporate member of the Association. It was further felt that the admission of new members to The Institute should be restricted to professional engineers, all of whom must be registered with the Association in Manitoba. Any engineer not practising who wished to obtain membership in The Institute could not reasonably object to registering with the Association.

Mr. Swan stated that the Victoria Branch was in favour of the unification of the engineering profession, and the only way to prevent the chaos mentioned by Mr. Pratley and to prevent the formation of other bodies was to unify the profession. In British Columbia the members of The Engineering Institute were only a small proportion of the total registered professional engineers, and all the younger men registered with the Association, while few joined The Institute. Distinctions must be made between trained and untrained men if the profession was to be protected.

Mr. C. C. Kirby said that in New Brunswick the words "in a professional capacity" had been taken to mean that any person who holds himself out as being capable and willing to do certain work for a reward, such work requiring training or skill, is acting in a professional capacity. This definition, he thought, applied whether the engineer was working for a fee from a client or for remuneration from a corporation, organization or government.

Mr. Robertson pointed out that the letter transmitting the British Columbia resolution presented the majority opinion of the Council of the B.C. Association, and their objection to the scheme of the Committee on Consolidation was based on the proposal to collect fifty cents from each member of the Association, which would be absolutely unacceptable in British Columbia.

Mr. McLean stated that the Calgary Branch of The Institute favoured the proposals, assuming that in Subsection 7 (*b*) present members would retain their corporate membership in The Institute even if they did not desire to become registered professional engineers. He could also state that the Professional Association in Alberta was in accord with the proposals and hoped they would go through.

Dr. Lefebvre explained that Mr. McLean's interpretation of Subsection 7 (*b*) was correct.

Mr. C. C. Kirby remarked that the Associations had not been asked for their views on the proposals since these were not yet in their final form, but the attitude of the eight Associations would be known at the time of The Institute's Annual Meeting.

Professor McKiel believed that the Cape Breton Branch was not interested in consolidation, and that the Halifax Branch was opposed to the present proposals.

Mr. Pitts understood that the difficulty in Nova Scotia was that the proposals of the Committee did not go far enough.

Mr. Hay believed that the majority of the Ottawa members favoured the present proposals, even though most of them were in the government service and therefore not required by law to belong to a Professional Association.

Mr. Webb observed that the opinion of the Edmonton Branch was not unanimous, although the majority might be in favour of the present scheme.

Mr. Busfield expressed disappointment at the absence of any clear explanation for the necessity of the proposed changes in the By-laws, or of The Institute's abandoning the right to admit its own members.

Mr. Pitts suggested that Mr. Busfield should read the report of the Committee on Consolidation presented at the 1936 Annual Meeting. That committee was trying to create in Canada a group of educated people who would represent the engineering profession and who could act together for the benefit of the whole group and for the Dominion.

Mr. C. C. Kirby stated that the proposed Standing Committee on Association Affairs was essential as a connecting link between the Associations and The Institute. Years ago The Institute had recognized that the decision as to the competence of an engineer should be left with the provincial authorities. Having done so it was reasonable for The Institute to accept their decisions. The Institute would not lose the right of bringing in competent and desirable engineers. He admitted that there were engineers who were not required under the law to register.

Dr. Goodwin said that the main difficulty appeared to be the divergence of opinion regarding Subsection 7 (*b*). Owing to the wording of the law in Quebec there would be a hardship in requiring membership in the Provincial Association in all cases as a preliminary to membership in The Institute. In Ontario conditions were different. He would support the suggested amendment to Subsection 7 (*b*) as a compromise which would not hurt Quebec, and would be the solution for Ontario.

Discussion ensued on the procedure to be followed at the Annual General Meeting when the proposals are discussed there, before preparing the ballot. It was agreed that the phrase in the second paragraph of Section 75 of the By-laws "the members then present. . . . . .ballot" should be taken to mean that the ballot should include only such amendments to the proposals as are approved by a majority of the group of members present at the meeting. This interpretation was considered necessary, because if a number of amendments of this kind appear on the ballot paper, the vote will be so divided that none will secure the two-thirds majority necessary for acceptance.

It was then decided to proceed with the consideration of the Committee's proposals, section by section.

In respect to the proposed additional Subsection to Section 1 (objects of The Institute) Mr. Robertson pointed out that the proposals put forward by the Council of the British Columbia Association (B.C. Revision No. 1) also contained this suggestion.

Mr. C. C. Kirby asked whether the meeting was prepared to approve either of the sets of proposals from British Columbia.

Mr. Crealock observed that if the scheme suggested in B.C. Revision No. 1 were accepted, action on the part of The Institute would be limited to the admission of any professional engineer, and the arrangement that any professional association could collect Institute fees. This revision was apparently intended to take the place for the time being of all the proposals of the Committee on Consolidation.

Mr. Busfield noted that copies of the "B.C. Revisions" were in the hands of all members, but thought that Council should proceed with the discussion of the proposals of the Committee on Consolidation. If all of these could not be approved, other alternative methods of handling the problem should be discussed.

The President remarked that the various communications received (including those from B.C.) would be brought up in connection with the sections of the Committee's proposals to which they referred, and this course was approved.

It was then *moved* by Mr. Gates, *seconded* by Mr. Brown, and *resolved:*

> That Council approve of Section 1 in the form proposed by the Committee on Consolidation.

In regard to the proposal to omit the existing Section 2 and substitute a section headed "Associations" defining an "Association" and a "Component Association," Mr. Robertson pointed out that British Columbia desired the omission of all references to "Component Associations."

Mr. Pitts said this would not be possible because it was necessary in the By-laws to refer to Associations which did not co-operate as well as those who did.

Considerable discussion ensued regarding the omission or retention of the term "Component" after which it was *moved* by Mr. Vandervoort, *seconded* by Mr. McLean

> That Council approve Section 2 in the form proposed by the Committee on Consolidation with the exception of the last sentence which should be deleted.

It was then agreed to postpone decision on this Section.

The proposed revision to the present Section 3 regarding membership was next discussed, including the abolition of the present class of Associate Members.

Dr. Goodwin said that members of the Kingston Branch felt that the class of Associate Member should be retained; Mr. Armstrong said that the Border Cities Branch concurred in this. Mr. Dickson observed that the Moncton Branch did not see why there should be only one class of corporate member. Past-President F. P. Shearwood believed there should be only one class of corporate member, but would like to see a class of Fellow, as in the By-laws proposed the recent graduate would have the same standing as one of twenty-five years experience.

Past President Grant was in accord with the abandonment of the term "Associate Member"; if a class of Fellows were established, they should be limited in number.

Professor McKiel and Major Taunton expressed the approval of the Halifax and Winnipeg Branches of one class of corporate members.

It was *moved* by Colonel Smythe, *seconded* by Mr. Crealock, and *resolved*

THAT Council approve of Section 3 in the form proposed by the Committee on Consolidation.

It was then *moved* by Mr. Crealock, *seconded* by Mr. Burbidge, and *resolved*

THAT Council approve of Section 4 as proposed by the Committee on Consolidation.

Discussion followed on the proposals to replace the present Sections 7 and 8 by a section dealing with "Members."

In regard to this Mr. Crealock pointed out that the proposed Subsection 7 (*a*) simply admitted to corporate membership in The Institute any registered professional engineer with the required credentials.

Mr. Heward urged that Subsection 7 (*a*) be amended by putting in the word "Component" before "Association," as the level of admission standards was not uniform in all Associations, and The Institute should therefore maintain its prerogative in the matter of admission of Association members.

Mr. Crealock desired to support Subsection 7 (*a*) as proposed by the Committee, and so provide that any professional engineer could automatically become a member of The Institute.

The President pointed out that if the word "Component" were not inserted, the admission into The Institute of members of a non-component association might possibly change the attitude of that province, and increase that Association's willingness to co-operate. He believed the inclusion of the word would be a step backward. At the present time Council was admitting members in good standing from practically all the Associations, but if the word "Component" were included it would have to subject applications of members of non-component associations to the formalities to which objection had been expressed.

It was *moved* by Mr. Crealock, *seconded* by Mr. Webb,

THAT Council approve of Subsection 7 (*a*) in the form proposed by the Committee on Consolidation.

Mr. Hay then *moved* as an amendment to this motion, that the word "Component" be inserted before "Association" in the second line of the Subsection, and that an additional clause be added giving Council power to admit at its discretion members of non-component associations. This was *seconded* by Mr. Ryan. After further discussion the amendment was put to the vote and *lost*.

Mr. Crealock's motion was then put and *carried*.

The Council adjourned at six twenty-five p.m.

OCTOBER 16TH—EVENING SESSION

Council reconvened at seven forty-five o'clock p.m. and proceeded with the consideration of Subsection 7 (*b*).

Mr. Shearwood observed that if this subsection were adopted without modification, it would restrict membership in The Institute to those who are licensed to practise by one of the Provincial Associations. The Committee had never given any reason for excluding from membership in The Institute the large body of engineers who should not be called upon to take out a license. Moreover, the Committee had not stated whether licensing is of the same standard in each of the provinces, and whether these standards are equal to The Institute's qualifications. It was difficult to understand why there was any objection to Mr. Crealock's revision, for if it was beneficial to have engineers licensed, the Provincial act must include everyone eligible for Institute membership. The Committee had not yet stated whether licensing can or cannot be legally enforced on all engineers. These questions must be answered if the membership is to understand what this subsection signifies.

The President enquired as to the wording of what Mr. Shearwood had referred to as Mr. Crealock's revision to Subsection 7 (*b*). Mr. Crealock replied that this amendment contained the addition after the words "Component Associations" in the second line, of the words "who is required by law to be a member of the Association."

Dr. Lefebvre explained the nature of the objection to this amendment. In the Corporation of Professional Engineers of the Province of Quebec it was believed that The Institute should be the national body. This would mean the adoption of only one class of corporate membership in The Institute, which it was felt should originate with the Provincial Associations. The Institute would be the technical body, helping its members to exchange their views, experience and professional knowledge. Suppose the amendment were accepted, who would be responsible for the decision that the applicant must under the law of his province belong to an Association? In Quebec there could not be any consolidation of the Corporation with The Institute if this amendment were adopted. The subsection as proposed by the Committee was in accord with the discussion at the Hamilton meeting with representatives of the Dominion Council. The amendment had come from Ontario, as in that Province under the present law no one is obliged to belong to the Association. He believed that the subsection as proposed by the Committee would be beneficial in Ontario. In his opinion consolidation with the Professional Associations was essential to the continued existence of The Institute.

Mr. Pitts explained that the Committee's version of Subsection 7 (*b*) was based on what was believed to be the wish of the majority of members of the profession.

Dr. Lefebvre then read several clauses from the act of the Corporation of Professional Engineers of the Province of Quebec, and did not believe that in view of these clauses that anyone could practise there if not a member of the Corporation.

Mr. Crealock stated that the last two speakers had really presented arguments in favour of the amendment to Subsection 7 (*b*). How could the Quebec Corporation object to the amendment since everyone engaged in engineering work in the Province must belong to the Corporation? Six of the Provincial Associations had supported the Dominion Council and conferred with representatives of The Institute. The Corporation of the Province of Quebec had not been one of these Associations, and he therefore thought they might well compromise on that particular point. If the Ontario Association should become a Component Association of The Institute on acceptance of the proposed by-laws as proposed by the Committee, The Institute could only obtain about four hundred and fifty new members from Ontario, whereas, with his amendment, the potential field for membership would be increased to about two thousand.

Dr. Goodwin reminded the meeting that opinions in favour of the amendment had been expressed by Past-Presidents Julian C. Smith and General Mitchell, and by resolutions from the Toronto and Kingston Branches, and by Councillor Johnston of the Halifax Branch.

Mr. Pitts remarked that the whole argument regarding this amendment was based on the Ontario situation. The amendment was not required in British Columbia, Alberta, Manitoba, Quebec, or New Brunswick, and he believed Nova Scotia was also favourable to the Committee's recommendation.

Mr. Pratley differed from Dr. Lefebvre and Mr. Pitts in believing that there were many engineers in Quebec who were not legally required to register with the Corporation, and The Institute should not take any action which would prevent these men from joining The Institute.

Professor McKiel believed that the New Brunswick law would not require more than three or four members of the Moncton Branch to be registered in the Professional Association, as nearly all members were employees of the Canadian National Railways. A similar situation would no doubt arise in the Cape Breton Branch, where the majority of members were employees of the Dominion Steel and Coal Corporation.

Mr. Vandervoort thought that the Saint John Branch Executive would be willing to accept the amendment.

Mr. Swan deprecated the use of the words "compelled" or "required by law" and thought that references should be worded so as to stress exemption rather than compulsion. He read extracts from the British Columbia Act, and noted that although engineers in the government service in British Columbia were presumably exempted from the operation of the Provincial act, they all registered. Why should not all engineers be willing to register out of loyalty to the profession? An engineer employed by an industrial concern would not suffer in any way by securing a license to practice. On the other hand, the registration of all engineers was a vital point to the Associations, since it involved an important principle.

Professor McKiel remarked that a great argument in favour of consolidation had been the reduction in fees, but that this did not seem to be met by the present programme.

Mr. Vance observed that in the London Branch a large proportion of the members held government positions, and many did not have to belong to the Ontario Association. If the Committee's version of Subsection 7 (*b*) were accepted, The Institute would eventually lose many of these men, further, the younger men would only join the Professional Association.

Mr. Busfield noted frequent references to the prospective loss of members to The Institute, but he did not take this view. His optimism regarding The Institute's future had increased since he had become Chairman of the Committee in charge of arrangements for the Semicentennial Celebrations and had realized the general appreciation of The Institute's standing. He believed that no matter what the outcome of this discussion, The Institute would increase in membership.

Under Mr. Crealock's amendment, it would be necessary for The Institute Council to tell a man whether he was required by law to belong to a Provincial Association; this would be an impossible task, as it could only be decided by the courts. He did not think that this Subsection was essential for consolidation, and further did not think that The Institute Council should pass to someone else the work of ruling on applicants for admission. He would therefore suggest that the subsection should be omitted from the draft of the By-laws. With a contentious clause of this kind it was doubtful whether the necessary two-thirds majority could be obtained on ballot. However, he believed that ultimately the principle involved would be accepted, and that people would come to look upon the Associations as the portals to The Institute.

Dr. Lefebvre stated that the ideal arrangement would be for all fees to be collected by the Associations, and a proportion then remitted to the central body. That, however, would be possible only when The Institute recruits all members from the membership of the Provincial Associations. In his opinion the Associations did not stand to gain or lose anything by consolidation, while The Institute had much to gain.

It was then *moved* by Mr. Vandervoort:

That in Council's opinion Subsection 7 (*b*) should be deleted.

Mr. Pitts enquired as to the position of the Association in Manitoba if Subsection 7 (*b*) were deleted.

Major Taunton said that the Manitoba proposals were approved both by the membership of the Winnipeg Branch and the membership of the Professional Association, and he did not believe there would be any danger of building up a separate group of engineers in the province.

The President asked whether the Associations recognized that there were engineers entitled to practise who are exempted from the provisions of their respective acts.

Dr. Lefebvre stated that as far as the Corporation of the Province of Quebec is concerned, they would not admit that there is anyone who takes the title of "engineer," whether in government service or otherwise, who is exempt from being a member of the Corporation, and that mining engineers were included in the definition of the act.

Mr. Desbarats explained that some time ago he had represented The Institute in negotiations with the Civil Service Commission, as a result of which a ruling had been made requiring any engineer applying for a position with the Dominion Government to be either a member of The Engineering Institute of Canada, or a Provincial Association, or to possess similar qualifications. The Dominion authorities would not bind themselves to limit appointments to members of The Engineering Institute or the Provincial Associations, and it was made clear that no provincial legislature can legislate as to the qualifications of the employees of the Dominion Government.

The President remarked that in view of this explanation there would seem to be at least two classes of engineers who are not obliged to belong to the Provincial Associations: military engineers and engineers in the employ of the Dominion government.

Mr. Crealock stated that the situation in Ontario was peculiar, in that the only persons legally required to belong to the Ontario Association in order to practise engineering in the province were members of the Associations of other provinces, and that a person residing in Ontario, and doing engineering work there was not compelled to belong to the Association. Anyone not a member, however, could not call himself a "professional engineer."

Major Taunton explained that in Manitoba persons employed in the forces of the Crown, or Dominion government employees were not obliged to register. He then read the definition of the practice of engineering as appearing in the Manitoba act.

Mr. C. C. Kirby stated that in New Brunswick, and he thought also in Nova Scotia, there was a special exemption for assistants, whose only responsibility was to their superiors.

Mr. Swan said that in British Columbia the only exemptions were in the cases of architects, land surveyors and members of His Majesty's forces when on duty.

Mr. Busfield observed that in addition there was another type of engineer who would be exempt, namely executive officers like Past-Presidents Duggan and Julian C. Smith.

The President suggested that possibly a way could be found out of the difficulty with Subsection 7 (*b*) if a somewhat different wording were adopted, namely:

"No person residing in any province in which there is a Component Association shall be admitted as a Member of The Engineering Institute of Canada unless he be a corporate member of such Association or is recognized by such Association as being exempted from that requirement."

Dr. Lefebvre said that this was a compromise that was quite agreeable to him, as it removed the difficulty as to the body responsible for the decision.

Mr. Crealock, as proposer of the original amendment, agreed to withdraw that amendment and accept the alternative which the President had suggested.

Mr. Pratley was of the opinion that the objection still remained, that The Institute yielded all its autonomy, leaving the responsibility for the admission of members in the hands of the Associations.

Mr. Heward regretted Mr. Crealock's action in withdrawing his amendment, and like Mr. Pratley, felt that the President's suggestion was open to objection because it affected The Institute's autonomy.

Mr. Armstrong pointed out that some ten per cent of the membership of the Border Cities Branch were engaged in engineering work in the United States, some living in the United States and some on the Canadian side, and he wished to know what would be the status of prospective members now living in the United States.

Mr. Pitts stated that the status of these engineers would be unchanged, and to this Mr. Crealock wished to note one slight exception; that if an applicant resident in the United States were licensed as an engineer in Michigan, and were doing work in Ontario, he would then come under the provisions of the Ontario Act.

After further discussion Dr. Lefebvre *moved*:

That Subsection 7 (*b*) be amended by the addition of the words "or is recognized by such Association as being exempted from such membership."

On further discussion this wording was altered to "or exempted from that requirement under the Act," but this amendment found no seconder.

Mr. Busfield thought the wording unsatisfactory, as an applicant for admission to The Institute would have to ask some Association whether it would admit him, and this would be followed by discussion as to whether or not the man could belong to the Association. In his opinion this was undignified and would lead to further confusion.

At this point Mr. Shearwood desired to *second* Mr. Vandervoort's proposal to delete Subsection 7 (*b*).

After further discussion, during which Dr. Lefebvre's amendment was not supported, Mr. Crealock, on receiving permission from the chair, *moved* as an amendment to Mr. Vandervoort's motion

That Subsection 7 (*b*) as proposed by the Committee on Consolidation be amended by the addition of the words "who is required by law to be a member of that Component Association" after the word "Association" in line 2.

Accordingly, Mr. Crealock's amendment, having been *seconded* by Dr. Goodwin, was put to the meeting and *carried* by a vote of 13 to 8.

The meeting adjourned at eleven o'clock p.m.

October 17th—Morning Session

The Council convened at ten o'clock a.m.

Major Taunton urged the desirability of taking steps to put into effect as soon as possible the proposals from Manitoba for group membership which had been in the hands of Council for more than a year.

Mr. Swan accordingly *moved* that Council recommend to the Committee the addition of a new subsection providing that any Association upon application duly made and approved by Council, may register its total corporate membership as members of The Institute, thus becoming a Component Association.

Mr. Pitts pointed out that it would also be necessary to make provision for the payment by the Association of a per capita annual fee.

Mr. Pratley assumed that the amount of such group membership fee would be decided by Council, after which it was arranged that Mr. Swan, with his seconder and Mr. Pitts should put this proposed subsection in the form desired.

In the meantime Subsection 7 (*c*) was considered, dealing with the qualifications for membership in The Institute for applicants other than members of Associations. Mr. Busfield remarked that difficulty had arisen in past years as to the meaning of "professional responsibility." Would it not be desirable to change this term now so as to have a term which could be more easily interpreted; possibly the holding of a "responsible engineering position" might be specified. After further discussion, Messrs. Smallwood, Shearwood, Busfield and Pitts were asked to suggest a revised wording for this subsection.

It was then *moved* by Mr. Crealock, *seconded* by Mr. Brown, and *resolved*:

That Council approve Subsection 7 (*d*) in the form proposed by the Committee on Consolidation.

This subsection provides that all present Associate Members shall become Members.

The adoption of Section 8, providing for the relations with The Institute of members of Component Associations who are not members of The Institute and become "Associates," was then *moved* by Mr. Young, *seconded* by Mr. Vandervoort, and it was *resolved*

That Council approve of Section 8 in the form proposed by the Committee on Consolidation.

In regard to Section 9, providing that Council shall admit as Juniors of The Institute "engineers in training" from any Component Association upon application made, comment was made by the Council of the B.C. Association, who desire a provision to be included that The Institute shall refuse to admit as Juniors persons who are not "engineers in training" should that classification be included in the Professional Association of the province. This did not meet with approval, and it was *moved* by Mr. Hay, *seconded* by Mr. Newell, and *resolved*.

That Council approve of Section 9 in the form proposed by the Committee on Consolidation.

Section 10, making a similar provision as regards Students or "pupils" was then *approved* on the *motion* of Mr. Crealock, *seconded* by Mr. Newell.

Section 11, providing that no Affiliates shall be admitted to The Institute after June 1st, 1937, was *approved* on the *motion* of Mr. Dobbin, *seconded* by Mr. Armstrong, it being pointed out that for persons interested in engineering, who cannot come into The Institute as corporate members, the class of Branch Affiliate would still be available under the same conditions as before, namely that although not members of The Institute they are admitted to Branch privileges.

Messrs. Heward and Pitts, having been requested to draw up a sentence which could conclude Section 2, suggested the following wording:

"The Institute or any Component Association may withdraw from the co-operation established under these by-laws and the formal agreement implementing the same, under conditions provided for the purpose in the agreement."

It was *moved* by Mr. Heward, *seconded* by Mr. Newell, that this should be approved.

Discussion followed regarding the nature of the agreement referred to, and as to the date when the new by-laws, if accepted by The Institute membership, would become effective.

Dr. Goodwin and Mr. Busfield objected to the mention of an agreement in the by-laws unless its terms were available for reference, but it was pointed out that several documents referred to in the by-laws had not yet been prepared, and it was thought that the nature of the agreement was covered in the words "the formal agreement implementing the same."

Mr. C. C. Kirby pointed out that in some provinces it might be necessary to get enabling legislation to empower the Associations to co-operate with The Institute in the manner suggested, but probably this would not be difficult.

On the suggestion of Mr. Pratley it was decided to put in the word "any" instead of "the" in order to make it clear that The Institute could withdraw from any one agreement rather than from co-operation as a whole.

Mr. Vandervoort's original motion as thus amended was then put to the meeting and it was *resolved:*

> That Council approve of Section 2 in the form proposed by the Committee on Consolidation, with the exception of the last sentence, which should be changed to read "The Institute or any Component Association may withdraw from the co-operation established under these by-laws or any formal agreement implementing the same, under conditions provided for the purpose in the agreement."

In regard to Section 12, dealing with the officers of The Institute, Mr. C. C. Kirby presented the suggestion from British Columbia, that all Associations should have representation on the Council of The Institute in proportion to the number of their members, provision also being made for accredited substitutes with proxy rights.

Mr. Kirby did not think that such a proposal had ever been made in connection with the Dominion Council, and said that under the Committee's proposals every member of an Association would be represented on The Institute Council by his own Association's appointee. In British Columbia it seemed to be feared that the proposed standing committee could control the Associations. This was not so, as the standing committee's functions would be purely advisory. Further, as the eight members of the standing committee would be registered professional engineers, and as nearly all the other members of The Institute Council would also be registered, that Council would be entirely familiar with Association problems.

Mr. Kirby also pointed out that the Montreal "control" feared by the British Columbia Council could not exist, since the standing committee appointed by the Associations would deal with Association matters. There was no intention or possibility of transferring any powers legally belonging to the Associations to The Institute or its standing committee.

Mr. Young drew attention to the increase in the number of Councillors of The Institute which would result from the proposals, from forty-one to forty-nine. He also pointed out the inequality of the representation in The Institute Council as now constituted. For instance, in Manitoba one councillor represented 132 corporate members; while in Alberta three councillors represented 131 corporate members. It was apparently the intention of the present by-laws to have each Councillor represent about two hundred members, but this was not actually the case.

Mr. Swan suggested that Section 12 of the proposals should be changed in such a way as to provide that each Component Association should be entitled to appoint or elect one councillor for each two hundred members of its total membership. This would provide for proportional representation in the Component Associations, and would at the same time cut down the present Branch representation.

Colonel Smythe thought that a vote should be taken on the general principle as to whether Council should be reduced in number or not.

Mr. Pitts suggested that the simplest solution of the difficulty would be to have eight vice-presidents, one from each province; while this would increase the number of Council, an executive committee could be appointed to carry out the work of The Institute. Mr. Pitts remarked that Mr. Swan's suggestion would materially increase the expenses of the Committee on Association Affairs.

Mr. Brown, expressing the views of the Lethbridge Branch, urged that the number of councillors should be reduced.

Mr. Crealock supported the idea of a vice-president from each province, with a meeting of vice-presidents twice a year to which expenses would be paid for the eight members of the standing committee and the eight vice-presidents.

Mr. Busfield pointed out that the problem of reducing the number of councillors had been studied repeatedly in past years, particularly by the Committee on Development, and on examination had proved to be extremely difficult. Everyone agreed that the Council was too numerous, but when any possible method of reducing it was studied, difficulties appeared. For instance, if only one councillor was elected from each branch, it would be practically impossible to get a quorum for a regular Council meeting held in any city in Canada. If a smaller Council were organized, and expenses paid to Council meetings, it would still be difficult for many councillors to find the time to travel and attend meetings. The whole subject was so involved that it could not be settled at this meeting.

Mr. Challies urged the retention of the present system, under which every branch has at least one member of Council. This constituted the real strength of The Institute. Dr. Goodwin agreed with Mr. Challies. He had noted an undercurrent of anxiety from Mr. Wheatley as to the dominance of the Montreal members of Council. His experience as a member of Council from Kingston attending numerous Council meetings in Montreal, had satisfied him that such a fear was entirely unfounded.

Professor McKiel had heard a good deal about the "Montreal gang" and agreed with Dr. Goodwin on this point. He thought that the present meeting should go on record as favouring a reduction in the size of the Council. He then *moved*:

> That the Council approve of Section 12 in the form proposed by the Committee on Consolidation and that the Council should go on record as favouring a reduction in the size of the Council.

This motion was *seconded* by Mr. Dickson.

Mr. Swan believed that the British Columbia Association is definitely opposed to an Institute Council which would not have proportional representation for all the Associations on the Standing Committee on Association Affairs, but the Committee on Consolidation did not agree with that view. He thought that the B.C. Council had overlooked many of the difficulties which such an arrangement would involve.

Mr. Robertson suggested that on the Standing Committee accredited substitutes should be arranged for who should have the same powers as the persons they represent, and also have proxy rights.

Messrs. Pitts and Kirby agreed, and suggested that this point should be dealt with by a suitable provision in Section 23 (*a*) or 46.

Mr. Swan *moved* an amendment to Professor McKiel's resolution, so as to provide for proportional representation of each Association on The Institute Council, but his amendment found no seconder, and Professor McKiel's original resolution, being put to the meeting was *carried.*

Colonel Smythe desired to move that a committee should be appointed to report to Council as to the best method of reducing the number of Council; after discussion it was agreed that this should be considered when Council takes up Part II of the revisions to By-laws suggested by the Committee on Consolidation.

In regard to the addition of a new paragraph to Section 13, providing that the term of office of councillors from the Associations should be determined by the respective organizations, it was *moved* by Mr. Crealock, *seconded* by Mr. Brown:

> That this paragraph be approved in the form proposed by the Committee on Consolidation.

Discussion followed as to the desirability of limiting the term so that a councillor would not remain on the standing committee for a long period without re-election. An amendment *moved* by Dr. Goodwin, *seconded* by Mr. Heward, was finally *carried* as follows:

> That Council approve of Section 13 in the form proposed by the Committee on Consolidation, but with the addition of the words "and shall not exceed three years without re-appointment or re-election."

Section 18 of the Committee's proposals, to add a paragraph establishing a Standing Committee on Association Affairs, was *approved* on the *motion* of Mr. Newell, *seconded* by Mr. Dickson.

In regard to the Committee's proposal for Section 23A, defining the functions of the Standing Committee on Association Affairs, Mr. Robertson presented a suggestion from British Columbia which, in effect, would provide that no other members of Council except the eight councillors representing the Associations would have any say on Association affairs; this did not meet with approval. After further discussion it was *moved* by Mr. Webb, *seconded* by Mr. Hay:

> That Council approve of Section 23A in the form proposed by the Committee on Consolidation.

As an amendment to this motion it was *moved* by Dr. Goodwin, *seconded* by Mr. Heward, that the word "simultaneously" be inserted in this section after the word "report." The amendment on being put was *lost* and Mr. Webb's motion was *carried.*

The Committee's proposal to add a new Subsection 26 (*b*), providing for a brief form of application for the use of Association members, gave rise to discussion. It was then *moved* by Professor McKiel, *seconded* by Mr. Brown, and *resolved*:

> That Council approve of Subsection 26 (*a*) in the form proposed by the Committee on Consolidation.

It was then *moved* by Professor McKiel, *seconded* by Mr. Newell, and *resolved*:

> That Council approve of Subsection 26 (*b*) in the form proposed by the Committee on Consolidation.

The Committee's proposal in connection with the first paragraph of Section 27 was to except from the ordinary procedure in considering applications for admission those from Association members, for whom a special application form is proposed in Section 28.

It was *moved* by Mr. Dickson, *seconded* by Mr. Murphy, and *resolved*:

> That Council approve of Section 27 in the form proposed by the Committee on Consolidation.

The Committee's proposal as to Section 28 was to include a new subsection providing a simplified form of admission for Association members, and directing that Council shall admit such candidates on certification of the Association's Registrar.

It was *moved* by Mr. Brown, *seconded* by Mr. Vance:

> That Council approve of Subsection 28 (*a*) in the form proposed by the Committee on Consolidation.

After some discussion Mr. Webb *moved* that there be inserted in Subsection 26 (*a*) and in Subsection 28 (*a*) references to their respective Subsections (*b*) in order to clarify them. This amendment was *seconded* by Dr. Lefebvre.

Mr. Pratley drew attention to the expression "a majority of three-quarters or more" as used in Subsection 28 (*a*). He thought the intention of this phrase might be more clearly expressed and after further discussion it was decided to take up this point when Part II of the Committee's suggestions was being considered.

Mr. Webb's amendment was then put and *carried,* Mr. Pitts pointing out that in adopting it, approval was being given to Subsection 28 (*a*).

The Council adjourned at twelve-forty o'clock p.m.

October 17th—Afternoon Session

The Council reconvened at one forty-five p.m.

Subsection 28 (*b*) was then considered, dealing with the admission of Association members to The Institute, and it was *moved* by Mr. McLean, *seconded* by Dr. Goodwin, and *resolved*:

> That Council approve of Subsection 28 (*b*) in the form proposed by the Committee on Consolidation.

The adoption of the Committee's proposal to revise Section 29, dealing with notification of election, was *moved* by Mr. Webb, *seconded* by Mr. Vance, and it was *resolved*:

> That Council approve of Section 29 in the form proposed by the Committee on Consolidation.

In regard to an addition to Subsection (*a*) of Section 31, stating that the expulsion of any member from an Association would constitute automatic expulsion from The Institute, discussion followed as to whether this should apply only to Component Associations. Mr. Pitts pointed out that while members of non-Component Associations were not really affected, the matter was taken care of by the revision which had been made in Subsection 7 (*a*). If admission were granted to members of all Associations, expulsion should be governed in the same way.

The Committee proposed the addition to Subsection 31 (*a*) of the following sentence: "Expulsion of any member from an Association shall constitute automatic expulsion from The Institute."

Mr. Young inquired how, in the case of the expulsion of a member of an Association, The Institute would know of the fact.

Mr. C. C. Kirby pointed out that in the Professional Associations a man whose name was dropped for non-payment of fees could be re-instated when these are paid up. This matter would also have to be dealt with.

Mr. Crealock thought that the clause should be changed and *moved*:

That the proposed additional paragraph to Section 31 be changed to read "Expulsion of any member from a Component Association shall constitute automatic expulsion from The Institute."

Mr. Heward inquired as to the views of the Committee on Consolidation in regard to a member of an Association who might be expelled by The Institute, and Dr. Lefebvre replied that this would be a matter for the Associations.

Mr. Crealock remarked that all that the Association could do would be to deal with any charge which might be preferred against a member.

Major Taunton stated that a member of an Association who had been expelled could appeal to the courts, and might be re-instated in the Association; this would nullify any expulsion from The Institute.

After further discussion Mr. Crealock withdrew his motion, and said that if admission is granted to members of all Associations, expulsion should be applied in the same way.

After further discussion, it was *moved* by Professor McKiel, *seconded* by Mr. Brown, and *resolved*:

That Council approve of the addition to Subsection 31 (*a*) in the form proposed by the Committee on Consolidation.

In regard to Section 32, Mr. Heward noted that the chairman of the Finance Committee had not yet arrived, but he hoped that the Treasurer would be able to let the meeting have some information upon the probable result of the suggested changes upon the finances of The Institute.

While awaiting Mr. Pratley's arrival it was decided to proceed with Section 46.

In regard to Section 46, dealing with the meetings and expenses of the Standing Committee on Association Affairs, it was thought that the Committee's proposal to add Subsection (*d*) should indicate that the expenses covered are both for transportation and subsistence, but it was finally agreed that the wording proposed by the Committee would cover this, and on the *motion* of Professor McKiel, *seconded* by Mr. Young it was *resolved*:

That Council approve Subsection 46 (*b*) in the form proposed by the Committee on Consolidation.

Mr. Swan proposed the addition of an additional Subsection 46 (*c*) providing that at meetings of the Standing Committee on Association Affairs, councillors may be represented by accredited substitutes, who would have the same powers as the councillors they represent. After discussion it was decided to add this provision to Subsection 46 (*b*), and on the *motion* of Mr. Swan, *seconded* by Mr. Vandervoort, it was *resolved*:

That the following sentence be added to Subsection 46 (*b*) "Councillors may be represented by accredited substitutes at the meetings referred to in this Subsection; substitutes so appointed shall have the same powers as the Councillors for which they act."

The Committee's proposal to omit from Section 73 all references to Associate Members was approved. On the *motion* of Mr. Crealock, *seconded* by Professor McKiel, it was *resolved*:

That Council approve of Section 73 in the form proposed by the Committee on Consolidation.

The four members appointed to consider the wording of Subsection 7 (*c*) were now ready to report, and recommended an important change in the Committee's proposal, namely, that the requirement of "professional responsibility" should be replaced by a requirement of "engineering experience." They also recommended a verbal change in the second paragraph, which would become Subsection 7 (*d*).

Dr. Lefebvre urged that a definite age limit should be settled, below which Council would not be able to waive examinations for non-graduates. After discussion it was *resolved* on the *motion* of Mr. G. H. Kirby, *seconded* by Mr. Hay:

That this age limit should be thirty-five years.

These changes to Subsections 7 (*c*) and 7 (*d*) were approved on the *motion* of Mr. Shearwood, *seconded* by Mr. Smallwood, and to complete the Section Mr. Crealock *moved*:

That the former Subsection 7 (*d*) now become Subsection 7 (*e*).

His motion was *seconded* by Mr. Dickson and *carried*.

In regard to Subsection 7 (*a*)1 which had been mentioned by Mr. Swan, providing that an Association may register its total corporate membership in a group as members of The Institute and thereby become a Component Association, its approval was *moved* by Mr. Swan and *seconded* by Mr. Shearwood.

Discussion arose as to the amount of the group fee payable by such an Association, and it was agreed that this would have to be determined by Council in consultation with the Council of the Association in question. The matter would be further discussed later, when considering Subsection 34 (*c*).

Mr. Swan's motion regarding Subsection 7 (*a*)1 was then put to the meeting and *carried*.

In connection with the severe accident which happened last year to Past-President Duggan, Mr. Challies drew attention to Dr. Duggan's very satisfactory recovery from his injuries, and Past-President Shearwood was asked to convey to Dr. Duggan the regards of the Council and an expression of felicitation on his recovery.

Council then proceeded to consider the following report on the probable financial results of the proposed changes, this report having been prepared by the Chairman of the Finance Committee and the Treasurer of The Institute:—

The Financial Aspect of the Consolidation Committee's By-law Recommendations

1. So that the plenary meeting of Council may have before it a statement of the probable effect of the proposed By-law changes upon The Institute's finances, the following estimate has been prepared in consultation with the General Secretary.
2. Obviously an accurate estimate is impossible. The unpredictable facts involved are in the main—
   - (*a*) the number of associations which may become component;
   - (*b*) the number of members of such component associations who do not now belong to The Institute but who may join when "co-ordination" takes place;
   - (*c*) the possibilities of effecting savings in Headquarters' expenses following "co-ordination."
3. The proposed By-law changes which affect revenue and expenditures are—
   - (*a*) Section 32. No entrance fees from members of Component Associations.
   - (*b*) Section 34a. Annual fees for Members are reduced to the present Associate Member levels.

(*c*) Section 34b. Fee of fifty cents per capita is payable by each Component Association on its practising membership.
(*d*) Section 46b. Travelling expenses of Standing Committee for Association Affairs to be paid by The Institute.
(*e*) Section 34A—"(*b*)." Collection of annual fees through component Associations.

4. The probable effect of these By-law changes is indicated on the accompanying tabular statement for three hypothetical cases—
"X"—Assuming that all eight Professional Associations become component.
"Y"—Assuming that five become component—namely Nova Scotia, New Brunswick, Quebec, Manitoba and Saskatchewan.
"Z"—Assuming that four become component—Nova Scotia, New Brunswick, Manitoba and Saskatchewan.

5. Careful study has been given to the possible savings in Headquarters expenses should the Consolidation Committee's recommendations secure the necessary two-thirds support of the corporate membership. In the event of a possible acceptance of the set-up by the provincial associations as indicated in cases "Y" and "Z" above, no such saving could possibly be realized, and even in the event of all eight associations becoming component as indicated in case "X" above, the saving will hardly exceed $2,000. It is difficult to estimate the number of accessions to the membership over and above the normal annual increment that would result from the voluntary effort on the part of component associations to induce their members to join The Institute, but a study of the available field does not suggest any great influx even under case "X." Further, the Committee is concerned as to the loss of membership which they believe would follow the putting into effect of the Consolidation Committee's proposals. It is therefore the considered opinion of the Finance Committee that the alleged financial advantage to The Institute of this scheme of consolidation is exceedingly doubtful, indeed the Finance Committee cannot help but view with some alarm the adverse effect upon The Institute's income which is bound to ensue from the acceptance of Sections 32 and 34A.

Respectfully submitted,
P. L. Pratley, Chairman of the Finance Committee.
J. B. Challies, Treasurer.

Estimate

Arrangement considered	"X"	"Y"	"Z"
1. No. of Associations becoming "component"	All eight	N.S., N.B. Quebec Man., Sask.	N.S., N.B. Man., Sask.
2. Total No. of members of component Associations	3832	1558	630
3. No. not now members of Institute	2300	710	332
4. Expenses of Standing Committee on Assn. Affairs (Section 46b) Rly. Fare and Lower Berth—Mtl. or Tor.	$1030	$485	$485
5. Receipts from 50 cent Fee under 34b	$1916	$779	$315
6. Difference between 5 and 4	+886	+294	−170 (deficit)
7. Reduction of present Members' Fees (Section 34a) Mtl.Br.Res. say 220 at 3.00 $ 660; Rest 760 at 2.00 1520	$2180	$2180	$2180
8. Loss in entrance Fees, say (Section 32)	$1000	$ 405	$ 165
9. Financial Loss due to 7 and 8	$3180	$2585	$2345
10. Total financial loss due to 6 and 9	$2294	$2291	$2515

Montreal, October 15th, 1936.

In reference to this report Mr. Pratley pointed out the difficulty of making any detailed forecast as to the financial results of putting the Committee on Consolidation's proposals into effect. The three main items were as yet unknown: the number of Associations which would become component; the number of members of such Associations not now belonging to The Institute who would join, and the possibility of effecting savings in Headquarters expenses.

There would be a drop in revenue due to the reduction in the annual fees of present Members and due to the non-payment of entrance fees by members of Component Associations. The Institute would also have to pay the travelling expenses of the Standing Committee for Association Affairs, but on the other hand would receive the fifty cents per capita payable by each Component Association. His committee had done its best to estimate these various amounts, and in order to form some idea of the situation, three cases had been taken as explained in the report. The result indicated that in each case there would be a net loss of over $2,000.

Mr. Pratley questioned whether any saving in Headquarters expenses would be realizable for some little time, as there would be practically no reduction in the work at Headquarters until the arrangement became effective with all the Professional Associations. His committee had not put down any estimate of gain due to accessions to The Institute membership over and above the present normal annual increment. They were of opinion that the adoption of the present proposals might even result in a loss of membership, particularly on the part of industrial and government engineers. The changes proposed in Section 32 and Subsection 34 (*a*), dealing with entrance and annual fees, would certainly affect The Institute's income adversely, particularly if only a small number of Associations become component.

Mr. Pitts did not think that any loss due to the reduction of the present Members' fees to the Associate Member level should be attributed to his committee's proposals, as that change had been under consideration for some time. The revenue could be increased by placing the new Members' fee slightly higher than that of the present Associate Members.

In view of the present circumstances Mr. Busfield believed that a fee should be adopted for corporate membership somewhere between the present fee for Members and that for Associate Members.

During further discussion respecting the group membership fee, Major Taunton was of opinion that in Manitoba the fee payable to The Institute would work out at about $5.00 per capita, this including the Journal subscription.

Mr. Swan had been asked by the Victoria Branch to request that a group membership basis for British Columbia should be considered, but Mr. Swan was not authorized in any way to speak on behalf of the B.C. Association in that matter.

Further discussion followed, during which it was pointed out that in the case of a Component Association coming in under the group membership scheme no rebates would be payable by The Institute to the local Branches.

The subject of entrance fees was discussed. Mr. Pitts pointed out that while the regular entrance fee under Section 32 was now $25.00, this had not been effective during the past two years, having been reduced to $5.00 with the approval of an Annual General Meeting. His Committee thought that for the present, during a transition period, the entrance fee for members should be $15.00 as suggested by his Committee in Part II of their proposals.

After further discussion a suggestion that the annual fee for Members should be in all cases $1.00 more than the present annual fee for Associate Members met with approval, and on the *motion* of Mr. Crealock, *seconded* by Mr. Newell, it was *resolved*:

> That Council approve of Subsection 34 (*a*) in the form proposed by the Committee on Consolidation except with regard to the fees for Members, in which an increase of $1.00 is suggested.

In regard to the Committee's proposal for Section 32, it was *moved* by Mr. Crealock, *seconded* by Mr. Gates and *resolved*:

> That Council approve of Section 32 in the form proposed by the Committee on Consolidation.

In connection with Subsection 34 (*b*), dealing with the fee of fifty cents per capita payable to The Institute by each Component Association, it was suggested that this payment should if possible be made in January, as the money would be required to defray the expenses of the meeting of the Standing Committee on Association Affairs, which would probably be held at the time of The Institute's Annual General Meeting.

The adoption of the Committee's proposal was *moved* by Mr. Webb, *seconded* by Mr. Brown, but an amendment was *moved* by Mr. G. H. Kirby, *seconded* by Dr. Goodwin,

THAT the date be changed to January 31st instead of June 30th.

The amendment being put to the meeting, was *carried*.

Mr. Swan then *moved* the adoption of Subsection 34 (*c*), which had already been communicated to members, dealing with the annual fee to be paid by Component Associations having group membership. His motion was *seconded* by Mr. Shearwood.

Objection was taken to the use of the term "compounded fee" used in the Committee's proposal, and it was decided that the term "per capita annual fee" would be better.

Mr. Pratley thought there should be an annual revision of the registration of an Association coming in under group membership. New members would come in year by year; would they all benefit in the same way?

Mr. C. C. Kirby thought that in group membership the fee should be arranged so that the amount received by The Institute would be about the same as at present.

Mr. Crealock remarked that the fee should be specified as a group annual fee on a per capita basis, to make it plain that the sum paid was not a fixed total independent of the number of members in the group.

After further discussion, Mr. Swan having consented to the necessary modifications in his motion, Subsection 34 (*c*) was worded as follows:

"THAT a Component Association whose corporate members are admitted as Members of The Institute in accordance with Subsection (*a*)1 of Section 7, shall pay to The Institute, on or before the thirty-first day of July, upon conditions to be determined by the Council, a per capita annual fee to be determined by the Council, which shall include the fee provided in Subsection (*b*) of this Section, and the annual subscription to the Journal for each of its members."

Upon being put to the meeting Subsection 34 (*c*) was *approved* in this form.

The Committee's proposal to introduce a new section regarding the collection of fees (Section 34A) was next considered, and on the *motion* of Mr. Crealock, *seconded* by Mr. Armstrong, was *approved* in the form proposed by the Committee on Consolidation.

Major Taunton noted that if the proposals of the Committee on Consolidation failed of acceptance on ballot, the group membership feature which Manitoba was so anxious to establish would also fail to carry. To avoid this, would it be possible for the Manitoba proposal to be put forward by Council as a separate amendment to the By-laws?

It was pointed out that this course would cause certain difficulties, and several speakers deprecated any action indicating doubt as to the success of the main proposals. It was the sense of the meeting that it would be inadvisable to put forward the Manitoba proposal separately as suggested by Major Taunton.

Mr. Pitts observed that in addition to the proposals of his Committee, two other matters would need consideration, namely the brief form (Form C) for admission into The Institute of members of an Association, and the form of agreement which could be entered into between an Association and The Institute. He submitted drafts of these documents, one of Form C as suggested by Mr. Wheatley, and a draft agreement prepared by Mr. C. C. Kirby.

Mr. Robertson pointed out that the Vancouver Branch had for a long time advocated a very brief form of application for admission into The Institute.

Mr. Pitts presumed that these forms would not have to go forward to the membership for ballot, as they could be approved by Council in accordance with previous practice.

It was then *moved* by Mr. Crealock, *seconded* by Mr. Brown, and *resolved*:

THAT Form C should be left to be prepared by Council after the By-laws have been submitted and approved.

Colonel Smythe enquired whether, if the Committee's proposals carry, the membership of The Institute would include forest engineers and geologists, two categories included in the Association in British Columbia.

Dr. Lefebvre stated that forest engineers were not recognized by the Quebec Corporation.

Dr. Goodwin enquired whether, in connection with Subsection 34 (*c*), the per capita fee would be based on the number of members entitled to practise, as suggested from British Columbia, or would it include the classes in an Association equivalent to Students and Juniors of The Institute.

Major Taunton stated that in the Manitoba scheme, the group fee payable to The Institute was not intended to be based only upon the corporate membership of the Association, but would include a proportion of the fees obtained from the younger engineers, corresponding to the Students and Juniors of The Institute. The arrangement as to this would have to be worked out by the Council of The Institute and the Council of the Association.

Major Taunton having to leave at this point, Mr. Challies expressed the pleasure of the meeting that he had been able to come from Winnipeg to represent the Winnipeg Councillors. Major Taunton thanked Council for the courtesies extended to him.

In regard to the draft agreement as prepared by Mr. C. C. Kirby, Mr. Challies thought that it was not advisable for the Plenary Meeting to spend time on it, as such a document would have to be prepared in consultation with a legal adviser.

This suggestion was approved and the Council adjourned at six-forty p.m.

OCTOBER 17TH—EVENING SESSION

The Council reconvened at eight o'clock p.m.

The President announced that a telegram had been received by Mr. Busfield announcing that His Excellency the Governor General had provisionally accepted The Institute's invitation to be present at The Institute's Dinner on the occasion of the Semicentennial celebrations in June next.

Continuing the discussion on the nature of the possible agreement between an Association and The Institute, Mr. Pitts said that since the result of the ballot on the By-laws might affect the wording of the agreement, he would suggest that its preparation be left to the Committee on Consolidation and a legal adviser. A proposed form, including any modifications called for by the result of the ballot, could then be submitted to Council. Mr. Webb supported Mr. Pitts' suggestion.

Mr. Young *moved* that Council approve of this proposed course of action and his motion having been *seconded* by Colonel Smythe, was put to the meeting and *carried*.

Mr. Pitts thought that legal advice should also be obtained with regard to the wording of his Committee's proposals and the renumbering and rearrangement of the paragraphs. The idea of securing legal advice on the wording of the By-laws had already received the approval of the meeting, although not by formal resolution.

Mr. Crealock agreed that it would be advantageous to renumber and rearrange the By-laws, as their present arrangement was difficult to follow.

The Secretary suggested that renumbering and rearranging the by-laws at this time might make it more difficult to compare the existing by-laws with the new proposals.

Mr. Pitts pointed out that rearrangement was requested in the second part of his Committee's presentation to the Council. He felt, further, that the Committee on Consolidation might well take part in the drafting of the form of ballot as they could make suggestions that would be helpful in the presentation to the membership.

The Secretary stated that the ballot paper could not be drafted until after the Annual General Meeting because that meeting would decide what proposals would actually go to ballot.

Mr. Pitts' committee would naturally have to frame the reasons to be advanced in support of the proposals, work which would have to be done after the Annual General Meeting.

Mr. Challies thought that at this meeting Council should not do more than formulate its opinion on the Committee's proposals.

Mr. Pitts remarked that his suggestion merely involved Council's authorization to change the numbers of the By-laws into a consecutive series, and assemble the By-laws in logical order. In this way one reprinting of the By-laws would be avoided.

Mr. Pratley inquired as to the course to be taken by Council in the event of some of its opinions not being acceptable to the Committee, and therefore not included in their final proposals.

Mr. Pitts hoped that all the opinions expressed by Council would harmonize with the Committee's views. Mr. Kirby, as a member of the Committee on Consolidation, thought there was only one suggestion made by the Council which would not be accepted by the Committee, namely, with regard to Subsection 7 (*b*).

Discussion followed as to the difficulty which might arise in connection witht the ballot should the vote on Subsection 7 (*b*) be split, in which case neither the Committee's version nor that favoured by Council would be likely to secure the necessary two-thirds of all valid votes cast, and the whole scheme might fail to carry.

Mr. Swan requested permission to present a proposal regarding Subsection 7 (*b*) which he thought might result in agreement on this Subsection, and *moved* that the debate on Subsection 7 (*b*) be reopened for the purpose of hearing his proposal. This motion was *seconded* by Mr. Young.

It was pointed out that a number of members present at the debate on that Subsection had left, and Dr. Goodwin and Mr. Shearwood did not think it would be fair to resume the debate in their absence. Mr. Pratley suggested that the reopening of this question should really be subject to notice of motion. Dr. Goodwin did not think the matter should be reopened after so much time had already been spent upon it.

After further discussion Mr. Busfield suggested that it would be proper for Council to resolve itself into a committee of the whole to receive the proposal.

Mr. Swan then asked permission to withdraw his original motion, and with the consent of his seconder replace it by a motion:

That Council go into committee of the whole and reopen the question of Subsection 7 (*b*).

Mr. Swan's revised resolution having been put to the meeting, was *carried*, and at 9.10 p.m. Council went into committee of the whole.

PROCEEDINGS IN COMMITTEE

On the nomination of Mr. Pratley, the President was appointed chairman of the committee.

Mr. Swan stated that his proposal would be to change Subsection 7 (*b*) by adding an additional sentence to the version submitted by the Committee on Consolidation so that the end of it would read, "...... such Association, or he be recognized by the Standing Committee on Association Affairs as being exempt from the necessity of being a corporate member of an Association."

Mr. Swan pointed out that in the previous debate objection had been taken to giving the Association in any one province the privilege of ruling with regard to the admission to The Institute of candidates in that province. He would therefore propose to refer the question to the Standing Committee on Association affairs, which would mean that no one province would be able to say that a member is or is not exempt from the requirement of being a corporate member of its Association. He thought that this might possibly be an acceptable compromise.

Mr. Pratley did not think so, as the decision would still be practically in the hands of the Association in question, since the representatives of other Associations on the committee would hardly decide against the opinion of the representative of the particular province concerned.

Dr. Goodwin asked whether the decision of the Standing Committee would have to be unanimous. Mr. Swan replied that he did not think that that was necessary; a majority vote would be sufficient. Could we not rely on the members of that committee to see that justice was done?

Mr. Shearwood did not see why the committee should be any more just than the Council.

Mr. Pitts was not in favour of Mr. Swan's proposed addition to Subsection 7 (*b*). Mr. Pitts went on to discuss the attitude of certain groups and Professional Associations, upon which Dr. Goodwin suggested that having heard Mr. Swan's proposal, Council should resume its session.

Mr. Heward did not support Mr. Swan's suggestion, and agreed with Dr. Goodwin that the regular proceedings of Council should now be resumed.

Mr. Pitts wished to point out to Mr. Heward and those who supported him that a grave responsibility was being taken by representatives elected by The Institute who hesitated to put into effect what, as far as could be determined, was the majority opinion of the members of The Institute.

Mr. Pratley remarked that Council had gone into committee for one purpose—to listen to Mr. Swan—but would be glad to hear Mr. Pitts on Mr. Swan's proposal.

Mr. Pitts observed that Mr. Swan's proposal suggested that a committee of The Institute should pass on the eligibility of a candidate for acceptance in The Institute. Personally, he thought this a reasonable proposal, but still held that the original proposal of the Committee on Consolidation represented the wishes of the majority of the members of The Institute.

After further discussion, the President drew attention to the difficulties met with in considering this matter. It was to be gathered from Dr. Lefebvre that the Professional Corporation in Quebec did not like the Council's recommendation regarding Subsection 7 (*b*). On the other hand, it was Mr. Crealock's view that the Ontario Association did not approve of that Subsection as proposed by the committee. Another possible amendment to Subsection 7 (*b*) had now been suggested, but if the debate were reopened, some would feel that injustice had been done to the members who had left. This matter should not be treated lightly.

At this point Mr. Heward *moved* that the committee terminate its Session and reconvene as a meeting of Council.

Before doing so Mr. Young wished to make his position clear He felt sure that when he went back to Saskatchewan the members of The Institute there would be unanimously against the Council's version of Subsection 7 (*b*).

The President asked whether it would not be possible so to frame the ballot paper that a split of the vote on this one point could be avoided. It would be disastrous if the effort of years on the subject of consolidation should be brought to nothing by splitting the vote on a single phrase. Was there no other way of getting the real opinion of the whole membership of The Institute on this point? He thought that members should consider the wider aspect of the question. It would be necessary for him to leave in a minute or two, and he would like some light before he went.

Further discussion took place on how to avoid the anticipated difficulty in framing the ballot paper, but no definite solution was agreed upon.

Mr. Crealock explained his reason for moving the amendment in question, which was, to provide that if Ontario came into consolidation The Institute would not be limited in Ontario to members of the Ontario Association.

At this point the President was obliged to leave to take his train, and, on the *motion* of Mr. Shearwood, Vice-President Dobbin took the President's place as chairman of the committee.

Before leaving President Cleveland expressed his thanks to the councillors and members present, and wished them a successful issue in their further deliberations. Dr. Lefebvre, in reply, assured the President that at the conclusion of the meeting a motion would undoubtedly be unanimously adopted congratulating him on the dignity and effectiveness with which he had presided. Three cheers were given for Dr. Cleveland as he left the meeting.

Mr. Heward's *motion* to reconvene as a meeting of Council was then put to the meeting and *carried*.

The Council reconvened at 9.45 p.m. with Vice-President Dobbin in the chair.

Discussion followed in regard to renumbering and rearranging the By-laws, which Mr. Pitts pointed out had been recommended in Part II of the Committee's proposals. He drew attention to the revisions proposed by his Committee to Section 75 bearing on this matter. All that was necessary would be a paragraph authorizing the Committee on Consolidation to renumber all by-laws when approved by the ballot, and arrange them in their proper sequence.

Mr. Young then *moved* that the revisions to Section 75 as suggested by the Committee on Consolidation in Part II of their report, be sent forward as a recommendation from Council to be shown on a separate ballot. This motion was *seconded* by Mr. G. H. Kirby.

Mr. Busfield and Dr. Lefebvre pointed out the great difficulty there would be in carrying out the procedure directed in the new Subsection 75 (*b*) and its wording was accordingly revised, the Subsection then reading as follows:

> "Notwithstanding anything to the contrary in this Section, the Council may, at intervals of three years, strictly for purposes of clarification and simplification, re-word any By-law or re-arrange the By-laws. Such re-wording and/or re-arrangement shall become effective if and when (*a*) unanimously agreed to by letter ballot of members of the council, (*b*) accepted by resolutions of a majority of the executive committees of the branches, (*c*) published in the Journal and (*d*) finally approved by a formal motion at a regular business session of an annual meeting of The Institute."

It was agreed that the first portion of the second paragraph of the Section should read as follows:

> "All proposals shall be submitted for discussion at the Annual Meeting: the members there present may propose an amendment or amendments thereto, and all proposals together with such amendment or amendments as are approved by the Annual General Meeting shall be printed on a letter ballot to be submitted to the corporate membership of The Institute."

With these changes in wording, Mr. Young's motion was then put to the meeting and *carried*.

Mr. Pitts suggested that the meeting should next proceed to consider the revisions contained in Part II of his Committee's proposals, but Mr. Crealock pointed out that there was a good deal of unfinished regular business still before Council. It was therefore agreed to proceed with the applications for classification.

Before doing so, Mr. Pitts, on behalf of the Committee on Consolidation, desired to express to the chairman the thanks of his committee for the detailed consideration which Council had given their proposals.

Mr. Busfield expressed his appreciation of the honour of being invited to the meeting.

Mr. Crealock desired to *move* that the thanks of Council be voted to Mr. C. C. Kirby, the President of the Dominion Council, for coming up from Saint John to assist in the deliberations. This was *carried* by acclamation, and briefly acknowledged by Mr. Kirby.

Before the applications were considered, Dr. Goodwin drew attention to the case of an applicant who had recently been elected an Affiliate of The Institute, and later asked for reconsideration of his classification. His case was accordingly reconsidered, and he was then elected an Associate Member. Dr. Goodwin was of the opinion that before reversing or changing a classification duly made at a Council meeting, the additional information leading to such reconsideration should be in the possession of all members of Council, so that they could again express their opinions as to the candidate in question.

Dr. Lefebvre thought that in the past, applications for reconsideration had been too readily acceded to, and he believed that the present case was one of these. Mr. Crealock and Mr. Pratley concurred with these views, and on the *motion* of Dr. Lefebvre, *seconded* by Dr. Goodwin, it was *resolved:*

> THAT in the case of a request from a candidate for reconsideration of the classification accorded by Council, such reconsideration be granted only after all councillors have been notified of the request and of the additional information or representations made by the candidate, so that they may express their opinions thereon.

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

Elections.		*Transfers.*	
Member	1	Associate Member to Member	3
Associate Members	2	Junior to Associate Member	2
Juniors	3	Student to Associate Member	1
Students Admitted	2	Student to Junior	2

Four resignations were accepted; four reinstatements were effected; one member was placed on the life membership list, and three special cases were considered.

Further consideration was given to suggestions received from the various branches as to persons who might be considered for the award of Honorary Membership in connection with the Semicentennial Celebrations. This question and the question as to the desirability of revising the by-laws so as to reduce the number of Councillors, were left for consideration at a subsequent meeting of Council.

On the *motion* of Dr. Lefebvre, *seconded* by Vice-President Pratley, it was unanimously *resolved*:

> THAT the best thanks of the Council be accorded to President Cleveland for the service he has rendered to The Institute by presiding at this meeting with so much dignity and patience, and with such skill in the guidance of the debates.

The Council rose at ten fifty p.m.

Amendments Proposed to the By-laws of The Institute

Comprising the Proposals of the Committee on Consolidation and those of the Council of The Institute.

The Institute's Committee on Consolidation has drafted a series of proposals for the amendment of such of The Institute By-laws as would have to be changed in order to put into effect the committee's scheme for co-operation between The Institute and the various Provincial Associations of Professional Engineers. These proposals were duly presented to the Council over the signatures of eighty-nine corporate members; considered by the Council at a Plenary Meeting on October 16th and 17th, 1936; and the proposers have been notified of the Council's opinions thereon, all in accordance with Section 75 of the existing By-laws.

The Council of The Institute is submitting proposals to amend two other By-laws, Nos. 28 and 75, dealing with matters distinct from consolidation, and in addition is submitting an alternative form of amendment to part of Section 7, in regard to which Council could not accept the form proposed by the Committee on Consolidation for Subsection (*b*) of that section.

The sections of the By-laws to which amendments are being proposed, together with the proposed amendments and proposed new sections, are printed below for the information of the corporate membership and in accordance with the requirements of Section 75.

The proposals of the Committee on Consolidation are given first, under (A), and are worded as finally approved by the Committee acting for the signatories after consideration of the opinions of the Council and of the recommendations of legal counsel.

The proposals of the Council follow, under (B); in both cases brief explanatory remarks are added in italics. Matter not contained in the present By-laws is shown in **Bold Face** type.

The following sections of the existing By-laws remain unaffected by the changes here proposed and are not printed: 5, 6, 14 to 17 inclusive, 19 to 25 inclusive, 30, 35 to 45 inclusive, 47 to 72 inclusive and 74.

A copy of the present By-laws will be sent to any member on request.

R. J. Durley, *Secretary.*

(A). Amendments Prepared by the Committee on Consolidation

Objects

Section 1.—The objects of The Institute shall be (*a*) to develop and maintain high standards in the engineering profession, (*b*) to facilitate the acquirement and the interchange of professional knowledge among its members, (*c*) to advance the professional, the social and the economic welfare of its members, (*d*) to enhance the usefulness of the profession to the public, (*e*) to collaborate with universities and other educational institutions in the advancement of engineering education, (*f*) to promote intercourse between engineers and members of allied professions, (*g*) to co-operate with other technical societies for the advancement of mutual interests, (*h*) to encourage original research, and the study, development and conservation of the resources of the Dominion, **(*i*) to co-operate with the Associations (and Corporation) of Professional Engineers of the provinces of Canada.**

(*The present Section 1 with the addition of a new subsection* (*i*).)

Associations

Section 2.—(*a*) **For the purpose of these By-laws the term "Association" shall mean an Association or Corporation of Professional Engineers constituted by an Act of a province of the Dominion of Canada. The term "Component Association" shall mean an Association which agrees to co-operate with The Engineering Institute of Canada under the provisions of these By-laws. "Corporate Member of an Association" shall mean a member of an Association whose name appears on its Register as being qualified to practise his profession.**

(*b*) The Institute or any Component Association may withdraw from the co-operation established under these By-laws and any formal agreement implementing the same, upon conditions provided for the purpose in the agreement.

(*A new Section, replacing the present Section 2.*)

Membership

Classes of Members

Section 3.—The membership of The Institute shall consist of (*a*) Honorary Members, (*b*) Members, (*c*) Associates, (*d*) Juniors, (*e*) Students and (*f*) Affiliates. Members, and Honorary Members who have previously been corporate members, shall be styled corporate members. **For the purposes of these By-laws, unless otherwise mentioned, the term "Member" shall mean corporate member.** Honorary Members who have not previously been corporate members, Associates, Juniors, Students and Affiliates, shall be styled "non-corporate members." Non-corporate members shall not be entitled to vote on Institute affairs, or to hold office as an officer of The Institute, or as a chairman or vice-chairman of a branch **or provincial division,** or to vote on branch **or division affairs,** except as hereinafter provided. Juniors shall be entitled to vote on branch affairs and to hold branch offices other than those of chairman or vice-chairman.

(*A revision of the present Section 3, providing for only one class of corporate member in The Institute.*)

Title

Section 4.—Any Honorary Member, Member, Junior or Student, having occasion to designate himself as belonging to The Institute, shall indicate the class to which he belongs according to the following abbreviated forms:—Hon.M.E.I.C.; M.E.I.C.; Jr.E.I.C.; S.E.I.C.

(*The present Section 4, but omitting references to Associate Members and Affiliates.*)

Members

Section 7.—(*a*) **The council shall admit as a Member of The Institute any corporate member of an Association upon application duly made and on presentation of the credentials requisite under these By-laws.**

(*a*)1 **Upon application duly made to and approved by the council, and in accordance with the provisions of Section 2, any Association may be granted the privilege of registering its total corporate membership at one time as Members of The Institute, and shall thereby become a Component Association.**

(*b*) **No person residing in any province in which there is a Component Association shall be admitted as a Member of The Engineering Institute of Canada unless he be a corporate member of such Association.**

(*c*) **Except as provided in subsections (*a*) and (*b*) of this Section, any person to be eligible for admission as a Member of The Institute shall be at least twenty-seven years of age, and shall have gained engineering experience by being engaged in some branch of engineering for a period of at least six years.** In every case a candidate for election shall **be competent to design or carry out engineering work of the nature of the work on which he has been engaged. In the case of a graduate of** a school of engineering recognized by the council **the above period of six years may be reduced to two years.** Occupancy of a chair as a professor, an associate professor, or an assistant professor in a faculty of applied science or engineering shall be considered **equivalent to the engineering experience required above.**

(*d*) 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 **attained the age of thirty-five years and has been engaged in engineering work for a period of ten or more years, such work being of a nature comparable to that required in Subsection (*c*) of this Section.**

(*e*) **Upon the adoption of these By-laws, all Associate Members of The Institute shall *ipso facto* become Members, and the present class of "Associate Member" is hereby abolished.**

(*This important new Section takes the place of the present Sections 7 and 8. It states the conditions for the admission of corporate members of Associations, and changes the requirements for the admission of non-Association members, whether graduates or non-graduates. It also abolishes the present class of Associate Members.*)

Associates

Section 8.—**All members of a Component Association who are not members of The Institute shall be styled "Associates" of The Institute when the Registrar of such Component Association shall have advised the Secretary of The Institute of the names and addresses of the members of the Association in the above classification.**

(*A new Section.*)

Juniors

Section 9.—(*a*) 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 the 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.

(*b*) **Notwithstanding the provisions of Subsection (*a*) of this Section, the council shall admit as a Junior of The Institute an "Engineer in Training," where such or an equivalent classification is included in the non-corporate membership of any Component Association, upon application duly made and on presentation of the required credentials.**

(*The present Section 9 with a new subsection.*)

Students

Section 10.—(*a*) 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 the council special circumstances warrant the extension of this age limit.

(*b*) **Notwithstanding the provisions of Subsection (*a*) of this Section, the council shall admit as a Student of The Institute, a "Student" or "Pupil" where such classification or its equivalent is included in the non-corporate membership of any Component Association, upon application duly made and on presentation of the required credentials.**

(*The present Section 10 with a new subsection.*)

Affiliates

Section 11.—An Affiliate shall be one who is not an engineer by profession but whose pursuits, scientific attainments or practical experience, qualify him to co-operate with engineers in the advancement of professional knowledge.

No Affiliates shall be admitted to The Institute after June 1st, 1937.

(*The present Section 11 with an addition providing for the eventual disappearance of the present class of Affiliates of The Institute.*)

Officers

Section 12.—The officers of The Institute shall be a president, five vice-presidents **and the members of council.** One councillor **shall be elected** from each branch having less than two hundred corporate members, two councillors from each branch having two hundred and less than four hundred corporate members, three councillors from each branch having four hundred corporate members, and an additional councillor from each branch for each two hundred corporate members over four hundred. **Each Component Association in good standing shall be entitled to appoint or elect one councillor who must also be a corporate member of The Institute.**

(*A modification of the present Section 12, providing for representation of Component Associations on the council of The Institute.*)

Term of Office—Vacancies

Section 13.—The term of office of the president shall be one year, of the vice-presidents two years, and of the councillors two years, except in the case of councillors representing branches entitled to three or more councillors, whose term of office shall be three years. At least one councillor shall be elected each year from each branch entitled to two or more councillors, and one councillor shall be elected each alternate year from each branch entitled to one councillor. The elections for branches entitled to one councillor shall be so held that as nearly as possible one half of such branches shall elect their councillors in any one year.

The term of each officer shall begin at the close of the annual general meeting at which such officer is elected, and shall continue for the period above named or until a successor is duly elected or appointed by the council.

A vacancy in the office of president shall be filled by the senior vice-president. Seniority shall be determined by priority of election as a vice-president, and failing that, by priority of admission to corporate membership.

A vacancy in the office of vice-president shall be filled until the following annual election by the senior councillor from the zone in which the vacancy occurs. Seniority shall be determined by priority of election as a councillor and, failing that, by priority of admission to corporate membership.

A vacancy in the office of councillor shall be filled until the following annual election by a corporate member chosen by the council from a list of nominees submitted by the executive of the branch concerned.

The term of office of councillors representing the Component Associations shall be determined by their respective organizations and shall not exceed three years without re-appointment or re-election.

(*The present Section 13, with an additional clause.*)

Appointment of Secretary, Treasurer and Committees

Section 18.—The council shall meet within seven days after its election and shall then appoint the secretary, the treasurer, and the following standing committees:—

A finance committee of five members.
A library and house committee of five members.
A papers committee as prescribed in section 21.
A publication committee of five members.
A legislation committee of three members.

The chairman of each standing committee shall be a member of the council.

Standing committees shall perform their duties under the supervision of the council, and shall report to the council.

The council at any time, may appoint special committees to report upon engineering subjects or upon other matters of interest to The Institute. The annual general meeting may recommend to the council the appointment of special committees, and such recommendations shall be considered by the council at the first meeting following the annual general meeting.

Special committees shall perform their duties under the supervision of the council, and shall report to the council.

The councillors elected or appointed by the Component Associations shall constitute a Standing Committee on Association Affairs. The chairman shall be appointed annually by the members of this committee.

(*The present Section 18, with the addition of a clause forming a Standing Committee on Association Affairs.*)

Committee on Association Affairs

Section 23A.—**The Standing Committee on Association Affairs shall:**

(*a*) **Assist the Associations in securing improved legislation for the better protection and regulation of professional interests.**

(*b*) **Promote the adoption by the Associations of uniform standards of examination and membership.**

(*c*) **Promote the granting of reciprocal privileges between the Associations for the benefit of their members.**

(*d*) **Generally act in an advisory capacity to the Associations to secure harmony of action in all matters of common interest.**

This Committee shall report to the council of The Institute and to the councils of the Component Associations.

(*A new Section.*)

Applications for Admission or for Transfer

Section 26.—(*a*) Applications for admission to The Institute (Form A in the Appendix), **except an application by a member of an Association (see Subsection (*b*) of this Section)**, or for transfer from one class to a higher (Form B in the Appendix), shall contain a statement, over the applicant's signature, of his age, residence, the nature and term of his professional service, and an agreement to conform to the By-laws and regulations of The Institute if elected or transferred. The applicant shall give as references the names of at least five corporate members, from whom the council shall obtain satisfactory evidence in writing that they know the applicant personally, and that he is worthy of admission or transfer. The application of a Student shall require the name of only one corporate member as a reference.

(*b*) **An application for admission to membership in the Institute by a member of an Association (Form C in the Appendix), shall contain a statement over the applicant's signature, of his age, residence, the nature and term of his professional service and experience, class of membership in the Association, and an agreement to conform to the By-laws and Regulations of The Institute. This statement shall be certified to and signed by the Registrar of the Association from the records of the Association.**

(*A modification of the present Section 26, providing for the form of admission of Association members.*)

Consideration of Applications for Admission or for Transfer

Section 27.—Immediately upon receipt of an application, **except in the case of a member of an Association**, the secretary shall forward a copy thereof to the secretary of the branch, if any, to which the applicant belongs. The executive committee of the branch shall thereupon make such enquiries concerning the applicant as it deems advisable, and shall recommend to the council the action that it considers should be taken with reference to the application.

At stated periods to be determined by the council there shall be issued to corporate members whose addresses are known a list of new applicants for admission or for transfer, containing a concise statement of the record of each applicant and the names of his references, with a request that members transmit to the secretary any information in their possession which may affect the classification or eligibility of the applicant.

The secretary shall also forward to each member of council a concise statement of the record of each applicant and the names of his references on a form on which space shall be provided for each councillor to make his recommendation regarding the applicant. The forms shall be mailed to councillors at least thirty days before the applications referred to are dealt with by the council. Each form must be signed by the councillor returning it, but it is not necessary that he should express a recommendation regarding all or any of the applicants.

(*The present Section 27, slightly modified.*)

Election and Transfer

Section 28.—(*a*) The council shall consider all the information with reference to each application and, **except in the case of a member of an Association (see Subsection (*b*) of this Section)**, shall make further enquiries if deemed expedient, and shall then decide whether the application shall be accepted, and if so, to what class of membership the applicant shall be admitted. Before reaching this decision, however, not less than twenty-five of the forms referred to in Section 27 must be returned to the secretary, and the recommendations contained in these forms must be placed before the council. If five or more members of council oppose the admission or transfer of an applicant, he shall not be elected, otherwise a majority of three-quarters or more of those present at a council meeting shall determine the classification of the applicant, with or without examination, and thereby constitute his election, subject to examination if so required.

A rejected candidate shall be notified promptly that his application has not been accepted, and he may renew his application for admission or transfer at any time after the expiration of one year from the date of his notification.

Application for membership in the class of Student shall be passed upon by the council without the formality of notification to all councillors.

(*b*) **An application for admission to The Institute by a member of an Association, together with the accompanying certificate by the Registrar of such Association, shall be considered by the council at its first meeting following the receipt of such application. These documents being in conformity with these By-laws, the council shall admit the candidate to the class of membership in The Institute corresponding to his class of membership in the Association.**

(*The present Section 28, with a new subsection referring to Association members.*)

Notification of Election

Section 29.—On the election of a candidate, he shall be notified by the secretary and he shall then be entitled to the privileges of membership **of the class to which he has been elected.** Membership shall date from the date of **his** election.

(*The present Section 29, slightly modified.*)

Expulsion and Discipline

Section 31.—(*a*) The council shall have the right to expel from The Institute any corporate or non-corporate member who may be convicted by a competent tribunal, of felony, embezzlement, larceny, misdemeanour, or other offence which in the opinion of the council renders him unfit to be a member. Such expulsion shall be effected by causing the name of such member to be erased from the register of members, and such member shall not be entitled to receive previous notice of such expulsion, but upon such expulsion shall be notified in writing by the secretary to that effect.

Expulsion of any member from an Association shall constitute automatic expulsion from The Institute.

(*b*) If, in the opinion of the council, any corporate or non-corporate member be guilty of a breach of the code of ethics adopted by The Institute, or have acted in a manner unbecoming to a member of The Institute or in a manner detrimental to the character, reputation or interests of The Institute, or adverse to the objects of The Institute, the council may discipline such offending member by:

1. Censuring such member in writing by letter addressed to him by the secretary or by having such member appear in person before the council for the purpose of receiving such censure, or;
2. Suspending the membership of such member for such length of time as the council sees fit, or;
3. Causing the name of such member to be erased from the register and thereby expelling him from The Institute.

Any enquiry or investigation with a view to disciplining a member as aforesaid, may be instituted by the council at any time by its own action, or upon the complaint in writing of any member or members, addressed to the secretary, who shall submit the same for consideration to the council at its next meeting, and such enquiry and investigation shall be conducted in such manner and to such extent and at such time or times as the council may in its absolute discretion decide. No verbal or anonymous complaint against any corporate or non-corporate member shall be considered or acted upon by the council. If the council be of the opinion that any complaint is trivial and not of sufficient gravity or importance to justify an enquiry, the secretary shall notify the complaining member to that effect, and the council shall not be obliged to take any further action in regard thereto and no further record shall appear in the minutes.

No disciplinary action as aforesaid shall be taken by the council unless the same has been approved by the affirmative vote of at least three-fourths of the members of the council present at a meeting specially called for the purpose of considering the same, and at which at least twelve members of the council are present. Should the complaining member or offending member be a member of council, he shall not act as a member of council at any such enquiry or vote on any matter relating thereto.

Any member, whose conduct or action is to be made the subject of enquiry with a view to disciplinary action as aforesaid, shall be entitled to be notified by the secretary by registered letter addressed to his last known place of residence and specifying the nature of the charges against him, and before any such disciplinary action is taken by the council, such offending member shall be given a fair opportunity of being heard by the council, either by appearing in person before it, or, subject to the approval of the council, by submitting to the council a sworn statement in writing addressed to the secretary.

If the council, after holding an enquiry, decides to take disciplinary action, the same shall be duly recorded and the offending member notified in writing thereof by the Secretary.

(The present Section 31 with the addition of one sentence dealing with Association members.)

FEES

Entrance Fee

Section 32.—The entrance fee **for Members,** payable at the time of application for admission to The Institute shall be **$15.00.**

Honorary Members, **Members of Component Associations, Juniors,** and Students shall be exempt from entrance fees.

(The present entrance fee of $5.00 was authorized by the Annual General Meeting of 1936, as a temporary reduction from the regular entrance fees of $25.00 for Members, $15.00 for Associate Members, and $10.00 for Juniors.)

Section 33.—**Except as otherwise provided in these by-laws,** all annual fees shall be due and payable on the first of January for the calendar year then commencing, at which time a bill for the sum shall be mailed to each member, in accordance with the following Schedules of Fees:—

Schedules of Fees

Section 34.—(*a*) The annual fees payable by Montreal Branch Residents shall be as follows:—

		If paid on or before March 31st
Members	**$12.00**	**$11.00**
Juniors	7.00	6.00
Students	2.00	1.00
Affiliates	11.00	10.00

The annual fees payable by all other Branch Residents shall be as follows:—

		If paid on or before March 31st
Members	**$10.00**	**$ 9.00**
Juniors	5.00	4.00
Students	2.00	1.00
Affiliates	11.00	10.00

The annual fees payable by Branch Non-Residents and Non-Residents shall be as follows:—

		If paid on or before March 31st
Members	**$ 8.00**	**$ 7.00**
Juniors	4.00	3.00
Students	2.00	1.00
Affiliates	11.00	10.00

Honorary Members **and Associates** shall be exempt from annual fees.

In accordance with the above schedules, if paid on or before March 31st of the current year, a deduction of one dollar will be allowed on the annual fees of all classes.

(The proposed annual fee for Members is in each case one dollar higher than the present annual fee for Associate Members.)

(*b*) **A fee of Fifty Cents (50c.) per capita, based on the number of members entitled to practise as appearing on the register of the Association at the end of its preceding fiscal year shall be payable by each Component Association to The Institute on or before the thirty-first day of January of each year.**

(*c*) **A Component Association whose corporate members are admitted as Members of The Institute in accordance with Subsection (a) 1 of Section 7, shall pay to The Institute, on or before the thirty-first day of July, upon conditions to be determined by the council, a per capita annual fee to be determined by the council, which shall include the fee provided in Subsection (b) of this Section and the annual subscription to The Journal for each of its members.**

(Subsections (b) and (c) are entirely new.)

Collection of Fees

Section 34A.—(*a*) **The annual fees of all members shall be remitted directly to the secretary of The Institute unless otherwise directed by the council.**

(*b*) **The council may arrange with the governing body of any Component Association for the collection of the annual fees of members who are also members of such Association.**

(A new Section.)

Meetings of Standing Committees

Section 46.—(*a*) Standing committees, except the papers committee, shall meet at least once each month, from the beginning of October to the end of April, and at such other times as may be deemed necessary.

Three members shall constitute a quorum.

(*b*) **The Standing Committee on Association Affairs shall meet at least once each year. The travelling expenses (by which is meant all reasonable out of pocket personal disbursements for transportation, lodging and subsistence) for members of this committee attending such meetings, shall be paid by The Institute for one meeting in each year. Members of the committee may be represented at meetings by substitutes accredited by their respective Associations. Substitutes so appointed shall have the powers, also the privileges as to expenses, of the members of the committee whom they represent.**

(The present Section 46, with an additional subsection regarding the Standing Committee on Association Affairs.)

JOURNAL OF THE INSTITUTE

Section 73.—The annual subscription for the Journal of The Institute, for members of The Institute, shall be two dollars and shall be paid by members of all classes, with the following exceptions:—Honorary Members, Life Members and members who have compounded their fees, who shall receive the Journal gratis. **Associates and** Students shall have the option of subscribing to the Journal at the above rate. The annual subscription to the Journal **for Branch Affiliates and** non-members of The Institute shall be three dollars. All subscriptions shall be payable on the first day of January of each year.

(A slight modification of the present Section 73, omitting the last paragraph.)

(B). AMENDMENTS PROPOSED BY THE COUNCIL

(1) In connection with the foregoing amendments and in accordance with Section 75 of the existing by-laws, the council makes the following proposals for the amendment of Sections 28 and 75 of the existing by-laws:

Section 28—To amend the third sentence of the first paragraph to read as follows:

"If five or more members of council oppose the admission or transfer of an applicant, he shall not be elected, otherwise **the affirmative vote of** three-quarters or more of those present **and voting** at a council meeting shall determine the classification of the applicant, with or without examination, and thereby constitute his election, subject to examination if so required."

(A verbal change which does not alter the intent of the by-law, but removes a possible ambiguity. This proposal was approved by the council at its meeting on November 27th, 1936.)

Section 75—To amend the first sentence of the second paragraph of this section to read as follows:—

"All proposals shall be submitted for discussion at the annual general meeting; the members there present may propose an amendment or amendments thereto, and all proposals together with such amendment or amendments **as are approved by the annual general meeting** shall be printed on a letter ballot to be submitted to the corporate membership of The Institute."

(The whole of the existing by-law to form Subsection 75 (a). The additional words proposed as above are intended to avoid the issue of a ballot which would be unworkable by reason of the inclusion in it of a large number of amendments to a proposal. The change was suggested by the Committee on Consolidation as a desirable one, and the council approved it at its meeting on November 27th, 1936.)

Section 75—Add the following new subsection:

"Notwithstanding anything to the contrary in this Section, the council may, at intervals of three years, strictly for purposes of clarification and simplification, reword any by-law or rearrange the by-laws. Such re-wording and/or re-arrangement shall become effective if and when it has been (*a*) approved by a majority of members of the council upon letter-ballot, (*b*) approved by the resolutions of the executive committees of a majority of The Institute Branches, (*c*) published in The Journal, and (*d*) finally approved, upon a formal motion to that effect, at a regular business session of an annual general meeting of The Institute."

(This proposal was approved by the council at its Plenary Meeting on October 17th, 1936. It was suggested by the Committee on Consolidation as desirable, though not necessary for consolidation.)

(2) *Section 7*, Subsection (*b*)

At its meeting in Toronto on November 27th, the Council considered the proposed new subsection 7 (*b*) as finally drafted by the Committee on Consolidation, and noted that that Committee had expressed their inability to accept the Council's recommendation to amend the Committee's original proposal by inserting after the words "Component Association" in the second line, the words "who is required by law to be a member of that Component Association."

The Council accordingly proposes that the new Subsection 7(*b*) shall read as follows:

"(*b*) No person residing in any province in which there is a Component Association, who is required by law to be a member of that Component Association shall be admitted as a Member of The Engineering Institute of Canada unless he be a corporate member of such Component Association."

The above amendments as proposed by the Council are now published for communication to the corporate membership in accordance with Sections 74 and 75 of the existing By-laws.

R. J. Durley,
Secretary.

December 1st, 1936.

Trends in Aviation Lighting in the United States

The illustration of floodlighting equipment at Calgary given below was inadvertently omitted from Dr. Breckenridge's paper printed in the November issue of The Journal, pages 494 to 499. It is now published by the courtesy of the Canadian Westinghouse Co. Limited.

Floodlighting Equipment at Calgary, Alta., Airport.

Erratum

In connection with Fig. 5 of the paper "Trends in Aviation Lighting in the United States," by Dr. F. C. Breckenridge, on page 498 of the November, 1936 issue of The Engineering Journal, it is incorrectly stated that this illustration was supplied by the Canadian General Electric Company. This photograph was obtained from the Canadian Westinghouse Company, Limited, and reproduced by courtesy of that company.

Rolled Welded Alloys

Strips of two alloys, Copnic and Chromel, were welded together and rolled to a thickness of six millionths of an inch recently in the laboratories of the General Electric Company. Even when magnified 250 times the weld in the ultra-thin bi-metallic foil can be distinguished only by the difference in colour between the two alloys.

The six millionths of an inch thickness was achieved by placing the welded strips of the two alloys—the one of copper and nickel, and the other of chromium and nickel—between pieces of steel and reducing the combination as a unit by passing it between rolls. The final product of the rolling process is as delicate as gold leaf and must be handled with equal care.

Committee on Consolidation

Report for November, 1936

The Committee on Consolidation held its twenty-third meeting on Saturday, November 14th, at 10.30 a.m. There were present Messrs. Challies, Jamieson, Legget and Pitts.

This meeting was called primarily to receive the suggestions of the Plenary Meeting of Council of October 16th and 17th relative to the proposed revisions to the by-laws prepared by the Committee on Consolidation. At the same time the Committee had before it a memorandum from the legal adviser of The Institute to whom these proposals had been submitted, which indicated certain minor revisions in phraseology to more clearly indicate the sense.

The suggestions of the Council having been circulated to all "corresponding" members of the Committee, letters were placed before the meeting from C. C. Kirby, President of the Dominion Council, A. B. Crealock, Vice-President of the Dominion Council, Geoffrey Stead, President of the Professional Association of New Brunswick; G. J. Desbarats, member of the Committee; and F. S. B. Heward, Councillor of The Engineering Institute.

The Committee carefully reviewed those sections of the proposed by-laws relating to Consolidation as submitted by it to the Council, together with the suggestions of the Council, and subject to minor modifications suggested by the legal adviser, the Committee accepted all the proposals of the Council with the exception of one paragraph having to do with admission to membership in The Institute and notated in the present draft as Section 7 (*b*).

The Committee on Consolidation originally suggested that this paragraph should read as follows:—

> "7 (*b*) No person residing in any province in which there is a Component Association, shall be admitted as a Member of The Engineering Institute of Canada unless he be a corporate member of such Association."

Council suggested to the Committee that this paragraph should be amended to read as follows—

> "7 (*b*) No person residing in any province in which there is a Component Association, who is required by law to be a member of that Component Association, shall be admitted as a Member of The Engineering Institute of Canada unless he be a corporate member of such Association."

The Committee very carefully considered the amendment to this Section as proposed by the Council from every point of view and finally came to the conclusion that it had no alternative but to adhere to the Section as originally drafted by the Committee.

The revisions to the By-laws of The Institute as proposed by the Committee on Consolidation are presented officially in accordance with the provisions of By-law No. 75, on pages 550 to 553 of this issue of The Journal.

In connection with the present proposals for a revision of the By-laws of The Institute our legal adviser and the Committee on Consolidation recommended to the Council of The Institute that the occasion for such revision should be made the opportunity of rearranging and renumbering the By-laws of The Institute in a logical sequence in order that they may be presented in a clear and easily accessible form for the use of the members.

With the assistance of the legal adviser of The Institute, the Committee on Consolidation prepared and submitted to the Council the following draft of an "Agreement" between a Component Association and The Institute.

DRAFT of November 14th, 1936.

THIS MEMORANDUM OF AGREEMENT executed in duplicate on this day of 193 .

BETWEEN

a body corporate, incorporated under the laws of the Province of , having its head office at , said Province, hereinafter called the

Association

— and —

THE ENGINEERING INSTITUTE OF CANADA, a body corporate, incorporated under the laws of the Dominion of Canada, having its head office at Montreal, Province of Quebec, hereinafter called the

Institute

WITNESSETH THAT:

WHEREAS the Association desires to become a Component Association within the meaning of and subject to the By-laws of The Institute current as of this date and thus co-operate with The Institute in the furtherance of its objects; and

WHEREAS the By-laws of The Institute provide two methods whereby the Association may become a Component Association; and

WHEREAS the Association has elected to become a Component Association under the provisions of Sections........................ of the said By-laws:

NOW THEREFORE, the Parties, upon the considerations moving them in the Preamble and for the greater advantage of the Profession throughout Canada, mutually covenant as follows:

1. The Association hereby becomes and is recognized by The Institute as a Component Association within the intent and subject to the By-laws of The Institute, with which it declares itself familiar and content.

2. The Association agrees to submit to The Institute the credentials of each member applying for membership in The Institute required under the By-laws of The Institute.

3. The Association will appoint or elect as often as may be necessary one of its Members (who shall also be a Member of The Institute) to the Council of The Institute.

4. The Association will pay to The Institute on or before January 31, in each year, a sum of fifty cents (50 cents) in respect of each of its Members enrolled at the close of its then last fiscal year.

5. Subject to the By-laws of The Institute and when so requested by the Council of The Institute, the Association shall receive the fees of Members who are common to both the Association and The Institute as set forth in Section No. 34 of the said By-laws, and shall remit the same to The Institute with reasonable despatch, but not later than the end of the year in which such fees fall due, together with sufficient indication as to those who have or have not paid their fees.

6. When it is mutually agreed between The Institute and all the Component Associations that a change in the By-laws of The Institute would assist that co-operation which is the spirit of this Agreement, the Council of The Institute shall endeavour to effect such change.

7. In matters affecting the common interests of Component Associations and of The Institute, The Institute, after consultation with all Component Associations, will act to further the common interest as permitted by its By-laws.

8. The Institute shall use the moneys referred to in paragraph 4 above, as paid to it by all Component Associations, to further the activities of the Standing Committee on Association Affairs and toward the expenses of one plenary meeting of this Committee in each year.

9. This Agreement shall endure in any event for three years from its date, but may thereafter be terminated for any reason whatsoever by either Party as of the end of any calendar year by written notice addressed to the other party on or before the First day of such year.

AND THE PARTIES, declaring that they have read and are content with the foregoing, have signed and hereto set their respective seals.

....

....

The Committee also prepared and submitted to the Council the following draft of the form of application for membership in The Institute by a member of a Provincial Professional Association in accordance with the provisions of the proposed revisions to the By-laws.

DRAFT of November 14th, 1936.

FORM C.

THE ENGINEERING INSTITUTE OF CANADA

Application for Admission by a member of a Professional Association.

Section No. 1

I..
Full Christian Name and Surname of Applicant

residing at..
City or Town County Province

hereby make application for admission into The Engineering Institute of Canada, as a..
(State Class of Membership)

I was born at..
Place of Birth

on..........................and am a..........................
Date of Birth Nationality

Section No. 2

(*a*) I have carefully examined the Charter, By-laws and Code of Ethics of The Engineering Institute of Canada, and I promise and agree, if admitted to membership, to be governed by and to honourably follow and maintain them and to promote the interests and objects of The Institute to the best of my ability.

(*b*) I further agree, if admitted as a in The Engineering Institute of Canada, that should my membership cease at any time either by my resignation, or by any action taken by The Institute, I will then, by that fact, relinquish all rights in the property real or personal of The Engineering Institute of Canada, which I may have acquired under its Charter by reason of such membership.

....
Date (Signature of Applicant)

....
(Mailing Address)

Section No. 3

I, being the duly constituted Registrar of the..................
....
hereby certify that...
is a...............................in good standing of the
....
having been admitted to this class in the Association (or Corporation) on..

Signed..
(Signature of Registrar)

At..
On this........................day of......................19...

Section No. 4

For the records of The Institute the applicant is requested to furnish the following information.

The following is a statement of my education and engineering experience:

(*a*) EDUCATION. (State names and locations of Schools attended with grades and dates.

....
....
....

(*b*) SCIENTIFIC TRAINING. (State names of Colleges, Universities or Technical Schools attended, period of attendance, degrees or diplomas obtained and dates of graduation.)

....
....
....

(*c*) Membership in Technical Societies and Associations with Dates of Admission.

....

(*d*) ENGINEERING EXPERIENCE. (Give dates, Names and Addresses of Principals.)

(1) Early engineering work, covering employment prior to graduation..
....
....

(2) As a Practising Engineer or Responsible Assistant. (Give Firm Name, Address and years of Employment.)
....
....

(3) Present Professional Engagement or Occupation:

....

....

(4) Classification of Engineering Work:

....

General branch of engineering with which your work deals (e.g. Civil, Electrical, Mining, etc.).

....

Zone of interest (e.g. Hydro-electric, railway, combustion, industrial, municipal, radio, etc.).

....

Engineering function (e.g. Executive, construction, design, maintenance, production, research, etc.).

Dated.......................... ....
Signature of Applicant

The report of the work of the Committee on Consolidation during the past year is in course of preparation for presentation to the Annual Meeting with a view to its being published in the January issue of The Journal.

Gordon McL. Pitts,
Chairman.

OBITUARIES

Frederick Richardson Faulkner, M.E.I.C.

The members of The Institute will learn with regret of the death at Halifax, N.S., on November 4th, 1936, of Professor Frederick Richardson Faulkner, M.E.I.C.

Born at Truro, N.S., on June 30th, 1878, Professor Faulkner graduated from the Provincial Normal College in 1895, and in 1897-1898 taught in the public schools at Granville Ferry. He graduated from Acadia University in 1901 with the degree of A.B., and following this, taught in the public schools at Presqu'ile, and in 1903-1904 was instructor in science at the Perkins Institute for the Blind in South Boston. Professor Faulkner received the degree of S.B. from the Massachusetts Institute of Technology in 1909, and was subsequently an assistant instructor at the Institute until 1910, when he became an assistant engineer with the Bangor and Aroostook Railway. From December 1910 until October 1914 Professor Faulkner was

F. R. Faulkner, M.E.I.C.

resident engineer with the Kettle Valley Railway in British Columbia, and in 1915 he was appointed Professor of Civil Engineering at the Nova Scotia Technical College, which appointment he held until the time of his death. During the summer of 1917 he was engaged as a consulting engineer on surveys at Wabana, Newfoundland, for the Nova Scotia Steel and Coal Company, and in the summer of 1931 he was chief engineer for the Highway Dust Prevention Commission. For the last four years Professor Faulkner also acted as the representative of the Association of Professional Engineers of Nova Scotia in all of the matters concerning the Dominion Engineering Council.

Possessed of rare native teaching ability, Professor Faulkner was regarded by his students with an affection and respect which is seldom found in university life. He was greatly interested in the movement for the organization of the engineering profession, for the advancement of professional ethics and in measures which would lead in placing the profession on a higher status in the public mind.

He joined The Institute as a Member on August 27th, 1918, and took an active interest in Institute and Branch affairs. He represented the Halifax Branch on the Council in 1924, serving as a vice-president in 1930 and 1931.

His loss will be deplored by a wide circle of personal and professional friends, as well as by the many young engineers who studied under him.

George Reakes, A.M.E.I.C.

Regret is expressed in placing on record the death at St. Lambert, Que., of George Reakes, A.M.E.I.C., on October 25th, 1936.

Mr. Reakes was born at Torquay, Devonshire, England, on June 19th, 1860, and received his early education at King Edward VI Grammar School, and Queen's College, Birmingham, England. From 1881 to 1885 Mr. Reakes served his apprenticeship as a civil engineer with F. H. Phillips, county engineer of Glamorganshire, Wales, and was assistant engineer until 1887. He was subsequently engineer to the National Telephone Company Limited, and the G. P. O. System, being in charge of underground conduit design and construction for a number of towns, among which were Eastbourne, Hastings, Folkestone, and Hove. Coming to Canada, Mr. Reakes was engaged for some years on road and sidewalk work in Westmount, Montreal, Sydney, N.S., and Amherst, N.S. He was later town engineer for Beaconsfield, Que., and then entered private practice as a consulting engineer.

Mr. Reakes joined The Institute (then the Canadian Society of Civil Engineers) as an Associate Member on January 16th, 1917.

Aurelien Boyer, A.M.E.I.C.

It is with deep regret that we place on record the death, at Montreal, on November 24th, 1936, of Aurelien Boyer, A.M.E.I.C.

Mr. Boyer was born at Longue Pointe, Montreal, on March 20th, 1874, and received his early education at the Academie Commerciale Catholique de Montreal, and the College de Montreal, graduating as a civil engineer from the Ecole Polytechnique in 1896, and later receiving the degree of B.A.Sc. from the same institution.

Following graduation Mr. Boyer was connected as engineer with the Federal Geological Survey, and was later with the Department of Public Works, when he was locating engineer on the telephone line from British Columbia to Dawson in the Yukon. From 1905 to 1909 Mr. Boyer was superintendent of construction and later superintendent of operation with the A. D. Gall Petroleum and Chemical Company, at Mont Tremblant, Que., and from 1909 until 1911 was vice-president and chief engineer of the Duckworth-Boyer Engineering and Inspection Company. Subsequently Mr. Boyer was vice-president of the Canadian Inspection Company, and owner of the Silica Sand Company, with a plant at St. Canute.

In 1919 Mr. Boyer succeeded the late Ernest Marceau, M.E.I.C., as principal of the Ecole Polytechnique, which office he held until 1935 when he was compelled to resign on account of ill health. Under his regime the finances of the school were put in order, the school was enlarged, and modern laboratories installed. For twelve years Mr. Boyer directed with success the publication of La Revue Trimistrielle Canadienne.

Aurelien Boyer, A.M.E.I.C.

Mr. Boyer was a member of the Cercle Universitaire, the Corporation of Professional Engineers of the Province of Quebec, the Association des Anciens Eleves de l'Ecole Polytechnique, and the Club de Reforme. He was a life governor of the Notre Dame Hospital.

He joined The Institute (then the Canadian Society of Civil Engineers) as an Associate Member on January 4th, 1899.

PERSONALS

W. T. Moodie, M.E.I.C., formerly General Superintendent with the Canadian National Railways at North Bay, Ontario, has been transferred to Vancouver, B.C., where he will occupy the same position.

E. C. Luke, A.M.E.I.C., after spending six years with the engineering department of the Pacific Great Eastern Railway, at Squamish, B.C., has accepted a position as designing engineer on the staff of the Western Bridge Company, in Vancouver, B.C.

Lieut.-Colonel E. C. G. Chambers, A.M.E.I.C., who was formerly District Engineer Officer, M.D. No. 11, Department of National Defence at Victoria, B.C., is now assistant director, Engineer Services, Department of National Defence, Ottawa. Colonel Chambers was at one time stationed at M.D. No. 1, London, Ontario.

E. H. James, M.E.I.C., consulting engineer, specializing in harbours, docks and terminals, bridge piers, heave foundations, etc., has moved his office from 1188 Phillips Place, Montreal, to 1411 Crescent Street, Montreal.

G. E. Humphries, Jr.E.I.C., is now attached to the mining department of the Canadian Comstock Company Limited, at Toronto, Ontario. Mr. Humphries was formerly with the Edwards Gold Mines Limited, at Lochalsh, Ontario.

G. H. Duggan, D.Sc., LL.D., M.E.I.C., a past-president of The Engineering Institute, and the recipient of the Sir John Kennedy Medal in 1930, has been elected an Honorary Member of the American Society of Civil Engineers. The diploma certifying to Honorary Membership in the Society is to be presented publicly to Dr. Duggan at the Annual Meeting of the Society to be held on January 20th, 1937.

D. A. Evans, M.E.I.C., is now resident manager of the Power River Paper Company Limited at Powell River, B.C. Mr. Evans was at one time Manager of the St. Maurice River Boom and Driving Company at Three Rivers, Que., and later was with the Newfoundland Power and Paper Company at Deer Lake, Nfld. Subsequently he was on the staff of the Lake St. John Power and Paper Company at Mistassini, Que.

T. W. Toovey, A.M.E.I.C., who has, since 1934, been sulphite cellulose expert with the Harmanezer Papierfabrik, at Harmanec, Czechoslovakia, is returning to America, and will be connected with the chlorines sales division of the Pennsylvania Salt Manufacturing Company, at Philadelphia, Pa. Mr. Toovey was for a time chemical engineer with the B.C. Pulp and Paper Company Limited, at Port Alice, B.C.

Adhemar Laframboise, A.M.E.I.C., is now chief engineer for the Eastern Canada Steel and Iron Works, Limited, in Quebec City, Que. Mr. Laframboise was for a time city engineer of Lachine, Que., and was subsequently sales engineer for the Dominion Bridge Company Limited, Montreal. He then became town engineer for the Town of LaSalle, Que., and prior to accepting his present position was engineer with the Quebec Electricity Commission, Montreal.

A. M. Kirkpatrick, A.M.E.I.C., who has been senior assistant engineer, Department of Public Works, Canada, in the Winnipeg district since 1927, has been promoted to the position of District Engineer at Charlottetown, P.E.I. During the past five years Mr. Kirkpatrick, who graduated from Queen's University in 1911 with the degree of B.Sc., has had particular supervision of the works in Alberta and the Northwest Territories, having visited the Mackenzie river district and Great Bear lake each year in connection with work that the Department is carrying on there.

C. B. Thorne, M.E.I.C., Technical Director of the Canadian International Paper Company of Hawkesbury, Ont., has recently been the recipient of the degree of Doctor Ingenieur *honoris causa* from the Technische Hochschule (Institute of Engineering) of Darmstadt, Germany, on account of his research work in the pulp and paper industry. Mr. Thorne, who is a graduate of an engineering school in Norway, and the University of Hannover and the University of Dresden in Germany, was engaged as assistant engineer in sulphite mills in Norway and Germany before coming to the United States in 1902, where he was engaged as an engineer by mill architects in New York City. In 1903 Mr. Thorne became sulphite expert and engineer for the Riordon Pulp and Paper Company, and had charge of all new buildings erected for the mills in Merritton and Hawkesbury. In 1906 he was appointed manager of the company's Hawkesbury mill and engineer for the company and was subsequently vice-president and technical director of the Riordon Company.

W. J. Johnston, A.M.E.I.C., who was formerly assistant engineer of the Department of Public Works of Canada at Saint John, N.B., has been appointed senior assistant engineer of the Department at Winnipeg, Man. Mr. Johnston graduated from the University of New Brunswick in 1913 with the degree of B.Sc. and following graduation entered the service of the Department of Public Works Canada, and until 1917, when he went overseas as a gunner with the Canadian Garrison Artillery, was assistant engineer at Fredericton and Saint John, N.B. On his return from overseas Mr. Johnston resumed his position with the Department, and has held it until the present time. Mr. Johnston has always taken an active interest in the affairs of The Institute, and is a past Branch Secretary and a past-Councillor of the Saint John Branch.

M. Du Bois, Jr.E.I.C., has been appointed assistant to the director in charge of the Ateliers de Constructions Mécaniques, at Vevey-Vaud, Switzerland. Mr. Du Bois graduated from the Federal Polytechnical Institute at Zurich in 1926, and was awarded the degree of M.Sc. by the Massachusetts Institute of Technology in 1927. In 1928 he was for a time marine engineer with Alex. McKay Company Limited, at Quebec, Que., and was later in the hydraulic department of the Dominion Engineering Company, Limited, at Montreal. He was then for a time in the construction office of the Consolidated Mining and Smelting Company at Trail, B.C. Returning to Switzerland in 1929, Mr. Du Bois became mechanical engineer, and subsequently assistant to the director of Sulzer Brothers Limited, Winterthur.

C. H. Scheman, M.E.I.C., who has been vice-president and managing director of the Horton Steel Works Limited since 1924, has been transferred to the company's New York office, and is now with the Chicago Bridge and Iron Works, New York, N.Y. Mr. Scheman graduated from the Iowa State College in 1910 with the degree of B.S., and from November of that year until 1912 he was a draughtsman with the Illinois Central Railway at Chicago. From November 1912 until April 1917 Mr. Scheman was assistant to the president of Iowa State College, Ames, Iowa, in charge of development plans and the construction of grounds and buildings, and in 1917-1918 he was engaged on war work. In September 1918 Mr. Scheman became connected with the Chicago Bridge and Iron Works at Chicago, as contracting engineer, and in December 1919 he was appointed general sales manager of the Horton Steel Works Limited, at Montreal. From May 1921 to July 1924, Mr. Scheman was general manager of the same company, being located at Bridgeburg, Ontario, and in 1924 he was also appointed vice-president of the company.

Merger of Two Government Departments

Two historic government departments, the Department of Marine, and the Department of Railways and Canals, were recently merged into the new Department of Transport, and the following officers were named to head the various branches:

Colonel V. I. Smart, M.E.I.C., former Deputy Minister of the Department of Railways and Canals, is to be Deputy Minister of the new Department of Transport; R. K. Smith, former Deputy Minister of Marine, is to be director of marine services; Commander C. P. Edwards, A.M.E.I.C., former Director of Radio, Department of Marine, is to be chief of the air services, radio and meteorological branches; George W. Yates, for many years assistant Deputy Minister of Railways and Canals, continues as assistant Deputy Minister and secretary of the new department; J. G. Macphail, M.E.I.C., who was formerly commissioner of lights of the Department of Marine, is now chief of aids to navigation branch, marine engineering, and supervision of public harbours; Frank McDonnell, M.E.I.C., is chairman of the Board of Steamship Inspection, and chief of steamship inspection.

The air services branch will consist of the civil aviation division, transferred from the Department of National Defence, and the radio and meteorological divisions of the former Department of Marine. J. A. Wilson, M.E.I.C., continues as head of the civil aviation division with the title of Controller, and W. A. Rush, A.M.E.I.C., has been promoted from the position of General Superintendent of Radio, to that of head of the radio branch, with the title of Controller of Radio.

E. B. Jost, A.M.E.I.C., formerly senior hydraulic engineer, has been appointed General Superintendent of Canals. N. B. McLean, M.E.I.C., who was assistant chief engineer, River St. Lawrence Ship Channel, has become chief engineer of the St. Lawrence Ship Channel. Captain F. Anderson, M.E.I.C., who was hydrographer and director of the Canadian Hydrographic Service is now Chief Hydrographer with the Hydrographic Survey. D. W. McLachlan, M.E.I.C., is Engineer, Design and Capital Construction, General Engineering. John Murphy, M.E.I.C., becomes senior electrical engineer, General Engineering, and G. A. Lindsay, A.M.E.I.C., formerly senior office engineer, St. Lawrence Waterways Project, is now engineer in charge of the engineering office, draughting room and clerical staff, General Engineering.

ELECTIONS AND TRANSFERS

At the meeting of Council held on November 27th, 1936, the following elections and transfers were effected:

Associate Members

PICARD, Stanislas A., B.A.Sc., (Chem.), (Ecole Polytechnique, Montreal), chemist engr., Rock City Tobacco Co. Ltd., Quebec, Que.

*YOUNG, James William, asst. city chemist, City of Calgary, 1710-14th Ave. West, Calgary, Alta.

Junior

DERY, Jacques Louis, (Grad., R.M.C.), junior engr., Dept. Public Works of Canada, St. Johns, Que.

Transferred from the class of Junior to that of Associate Member

DAVIS, George Roland, B.Sc., (Queen's Univ.), engr., operating dept., H.E.P.C. of Ontario, Belleville, Ont.

GATHERCOLE, John W., B.Sc., (Queen's Univ.), steam plant engr., Price Bros. & Co. Ltd., Kenogami, Que.

GILMOUR, William Alexander Turner, B.Sc., (McGill Univ.), chief engr., Smart Turner Machine Co. Ltd., Hamilton, Ont.

Transferred from the class of Student to that of Associate Member

LAPLANTE, Arthur, B.A.Sc., C.E., (Ecole Polytechnique, Montreal), engr., Dept. of Highways, Prov. of Quebec, Quebec, Que.

McMORDIE, Robert Campbell, B.A.Sc., (Univ. of Toronto), asst. engr., H. G. Acres & Co., Niagara Falls, Ont.

Transferred from the class of Student to that of Junior

DICKSON, William Leslie, B.Sc., (N.S. Tech. Coll.), test engr., N.B. Electric Power Commission, Newcastle Creek, N.B.

ESMOND, Douglas C., B.Eng., (McGill Univ.), junior engr., Canadian Marconi Co., Montreal, Que.

NESBITT, Michael Cullum, B.A.Sc., (Univ. of B.C.), foreman, Columbia Development Company, Victoria, B.C.

NICHOLS, Judson Timmis, B.Sc., (McGill Univ.), mech. mtce. and design, Hudson Bay Mining & Smelting Co. Ltd., Flin Flon, Man.

Students Admitted

BATES, Ralph Edward, (Univ. of Toronto), 371 Huron St., Toronto, Ont.

COUTTS, Erskine, (McGill Univ.), 3469 Montclair Ave., Montreal, Que.

DEAN, William W. H., (McGill Univ.), 3483 Peel St., Montreal, Que.

FILION, Paul, B.Eng., (McGill Univ.), 5586 Phillips Ave., Montreal, Que.

HYMAN, Ernest Roy, (Univ. of Man.), Royal Military College, Kingston, Ont.

JOHNSTON, Elmer Munroe, levelman, Dominion Steel and Coal Corpn., Dominion, C.B., N.S.

LOISELLE, John Chester, (McGill Univ.), 5586 Queen Mary Rd., Montreal, Que.

MACKAY, William Brydon Fraser, (R.M.C.), (Univ. of Man), 820 Wellington Crescent, Winnipeg, Man.

MacLAREN, Frederick Winslow, B.Sc., (Univ. of N.B.), testman, Can. Gen. Elec. Co. Ltd., Peterborough, Ont.

McKEE, Gordon Hanford Whitehead, B.Eng., (McGill Univ.), Morris Hall D-30, Soldiers Field, Boston, Mass.

---

*Has passed Institute's examinations.

PLAMONDON, Sarto, B.A.Sc., C.E., (Ecole Polytechnique, Montreal), sanitary engr., Prov. Board of Health, Amos, Que.

TAYLOR, Dudley Robert, (McGill Univ.), 4366 Oxford Ave., Montreal, Que.

Students at the Ecole Polytechnique, Montreal, Que.

AIRD, Joseph André Philippe, 824 Stanley Park, Montreal, Que.
BEAUDET, Guy, 3444 St. Denis St., Montreal, Que.
BOLDUC, Armand, 207 Park G. E. Cartier, Montreal, Que.
BUTEAU, Lucien, 5807 Chateaubriand St., Montreal, Que.
DELISLE, Lucien, 4598 Christophe Colomb Ave., Montreal, Que.
CARTIER, Leonard, 1147 Bellechasse St. East, Montreal, Que.
CREPEAU, Georges Edmond Marcel, 4094 Ethel St., Verdun, Que.
DECARIE, Yves, 5211 Cote St. Antoine Rd., Montreal, Que.
DE LAMIRANDE, Paul, 3495 Berri St., Montreal, Que.
DUFOUR, Gaston, 5903 Durocher St., Outremont, Que.
FLAHAUT, Jean, Jr., 4205 Northcliffe Ave., Montreal, Que.
GAUTHIER, René, 5204 Trans Island Ave., Montreal, Que.
GERVAIS, Aimé, 480 Sherbrooke St. East, Montreal, Que.
GUENETTE, J. A. Paul, 5787 Cartier St., Montreal, Que.
LAPOINTE, Gérard Audet, 363 Sherbrooke St. East, Montreal, Que.
LAURENCE, Jacques, 3068 Maplewood Ave., Montreal, Que.
LEBLANC, Raymond F., 4581 Drolet St., Montreal, Que.
LECAVALIER, Jean Paul, 6280 St. Denis St., Montreal, Que.
MAILHOT, Gaston A., 3542 Ontario St. East, Montreal, Que.
NORMANDEAU, Paul D., 1253 Notre Dame St. East, Montreal, Que.
OSTIGUY, Maurice, 1430 St. Denis St., Montreal, Que.
POULIOT, Paul Louis, 805 Sherbrooke St. East, Montreal, Que.
RIOUX, René Henri, 2376 Grant Ave., Montreal, Que.
ROSE, Paul E., 2356 St. Antoine St., Montreal, Que.
ROY, Louis Philippe, 3641 St. Urbain St., Montreal, Que.
SAINTONGE, Rosaire, 3782 St. Andre St., Montreal, Que.
SIMARD, Jean Marcel, 7527 St. Gerard St., Montreal, Que.
THIBAUDEAU, Guy, 1200 Berri St., Montreal, Que.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Institution of Naval Architects: Transactions, 1936.

Reports, etc.

American Institute of Steel Construction: Annual Report, 1936.
Institution of Civil Engineers of Ireland: List of Members, 1936.
University of London: Calendar, 1936-1937.
Canadian Hydrographic Service:
Tide Tables for the Pacific Coast of Canada for 1937.
Tide Tables for the Atlantic Coast of Canada for 1937.
American Society for Testing Materials: Standards on Electrical Insulating Materials, September 1936.
Canadian Pulp and Paper Association: Technical Section—22nd Annual Meeting, 1936.
U.S. Bureau of Mines: Tabular Summary of State Specifications for Liquid Asphalt Road Materials.

Technical Books, etc.

Diesel Engines, by P. E. Biggar (*Macmillan Company of Canada, Toronto*).
Mechanical Catalogue, 1936-1937 (*American Society of Mechanical Engineers, New York*).
Kent's Mechanical Engineers' Handbook, 11th edition. (*John Wiley and Sons, New York.*) (*Renouf Publishing Company, Montreal.*)
Statistical Year Book of the World Power Conference, No. 1, 1933 and 1934.
Canadian Who's Who 1936-1937, by Roberts and Tunnell, Toronto.
Spon's Electrical Pocket Book, 1936. Edited by W. H. Molesworth and G. W. Stubbings. (*Presented to the Institute library by C. G. Moon, A.M.E.I.C.*)

BULLETINS

Wood Block Floors—A 20-page booklet received from the Canada Creosoting Company Limited, Montreal, Que., sets forth the advantages and uses of "Can-Creo" wood block floors.

Motor Trucks—The Four Wheel Drive Auto Company, Kitchener, Ont., have issued a 16-page bulletin giving examples of savings in trucking costs through the use of FWD trucks.

Turbine Pumps—A 4-page leaflet received from the Roots-Connersville Blower Corporation, Connersville, Ind. describes the company's Type T regenerative turbine pumps, ranging in capacity from 5 to 200 gallons at heads up to 300 feet.

Centrifugal Pumps—The Worthington Pump and Machinery Corp., Harrison, N.J. have published an 8-page leaflet describing their Mixflo pumps for irrigation, drainage, sewage disposal, condenser circulating. This is in sizes from 12 to 84 inches and delivers from 1,000 to 225,000 gallons per minute at heads from 5 to 50 feet.

Ball Mills—A 16-page booklet issued by the Dominion Engineering Company, Montreal, gives features of construction and details regarding the Dominion ball mills, data being included in a number of tables covering mills of 4 feet diameter to 10 feet in diameter.

BOOK REVIEWS

An Elementary Treatise on Statically Indeterminate Stresses

By John I. Parcel and George A. Maney. John Wiley and Sons, New York (Renouf Publishing Company, Montreal). 1936. 6 by 9¼ inches, 432 pages. $5.00. Cloth.

Reviewed by JOHN PORTAS, M.E.I.C.*

Many books, some of them of rather indeterminate merit, have been written on the subject of statically indeterminate stresses. The feature which puts this book in a class by itself is the effort the authors have made to clear up the confusion caused by the overlapping of the various theories and to clarify the subject by logical arrangement. As they say in the preface, they have tried to show the essential unity of the subject underlying the great diversity of method. In the opinion of the reviewer they have succeeded admirably. Numerous examples and problems illustrate the theory and throughout the book there is a commendable effort, unusual in books dealing with this highly theoretical subject, to tie up theory with practice.

In the introduction "Statical Indetermination" is defined, and the many different types of indeterminate structures classified.

Chapter I reviews the well known methods of determining deflections and steers a clear course through the troubled waters of work equations and elastic weights. A summary gives a recapitulation of the various methods and describes the comparative advantages of each. The value of this chapter is enhanced by a description of the practical applications of the theory of deflection, such as in the determination of camber and elastic deformations during erection.

Chapters II and III deal, in logical sequence, with a still more important application of the theory of elastic deflections—the analysis of statically indeterminate structures. The section concludes with an account of the "moment distribution" method of Professor Hardy Cross, which has found such wide application in the analysis of rigid frames.

Chapter IV is devoted to the stress analysis of continuous girders and swing bridges.

Chapter V deals with rigid frames, including multi-storey buildings and secondary stresses. Simple rigid frames are analysed by the slope-deflection and moment-area methods. There is a completely worked out example of the Vierendeel truss, and examples, using the slope deflection and moment-distribution methods, in the analysis of a multi-storey frame.

The section on secondary stresses, which concludes the chapter, is short but perhaps sufficient for an elementary treatise. The authors tie up this section with what has gone before by indicating how it is theoretically possible to determine secondary stresses by the general theory of indeterminate stresses. Actually they confine themselves to a description of Mohr's semi-graphical modification of the slope-deflection method. Examples are worked out by this method, the equations being solved by the method of successive approximations.

More than passing mention might have been made here of the application of the moment-distribution method to the solution of secondary stresses in bridges.

Chapters VI and VII deal in satisfactory manner with the theory of arches and suspension bridges. The "approximate" and "exact" theories of suspension bridge design are described and illustrated by worked out examples. A cursory reading does not disclose any of the errors in formulae which greatly detract from the value of many text books on this subject.

The book closes with a general discussion of statically indeterminate construction, a historical review, and bibliography.

Written in an easy style, well printed and illustrated, this book is a complete course in advanced structural design for the student, and an invaluable book of reference for the practising structural engineer.

*Chief Engineer, J. W. Cumming Manufacturing Co. Ltd., New Glasgow, N.S.

Theory of Lubrication

By Mayo D. Hersey. John Wiley and Sons, New York. (Renouf Publishing Company, Montreal.) 1936. 6¼ by 9¼ inches. 152 pages. $2.50. Cloth.

Reviewed by PROFESSOR E. A. ALLCUT, M.E.I.C.*

This is essentially a review of a review, as it is evident that so complex a subject as lubrication can only be treated in an outline within the compass of so small a book. The treatment, however, is by no means superficial; on the contrary, it deals with the fundamental nature of lubrication so thoroughly, that the book should be read and digested piecemeal, rather than as a whole. It is stated in the preface that the lectures upon which the book is based "aimed to give the scientific background of modern lubrication, so that the problems arising in practice might be better understood."

The history of the subject is first briefly described, with particular reference to the work of Beauchamp Tower, Reynolds, Kingsbury, Michell and others. The definition of viscosity and its measurement, friction and power losses occupy the second chapter. Hydrodynamic

*Professor of Mechanical Engineering, University of Toronto, Toronto.

theory as applied to the fluid film and the application of the dimensional theory are treated in some detail, as these chapters form one third of the book. A further chapter of 23 pages is devoted to the important question of heat generation and the consequent temperature rise in bearings. The rather elusive property of "oiliness" is discussed in considerable detail, and after making an attempt to define this quality the author proceeds to indicate the reasons why it is difficult to devise a method of testing that will indicate the relative values of different lubricants. Many devices have been tried, but none of them is entirely satisfactory, and the theory indicates that such correlation may have to be done indirectly by reference to well established curves, rather than by direct application.

This book is not for the average reader, or for the engineer who has forgotten much of his mathematics; it is suitable only for those specializing on the design of bearings and lubrication problems generally. for research workers and teachers of engineering subjects. The reference given at the end of each chapter will permit such readers to study in greater detail the mass of information given. It is regrettable, however, that the remaining lectures which dealt with the experimental side of the subject were not included in the book.

Reinforced Concrete

By Robert A. Caughey. D. Van Nostrand Company Inc., New York. 1936. 6¼ by 9¼ inches. 292 pages. $3.75. Cloth.

Reviewed by Professor R. E. Jamieson, M.E.I.C.*

As the author states in his preface, this is primarily a text-book. The first seven chapters, constituting about one-half the text, deal with fundamental principles and the calculations involved in the proportioning of simple structural elements. Basic flexural calculations are developed initially without the use of formulae, an order of treatment to be commended in that it drives home to the student the significance of the basic design assumptions before he becomes involved in the usual maze of symbols. Numerous examples are worked out in detail, and some additional problems with answers are given. Many problems are given without answers, and in most cases will be of use only to a student working under the guidance of an instructor. Some space might with advantage have been saved by leaving some of these problems to be set by the instructor.

Chapter VII is devoted to the methods of computing bending moments in statically indeterminate beams and rectangular frames. Expositions of the use of the Moment Distribution Method and of the Method of Conjugate Points are included, in addition to the usual three-moment theorem, the elastic curved-beam theory, and the methods of slope-deflections and area moments. This chapter should prove valuable as a reference in that it summarizes all the usual tools available for such computations in convenient space.

Chapter IX discusses the design of steel beams haunched with concrete and figured as composite beams. The inclusion of such material in a text-book at this time is open to question, inasmuch as standard specifications for the design of reinforced concrete do not at present legislate on all points encountered in such a method of design. In this connection, members of The Institute will recall the article by the late Dean H. M. MacKay, M.E.I.C., giving the results of a series of tests conducted by a committee under his chairmanship and sponsored by the Dominion Bridge Company.†

The outlines of the procedure to be followed in the design of masonry dams and retaining walls are clear and concise. Throughout the book reference is made to standard specifications, in particular to the 1936 Report of Committee 501 of the American Concrete Institute, and this specification is given in Appendix A. Design graphs and tables suitable for use in connection with this code and for high-strength as well as low-strength concretes, and several excellent plates showing methods of detailing concrete work, are included in Appendix B.

**Professor of Civil Engineering, McGill University, Montreal.*

†Steel I-Beams Haunched witd Concrete, by H. M. MacKay. Canadian Engineer, November 30th, 1926.

Diesel Engines

By P. E. Biggar. The Macmillan Company of Canada Limited, Toronto. 1936. 6 by 9¼ inches. 162 pages. Cloth. $2.00.

Reviewed by J. L. Busfield*

The reviewer finds it hard to improve upon the author's own words in describing the scope of this book, and therefore the following is quoted verbatim from the preface:

"The book deals with principles and methods, but most of all with practical operation. It tells the history of the Diesel engine, in order to show how its characteristics, which give it certain advantages over its competitors, can be traced back to those of the parent types from which it has been developed. It describes the engine in detail, its fuel, its injection system, its various types of combustion chambers, each with its own special advantages, its methods of starting, its likes and dislikes in lubricating oils. It tells about the various duties to which Diesel engines have been applied and describes typical engines which have proved successful in these fields. It gives detailed information on engine and fuel pump maintenance. Finally, it mentions some of the directions in which future development must proceed."

The book is well prepared, well illustrated, and is very "readable." Characteristic features of various engines not only with regard to design but also in connection with operation and maintenance are given in a clear and exceptionally concise manner. The first half of the book deals with engine principles and with the methods of injection, combustion, governing and so on in general use. The second half deals with the applications of the Diesel engine, its use in the transport, marine and stationary fields, the special requirements of these various services and with engine maintenance.

In the reviewer's opinion, this book will be a valuable adjunct to the library of any engineer who is interested in Diesel engines.

**Managing Director, Gardner Engines (Eastern Canada) Limited, Montreal.*

Statistical Year Book of the World Power Conference

No. 1—1933 and 1934. Edited, with an introduction and explanatory text by Frederick Brown, B.Sc., F.S.S., London. The Central Office of the World Power Conference, 36 Kingsway, London, W.C.2. 1936. £1.

This is the first volume of a new statistical annual devoted to the power resources of the world and their development and utilization. It contains an inventory based on the latest available estimates of the power resources of the various countries and annual statistics relating to 1933 and 1934, of the production, stocks, imports, exports and consumption of coals, brown coal and lignite, peat, wood, petroleum, benzoles, alcohols, natural gas, water power and electricity. In the statistics of electricity, production at different types of plant and consumption in different uses are shown separately as well as in totals; the statistics of water power are also given in considerable detail. Statistics for about sixty countries are included, and where practicable, continental and world totals are presented.

All the important sources of power are included, except manufactured gas, which will be included in subsequent issues of the Year Book; and though it has not been possible to include figures for every country in every table, the omissions are generally due to the minor importance of the particular form of power in the economy of the country omitted.

Most of the statistics were specially compiled by the National Committees of the World Power Conference and by government departments in England and abroad in conformity with standard definitions drawn up by a committee of experts; these definitions are reproduced in the text.

Some of the information presented has not been published before in any country, and it is believed that the volume is the most comprehensive collection of comparable statistics of power resources, development and utilization yet published.

Statisticians, economists, engineers and others, who require such information as comparable figures of coal consumed in the United States and the U.S.S.R. or of electricity generated in metallurgical works in Poland and Japan, or estimates of the world production of petroleum or wood, or the proportion of electricity generated in Europe by water power, will find it in this Year Book.

A Survey of the Trade in Electrical Machinery and Apparatus

The twenty-ninth report of the Imperial Economics Committee, London, 1936, shows that in 1929 electrical equipment worth one hundred and six million pounds was exported by the fourteen countries which cover the bulk of this trade. Their exports fell to fifty-seven million pounds in 1933, but by 1935 had recovered to seventy and a half million pounds.

Since 1933, wireless apparatus has accounted for about one-quarter of the value of the world trade in electrical equipment.

The principal competitors in the world market are Germany, the United States and the United Kingdom. Together these three countries accounted for about two-thirds of the world trade in 1935.

The United Kingdom is not only one of the principal exporters of electrical equipment, it is one of the chief importers. In 1935 the Union of South Africa, the United Kingdom and India were the three largest markets in the world for imports of electrical goods.

Specifications of the Canadian Government Purchasing Standards Committee

This committee, recently established in order to standardize and simplify the purchase of technical equipment by the various departments of the Dominion government, has just issued the first of its specifications to be adopted, namely a tentative specification for testing sieves. It deals with sizes, construction, openings and tolerances, and numerical mesh designations, for which the micron has been adopted as a unit. It makes use of the "square root of two" relationship which is practically standard in the industry.

Enquiries regarding specifications issued by the Committee should be addressed to the Secretary of the Committee, National Research Council, Ottawa, Ontario.

BRANCH NEWS

Border Cities Branch

Boyd Candlish, A.M.E.I.C., Secretary-Treasurer.
F. J. Ryder, Jr.E.I.C., Branch News Editor.

On October 17th, 1936, the Border Cities Branch of The Institute held a joint meeting with the Windsor Chapter of the Ontario Association of Architects. The guest speaker was Norman A. McLarty, K.C., M.P., whose address dealt with "Benefits of the Home Rehabilitation Plan."

Benefits of the Home Rehabilitation Plan

Mr. McLarty described the work to date of the National Employment Commission under the chairmanship of Mr. A. B. Purvis, and spoke in some detail of the benefits which will accrue from the Dominion Government housing rehabilitation project and the Housing Act. This was of particular interest to residents of Windsor, Ontario, where the plan is now in operation. Mr. Wallace Campbell, president of the Ford Motor Company, has been appointed chairman of the local advisory committee of the National Employment Commission.

Architecture in the Nineteenth Century

In the absence of Professor Eric Arthur of the University of Toronto, an illustrated lecture on "Architecture in the Nineteenth Century" was presented by A. S. Mathers, of Toronto. Slides showed a wide variety of buildings, many of which were familiar to those present.

Edmonton Branch

M. L. Gale, A.M.E.I.C., Secretary-Treasurer.

Following an inspection tour of the new plant of the Canada Packers Limited, on Tuesday, November 10th, 1936, members of the Edmonton Branch assembled at the Corona hotel for the first dinner and meeting of the 1936-37 season.

Alex. Ritchie, A.M.E.I.C., vice-chairman, was in the chair in the absence of Professor Edgar Stansfield, M.E.I.C.

The speaker of the evening, introduced by H. R. Webb, A.M.E.I.C., was Mr. C. J. Long, Superintendent of Canada Packers Limited.

Processing and Equipment

Mr. Long stated that the first consideration in establishing a new plant was its location. The district was analysed from the livestock and sales possibilities and with the idea of establishing a link with the other plants of the company in the export trade. When the district was selected, the plant site had to be chosen and in this, trackage, yards, sewer, water and power, were the main features to be considered.

In the design of the plant, the capacity to insure a regular movement of livestock, and the cooler and storage space, were the governing factors. A great deal of thought must be given to the planning. The engineer has to plan each floor and tie in all processes. The livestock walks to the top floor and then, as the processing progresses, the meat must be dropped through all departments by gravity, without rehandling, and end up in the coolers or storage.

The speaker then gave a description of the processing of meats through the plant and explained the selection and features of the different pieces of equipment.

He described the power plant and the various types of machinery connected with it. It was explained how steam, hot and cold water and refrigeration had to be supplied to the different departments. Nearly every process requires a different temperature, and as a result, there is a great complexity of lines running through the building. The duplex units supplying the refrigeration and cooling systems are capable of being divided up so that one part is the standby of the other, and a greater flexibility is the result. The ice plant is an interesting feature, it being the only one of its kind in Canada at present. The large storage space for pans and ice crusher is not required and the troublesome features of handling and crushing are done away with.

At the close of the address, Mr. Long answered a number of questions, after which a hearty vote of thanks was given the speaker.

Hamilton Branch

A. Love, M.E.I.C., Secretary-Treasurer.
A. B. Dove, Jr.E.I.C., Branch News Editor.

The Hamilton Branch of The Engineering Institute of Canada met Tuesday October 20th, 1936, at McMaster University to hear a most interesting lecture on the subject of "James Watt." The lecturer of the evening was Professor R. W. Angus, M.E.I.C., of the Department of Mechanical Engineering, Toronto University. W. Hollingworth, M.E.I.C., chairman of the Branch, introduced the speaker.

James Watt, 1736-1819

James Watt was born 1736 at Greenock, Scotland, the son of a family of mathematicians and mapmakers. He was a delicate, sensitive child, much addicted to violent headaches. These weaknesses followed him through life and accounted, in a large measure, for the fact that he was at times exceedingly difficult to understand and get along with. He studied astronomy, chemistry and anatomy, having at one time intended to study medicine as a profession. Family misfortunes led him, however, to a position as mathematical instrument maker to Glasgow University, although he was, as yet, unapprenticed to his trade. Dr. Dick of the university staff urged him to go to London, where he took his apprenticeship at a cost of 20 guineas, working ten hours per day without pay. Illness finally caused his return to Scotland after a year of hard work in London, and he became once more instrument maker to Glasgow University. Watt was married in 1764 at Glasgow.

At this time Newcomen engines were used extensively in mine work, but unless fuel was exceedingly cheap and the lift small, this engine was almost useless. Great boilers were required for low horse power, and pumping costs were so high that many mines had to be abandoned. Dr. Black of the staff of Glasgow University had discovered latent heat, but little use had been made of his results. With the stage thus set, Watt's cue for entry into the play came with the sending of a Newcomen model engine to him for repair. Watt was quick to see the faults of this engine in the light of Dr. Black's discoveries, and at once set about to redesign the engine, condensing the steam in a separate condensor (May 1765.)

In 1769 Watt's first patent was granted. The points brought out were the important ones which we know to-day:—

1. The cylinder must be kept hot by enclosure.
2. The cylinder must not be permitted to fall to a lower temperature than that of the steam.
3. The expansive force of steam was to be used.
4. Oils and wax were to be used to keep the piston tight.

This patent expired in 1800. Roebuck financed the building of the first engine.

Watt went to the Soho Foundry in 1768 where he met Boulton. In 1774 he went to Birmingham, and in 1775 he entered into partnership with Boulton and built his first double and single acting engines. By 1781 there was a definite demand for power engines, and, unable to use Pickard's patented crank and connecting rod to control piston speed, Watt tried all manner of walking beams and clumsy equipment to get around the patent. On the expiration of Pickard's patent, however. he used the crank and connecting rod in his own engine.

Watt first applied the term horsepower which, in 1782, he defined as 32,400 ft. pds. per minute; in 1783 however, he changed this figure to 33,000 ft. pds. per minute—the figure which we know. In 1800 Watt retired, being honoured with a Fellowship of the Royal Society, a degree of Doctor of Laws from Glasgow University, and the offer of a Baronetcy—the latter he declined. Watt was truly the first scientific engineer—the first real mechanical engineer, and the father of modern engineering.

A. Love, M.E.I.C., secretary of the Hamilton Branch, moved a vote of thanks to Professor Angus for his interesting lecture which was completed with lantern slides showing many of the engines discussed during the talk. On the adjournment of the meeting, refreshments were served.

Lakehead Branch

G. R. McLennan, A.M.E.I.C., Secretary-Treasurer.

The activities of the Lakehead Branch of The Institute for the fall and winter seasons were resumed when the first monthly dinner meeting was held on September 16th, 1936, in the Kakabeka inn at Kakabeka Falls. Thirty-two members and guests were present.

The names of the committees for the coming season were announced and an outline of the activities planned by the executive committee for the season was given.

Kaministiquia Power Plant

After a short business session, the meeting was turned over to Mr. W. L. Bird, president of the Kaministiquia Power Company, who gave an interesting historical sketch of the plant. He stated that the present total installed capacity of the plant is 35,000 h.p., developed under a head of 190 feet. The first unit was installed in 1906, the second in 1911 and the third in 1914. All turbines are of German manufacture. An interesting feature of the installation is that the third unit was installed by German erectors after the beginning of the Great War. Mr. Bird mentioned the exceptionally good engineering in connection with the project, and of the extremely few power interruptions during the thirty years the plant has been in operation.

A vote of thanks was moved by P. E. Doncaster, M.E.I.C., and seconded by H. G. O'Leary, A.M.E.I.C.

The last part of the meeting consisted in an inspection of the plant under the guidance of Mr. Elvish and Mr. Fallen of the Power Company's staff.

Geodetic Surveying

A special meeting of the Branch was held on September 23rd in the council chambers of the city of Port Arthur, with G. R. Duncan, A.M.E.I.C., in the chair.

J. L. Rannie, M.E.I.C., was the speaker of the evening, and gave an interesting talk on geodetic surveying, outlining the development of the instruments used in this work. He compared the instruments of some twenty years ago with the modern ones; one interesting feature being the reduction in weight from about 150 pounds to 35 pounds. He gave an account of some of the errors encountered in field work and the procedure to determine their cause.

A vote of appreciation was moved by S. E. Flook, M.E.I.C., and seconded by P. E. Doncaster, M.E.I.C.

Seventeen members and guests were present.

ROAD DEVELOPMENT IN THE PORT ARTHUR DISTRICT

The regular monthly dinner meeting of the Branch was held at the Royal Edward hotel, Fort William, on October 21st, with F. C. Graham, A.M.E.I.C., in the chair.

G. H. Burbidge, M.E.I.C., made a few remarks in regard to the Plenary Meeting which he had attended the previous week, and was asked to make a complete report of the meeting at the next regular meeting in November. Mr. Doncaster gave notice that he would present a resolution dealing with the pay of engineers at the next regular meeting. The Secretary read a letter from the chairman of the Semicentennial Committee in regard to publicity and the appointing of a committee for the purpose of advertising the Semicentennial of The Institute.

The guest speaker was Mr. Erle Smith, district engineer for the Department of Northern Development. Mr. Smith gave an interesting talk on the development of roads in the district, tracing the progress of the Trans-Canada highway from the summer of 1931 to the present. He discussed many problems of road building peculiar to the district, and described the various sections of the road, stressing the scenic beauty of the road from Port Arthur to White River. The section east of White River to the Sault is approximately 135 miles, which it is estimated will cost five million dollars to complete. Mr. Smith outlined the work now being done in the mining area to the north of the Lakehead. Several roads are being made to connect the mines to the railroad.

A vote of thanks was moved by R. J. Askin, A.M.E.I.C., and seconded by G. H. Burbidge, M.E.I.C.

Lethbridge Branch

E. A. Lawrence, S.E.I.C., Secretary-Treasurer.

The Lethbridge Branch opened its series of dinner meetings on Saturday October 10th, 1936, when the members and their wives gathered at the Marquis hotel.

During the dinner music was furnished by George Brown's instrumental quartette and vocal solos were given by Mr. Tom Smith.

The guest speaker was Air Commodore H. Hollick-Kenyon of Canadian Airways Ltd., and formerly chief pilot of the Ellsworth Antarctic Expedition.

THE ELLSWORTH ANTARCTIC EXPEDITION

Lincoln Ellsworth who organized the expedition was unique in being one of the few men with both the money and inclination for expeditions of high adventure. He was at one time a surveyor in Western Canada and had been on two Arctic expeditions by air, on one of which he was marooned within 125 miles of the North Pole.

His Antarctic expedition was the result of four years preparation. The plane was a Northrop single engine monoplane and the vessel a small ship from Norway with a Norwegian crew of ten men. The expedition's personnel of seven was composed of Ellsworth, a doctor and a radio operator, all Americans; Hollick-Kenyon, Lymburner and Howard, the flying staff, all Canadians, and Sir Hubert Wilkins, an Australian. The plane had a speed of 120 miles per hour and carried fuel for twenty-one hours flying, besides food for three months, sleds, camp equipment, instruments, etc; the total load being 8,500 pounds.

The speaker joined the ship at Montevideo, Uruguay, and the expedition proceeded to its base at Dundee Island, where the plane was set up and a base camp established.

On the first attempt to cross the Antarctic by air, fuel trouble developed after two hours flying, making it necessary to turn back. A second attempt was frustrated when after proceeding up the peninsula for 700 miles, clouds about a high mountain range forced them back.

Finally on November 23rd, a third take-off was made and a quick progress made along the peninsula, explored and mapped by Wilkins in 1930, when he had a Canadian pilot Al Cheeseman. The high mountains were crossed at 15,000 feet and then head winds retarded progress.

Another high range was crossed and on they flew over the great Antarctic plateau for about twelve hours. The radio had failed and all communication with the base cut off. After crossing the plateau, three minor mountain ranges were passed. Landings were made for observations of position, followed by two forced stops due to bad weather, one of several days. The fliers eventually came out over the Ross Sea barrier, which lies due south of New Zealand, about one hour and ten minutes flying from the abandoned base camp of the Byrd Antarctic expedition. The fuel supply however was nearly exhausted, and gave out twenty-five miles from the objective, making it necessary to proceed on foot to the camp, the journey taking five days. Here they settled down to await the base ship which was on its 3,000 mile journey around the coast to meet them. However before it arrived a Colonial office patrol ship, the "Discovery," came along and its aeroplane established communication with them and they and their plane were successfully taken off and returned to civilization.

The speaker expressed the opinion that Canada is on the eve of a great development in aeronautics. We are deficient in inter-city services, though our air developments on the northern frontier have been very successful. These developments, it was pointed out, would be a great stimulus to business and industry, as for every pilot and his engineer, there are fifteen to twenty-five men on the ground engaged in manufacturing the equipment and facilities used.

The meeting was also honoured by having another Antarctic explorer present, Captain Innes-Taylor, formerly of the Byrd Antarctic expedition, who was also a guest of the Branch.

London Branch

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

VISIT TO SILVERWOODS COLD STORAGE PLANT

On October 3rd the Branch visited the cold storage plant of Silverwoods Limited and by the courtesy of the management the members and guests, with their ladies, were shown over the establishment. In this case, however, the machinery units were not in operation, but the party was taken into most of the cold storage units containing meat, fish, fruit, vegetables, etc. Ice and butter making plants were particular objects of interest as was also the milk bottling and ice cream machinery.

The last unit visited was the efficient boiler room, so the party had the unique experience of passing through, in a couple of hours, temperatures ranging from 20 degrees below zero to around 80 degrees above.

An enjoyable lunch was provided by the management at the close of the tour, at which votes of thanks were given and suitably acknowledged.

Montreal Branch

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

DIESEL LOCOMOTIVES

At the meeting of the Montreal Branch of The Institute held on October 29th, 1936, Mr. R. Tom Sawyer, who is with the Railway Diesel Department of the American Locomotive Company, addressed the Branch on "Diesel Locomotives." The speaker outlined the various classes of service to which these locomotives are best adapted.

Prior to the meeting a dinner was held at the Windsor hotel.

G. G. Ommanney, M.E.I.C., was in the chair.

JUNIOR SECTION

"The Interdependence of Architecture and Engineering" was the subject of an address which Sidney S. Bunting, B.Arch., M.R.A.I.C., presented before the Junior Section of the Branch on November 2nd.

The contribution of architecture to a mutual field of endeavour was sketched by the speaker, who presented his views towards a closer co-operation between the architectural and engineering professions.

C. E. Frost, A.M.E.I.C., acted as chairman.

DEPRECIATION OF INDUSTRIAL PLANTS IN VALUATION STUDIES

Herbert H. Cantwell, A.M.E.I.C., was the speaker at the meeting of the Montreal Branch held on November 5th, his subject being "Depreciation of Industrial Plants in Valuation Studies."

The speaker reviewed the various factors of depreciation, age, condition, inadequacy, obsolescence and their several divisions, and also dealt with the legal aspects of tax adjustments.

J. H. Hunter, M.E.I.C., was in the chair.

FAN DESIGN AND CALIBRATION

At the meeting of the Montreal Branch held on November 12th, H. F. Hagen, Director of Research for the B. F. Sturtevant Company, spoke on "Fan Design and Calibration," discussing the different types of fans and the reasons for the differences in design. Details regarding calibration were discussed, also the reasons why laboratory results do not always coincide with field results.

A dinner was held at the Windsor hotel prior to the meeting.

James A. Kearns, A.M.E.I.C., was chairman.

JUNIOR SECTION

"Le Haut-Fourneau Electrique" was the subject of a paper by C. Hebert, S.E.I.C., who is at present with Messers. Lord and Company Limited, before the Junior Section on November 16th.

D. R. Taylor, who is a fourth year student in electrical engineering at McGill University, spoke on" The Development of Radio Communication in the Bush."

ACOUSTIC NETWORKS IN RADIO RECEIVER CABINETS

On November 19th, through the kind co-operation of the Committee of Montreal Members of the Institute of Radio Engineers, the members of the Montreal Branch of The Institute took part in a joint meeting, at which Mr. Hugh S. Knowles, chief engineer of the Jensen Radio Manufacturing Company, Chicago, was the speaker.

Mr. Knowles, who is a well-known authority on speaker design and acoustical applications, discussed the proper acoustical treatment of fidelity curve adjustment from circuit to cabinet design.

The chairman of the meeting was Mr. A. H. Patience.

Niagara Peninsula Branch

P. A. Dewey, A.M.E.I.C., Secretary-Treasurer.
C. G. Moon, A.M.E.I.C., Branch News Editor.

The November meeting of the Niagara Peninsula Branch of The Institute was held at the Hotel Leonard, St. Catharines, on November 18th, 1936. George H. Wood, A.M.E.I.C., presided, Roy A. Crysler, A.M.E.I.C., was the principal speaker, and N. J. M. Lockhart, M.P., honoured the assembly with a few words of greeting.

Councillor E. P. Murphy, A.M.E.I.C., believes in the responsibility attached to his office. He attended the Plenary Meeting of Council in Montreal called to discuss consolidation, and rumour has it that he had to thumb his way both going and coming. The result however justified the means, for which the local membership is properly grateful, as he was able to indicate several new features which had a very pertinent bearing upon the question.

Mr. Crysler, who represents the Canada Cement Company in Toronto, spoke about the evolution of architectural concrete. He was ably assisted by Mr. Robertson who explained the fine series of slides showing ancient and modern buildings.

Messrs. Graham and W. D. Bracken, A.M.E.I.C., did the honours and sponsored a very hearty vote of thanks to the speakers.

Ottawa Branch

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

Radium, Its Production and Use

At a noon luncheon at the Chateau Laurier on October 22nd, 1936, G. C. Laurence, Ph.D., of the National Research Laboratories, Ottawa, spoke upon "Radium, Its Production and Use." Dr. Laurence has been engaged for several years in investigational work at the Laboratories and is in charge of research on radium and X-rays.

E. Viens, M.E.I.C., chairman of the Ottawa Branch, presided and in addition to the chairman and the speaker head table guests included: Dr. Paul Brodeur, radiologist of the Ottawa General Hospital; E. H. Scammell, secretary of the Department of Pensions and National Health; Dr. A. McCormick of the Department of Pensions and National Health; J. L. Busfield, M.E.I.C., of Montreal; G. J. Desbarats, C.M.G., Hon.M.E.I.C., Dr. R. W. Boyle, M.E.I.C., J. McLeish, M.E.I.C., F. E. Lathe, Group Captain E. W. Stedman, M.E.I.C., A. K. Hay, A.M.E.I.C., J. H. Parkin, M.E.I.C., and T. A. McElhanney, A.M.E.I.C.

There is nothing remarkable in the appearance of radium and its compounds, stated Dr. Laurence at the commencement of his address, though they evince the characteristic of causing discoloration to any glass containers in which they are held. This may readily be noticed on X-ray tubes that have been in use for some time. As for the danger to health from direct contact, this is obviated so far as possible by investigators using forceps and taking other precautions. The insidiousness of the danger is that the injury is cumulative. If a small tube of radium were held in the hand for a half-hour by one who had not been previously exposed he might not suffer harmful effects but if it were to come in contact with the person every day, even if only for a minute or two at a time, this would be very unwise. A bad burn would eventually result that would take a long time to heal.

The speaker then related the history of the discovery of radium in 1895 and paid tribute to Pierre and Marie Curie, who also were responsible for much development in its use and in X-rays. They were twice awarded the Nobel prize. Pierre died from an accident in 1906, and in 1934, one year after the death of Mrs. Curie, their daughter, Irene with her husband also won the Nobel prize for their work in the field of artificial radioactivity.

In 1930, previous to the discovery of radium-bearing ores at Great Bear lake in Canada, its production had been a Belgian monopoly. However, the Canadian discovery has altered this and now that Canadian production has been placed on a regular basis this country will undoubtedly have a very large share of the world's markets.

Concentrates from the Canadian find are shipped by airplane to Waterways, Alberta, the end of steel, and from there to the refinery at Port Hope, Ontario, they are transported by train. In 10 tons of concentrates there is about one gram of radium. The Canadian ore presented difficulties, Dr. Laurence said, which have been overcome through research by officials of the Department of Mines.

The radium as used by physicians is generally held in platinum containers, some of these are called "needles" but they look more like nails that have had their heads removed. Their application varies considerably with the nature of the ailment to be treated. The amount contained in any needle is certified to in national laboratories for the purchaser by obtaining a measurement of the ionization of the air induced from it. The quantity of radium is in direct proportion to the amount of radiation and in the measurements currents of extremely small amperage may be detected.

Experiments are now under way whereby table salt may, after certain treatment, assume for a short time radio-active properties akin to those of radium, and possibilities for the practical application of this are also being investigated.

Peterborough Branch

W. T. Fanjoy, A.M.E.I.C., Secretary-Treasurer.
E. J. Davies, A.M.E.I.C., Branch News Editor.

Metallizing and Metal Spraying

At the regular opening meeting of the year's activities of this Branch held on Thursday, October 8th, the speaker was Mr. C. E. Simpson, consulting engineer of Toronto, who gave the members a very thorough and enlightening address on the subject of "Metallizing and Metal Spraying."

The idea of metal spraying was first developed by Dr. U. Schoop of Switzerland some fifty years ago more as a hobby than as a practical process. The principle involved has not changed greatly since then, although the mechanism of the spraying machines has greatly improved and the range of its application greatly increased.

Metal spraying is done in two ways: with the use of wire rod or by using the powdered metal. In either case the metal is melted at the nozzle of a gun through which it is fed, being melted by an oxygen acetylene flame with the addition of air pressure to spray the melted metal onto the base. In the case of the wire machine the metal wire, similar to welding rods, is fed through the gun by means of a mechanism of gears. The powdered metal is drawn from a tank by an air turbine, which is operated from a by-pass from the air line and feeds the powdered metal through a tube to the nozzle at a rate depending upon the rate of operation of the gun. This machine necessitates the handling of four hose lines as against three lines and a wire in the other machine.

The softer metals such as zinc, aluminum, copper and tin, are more commonly used than the harder metals such as stainless steel. The metal breaks up into small particles; experiments of spraying into water showed that the particles varied from 400 mesh to 80 mesh. The particles adhere to the base with a mechanical bond and it is found that the smaller particles give the best adhesion. The particles should be smaller than 100 mesh but 300 mesh particles burn.

The surface to be sprayed must be clean and rough. Pickling is insufficient and even the sand blasting to which castings are subjected is insufficient as the rougher the surface of the base the better the adhesion obtained, as there is no fusion between the coating and the base.

The operation is fairly expensive at the present time as compared with competitive methods of doing this same work, but the speaker felt that in time this difficulty would be overcome and this process would be used to much greater extent. He emphasized the importance of the shop men presenting their problems to the spray people to give the latter better opportunity to test the application of this process.

Saguenay Branch

G. H. Kirby, A.M.E.I.C., Secretary-Treasurer.

Annual Meeting

The annual general meeting of the Saguenay Branch of The Institute was held at Kenogami on the evening of August 22nd, 1936.

During the afternoon several of the members enjoyed a round of golf at the Saguenay Country Club, after which they visited the Bayer Process section of the Aluminium Company of Canada's plant at Arvida.

Following the dinner held at the Kenogami staff house, the meeting was called to order by the chairman, J. Shanly, A.M.E.I.C., who asked W. P. LeBoutillier, Jr.E.I.C., in the absence of the secretary-treasurer, L. R. Beath, S.E.I.C., to read the minutes of the previous meeting, also the report of the secretary for the year. The motion for the adoption of the minutes and the secretary's report was made by A. W. Whitaker, A.M.E.I.C., and seconded by M. G. Saunders, A.M.E.I.C.

The scrutineers' report on the results of the election of officers was then given, S. J. Fisher, M.E.I.C., being elected chairman, F. L. Lawton, M.E.I.C., vice-chairman, and G. H. Kirby, A.M.E.I.C., secretary-treasurer.

Mr. Fisher expressed his appreciation of the honour done him in electing him to the chairmanship of the Branch, and said that he hoped to be able to procure speakers for the coming year who would maintain interest in the meetings. He then introduced F. L. Lawton, M.E.I.C., who presented a paper on cost and performance data secured on several forms of house insulation.

Cost and Performance Data for House Insulation

Fourteen one and a half or two storey houses of first class construction were built during 1935 at Isle Maligne in the Saguenay District, the average gross volume being 17,444 cubic feet. Their construction was to some extent experimental, in that different forms of heat insulation and interior finish were used. Careful cost records are kept for each. All the houses have full size basements of concrete, storm sash and storm doors; all are completely weather-stripped.

Eight of the houses were heated electrically, on a meter-rate basis, and careful records were kept with the co-operation of the tenants. The eight houses have pipeless hot-air furnaces, with the electric heating equipment of heavy wire resistance heaters mounted between the furnace and the jacket separating hot and cold air passages. The heaters were operated from an air-temperature actuated thermostat controlling a magnetic contactor in the supply circuit to the heaters.

In addition to the electric heating energy requirements, all domestic usage for cooking, lighting, hot water, etc., was separately metered.

Three forms of insulation were used as follows:—

Form A—A filler type insulation of flaked, dry and fluffy gypsum and fibrous material.

Form B—A foil type insulation in which the low conductivity of air has been combined with the low radiating power of bright aluminum foil in a foil-air cell structure designed to minimize convection currents.

Form C—A fibrous form of material made from rock in which the felted material is wrapped on chipboard centres, the "bat" being 15 inches by 18 inches by 2¼ inches.

A number of interesting conclusions have been drawn from the investigation, and the complete paper appears on page 524 of this issue of The Journal.

Sault Ste. Marie Branch

N. C. Cowie, Jr.E.I.C., Secretary-Treasurer.

The Sault Ste. Marie Branch of The Engineering Institute of Canada held its first meeting of the fall season at the Windsor hotel, Sault Ste. Marie, on October 30th, 1936.

Nineteen members and guests were present to enjoy the dinner which was served by the hotel staff at 7 p.m. The meeting which commenced at 8 p.m. was presided over by Wm. Seymour, M.E.I.C., vice-chairman of the Branch. The minutes of the previous meeting and a few items of business were first dealt with by the meeting.

Mr. Seymour introduced R. S. McCormick, M.E.I.C., chief engineer and general superintendent of the Algoma Hudson Bay Railway Company, Limited. Mr. McCormick spoke on the subject "Human Relations and the Engineer." In his paper Mr. McCormick dealt with the important question of human power and stressed the vital importance of human relations in the engineering profession. Mr. McCormick's address, which drew from his long experience in railroad work among entertaining and illuminating examples and incidents, was thoroughly appreciated and enjoyed by those present.

The appreciation of the meeting was extended to Mr. McCormick on a motion by E. M. MacQuarrie, M.E.I.C., and O. A. Evans, Jr.E.I.C.

The meeting adjourned on a motion of Carl Stenbol, M.E.I.C., and L. R. Brown, A.M.E.I.C.

Winnipeg Branch

H. L. Briggs, A.M.E.I.C., Secretary-Treasurer.

Boulder Dam

At the meeting of the Winnipeg Branch held on November 5th, 1936, Mr. J. McMahon outlined the location and purpose of the Boulder dam project in the Black Canyon of the Colorado River, prior to showing the Branch the film "Boulder Dam," furnished through the courtesy of the Barrett Company. The film depicted general features of the Boulder dam plant just before its completion, and in particular the construction of the roof of the plant, which is designed to withstand the impact of a two-ton boulder falling off the canyon wall.

Electrical Engineering Practice in England

An interesting feature of the evening was a short talk by J. W. Sanger, M.E.I.C., on electrical engineering practice in England thirty years ago. Among other things, he mentioned the use of full line voltage on the switchboards, the use of 12 inch by 12 inch by 10 inch steel pots for 10,000-volt oil switches, and the extremely reliable lead covered cable distribution systems of that time. As regards the remuneration of engineers in those days, a plant superintendent received £12 per month.

The vote of thanks for the entertainment of the evening was moved by D. M. Stephens, A.M.E.I.C. There were one hundred and thirty-nine members and visitors present.

Erratum

In publishing Dr. F. C Breckenridge's paper entitled "Trends in Aviation Lighting in the United States" in the November issue of The Journal, it was incorrectly stated that this paper had been presented before the Aeronautical Section of the Ottawa Branch of The Institute.

The material presented in the address by Dr. Breckenridge before the Ottawa Branch on September 4th was covered in the above mentioned article, which was published because of current interest in airway development.

Glass Bricks

A well-known firm of glass manufacturers at St. Helens, Lancashire, England, is beginning the production of translucent glass bricks which will be called "Insulight" on account of their insulation properties against sound and heat and their power of transmitting and diffusing light. Glass brick constructions of different kinds are to be found in America, and investigations and experiments are being made by the company in collaboration with one of the leading glass companies in the United States.—*Industrial Britain.*

Symposium on High-Strength Constructional Metals

This symposium comprises five extensive technical papers and discussion presented at the 1936 regional meeting of the American Society for Testing Materials. The papers cover the chemical and physical properties and manufacturing and fabricating properties of metals and alloys applied for various constructional applications including buildings, ships, automobile bodies, airplane wings, tanks, etc.

Copies of the publication of 126 pages, can be obtained from the American Society of Testing Materials, 260 S. Broad Street, Philadelphia, Pa. at $1.25 in heavy paper binding; $1.50 cloth binding.

Association of Professional Engineers of the Province of Ontario

The October Council meeting of the Association of Professional Engineers of the Province of Ontario was held in the mining district of Northern Ontario in the vicinity of Kirkland Lake and Timmins. Visits were paid to a number of mines.

Those attending were President R. W. Angus, M.E.I.C., Vice-President A. D. Campbell, M.E.I.C., Messrs. A. B. Crealock, M.E.I.C., J. Clark Keith, A.M.E.I.C., S. R. Frost, A. E. MacRae, A.M.E.I.C., C. C. Carris, E. Sterne, W. Patterson, S. A. Wookey and J. Rawlins.

A dinner held at Schumacher on October 3rd was attended by a number of engineers from the district, the speakers including several of the Councillors present, who outlined the history, purposes, aims and ideals of the Association. Mention was made of the endeavour to secure legislation in an attempt to make effective the protection of the public, which on account of misconceptions on the part of the men in the mining country had been withdrawn by the previous legislature. The protection of the public was the main issue, and this should be given the greatest emphasis. There was a responsibility on the part of all to educate public opinion along the right lines.

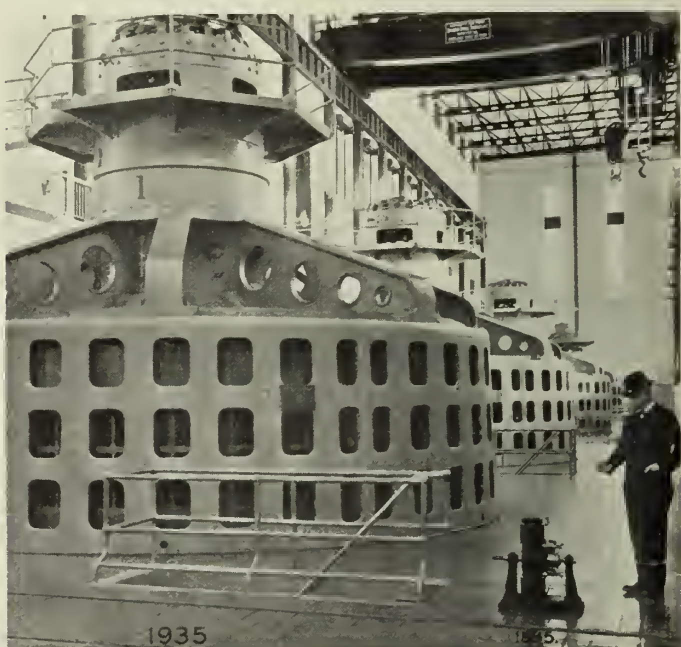
Qualifications for membership in the Association were outlined, and it was noted that they were at a minimum compatible with public safety. In justice to the profession and to the public only those registered should be allowed to use the title "engineer."

The meeting afforded an opportunity for the exchange of views between the Council and representatives from the surrounding district.

The Algoma Steel Corporation Limited reports that the range of rolled steel products produced by the company increased during the month of October by the production of 10-inch I-Beams and structural channels of a considerable range of weights.

The modern 30-inch mill at Algoma is now equipped to roll 8-inch beams of from 18.4 pounds per lineal foot up to 15-inch beams of 50 pounds per lineal foot, and 8-inch channels of 11.5 pounds per lineal foot up to 15-inch channels of 55 pounds per lineal foot. Also centre sill Zee-bars, steel sheet piling, and standard rails up to 130 pounds per lineal yard.

At the 18-inch and 12-inch merchant mills, sections from 7 inches down to 1½ inches are rolled, also a variety of sizes of round, square and flat bars.



Contrast in Generators

The growth of the electric service industry can offer no more graphic evidence than the accompanying picture.

The little dynamo operated two 40-watt arc lamps. Its capacity was 1.2 kilowatts or 1.6 h.p. It was one of the very early generators to be operated in Canada, and was installed in 1885 in the Gilmour Brothers lumber mill on the present site of the Chelsea (Quebec) plant of the Gatineau Power Company by Ahern and Soper of Ottawa.

John Murphy, M.E.I.C., of Ottawa, electrical engineer, Department of Railways and Canals and Board of Railway Commissioners for Canada, operated this small machine when it was first installed, and the photograph shows him looking at his pet of fifty years ago.

On the left in the photograph is a row of modern 34,000 h.p. vertical type waterwheel-driven Westinghouse generators in the Chelsea plant of the Gatineau Power Company—on the same site where the little dynamo was originally operated. This plant has a designed capacity of 170,000 h.p.

Preliminary Notice

of Applications for Admission and for Transfer

November 26th, 1936

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

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

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

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

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

The Council will consider the applications herein described in January, 1937.

R. J. Durley, Secretary.

*The professional requirements are as follows:—

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

An Associate Member shall be at least twenty-seven years of,age, and shall have been engaged in some branch of engineering for at least six years which period may include apprenticeship or pupilage in a qualified engineer's office or a term of instruction in a school of engineering recognized by the Council. In every case a candidate for election shsll 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 ofengineering 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 responsibilityfor five or more year.

A Junior shall be at least twenty-one years of age, and shall have been engaged in some branch of engineering for at lesst 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 equiva ent standard.

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

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

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

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

FOR ADMISSION

DEWAR—CHARLES LEONARD, of 104 Dufferin Road, Hampstead, Que., Born at Ottawa, Ont., May 5th, 1898; Educ., B.Sc., 1921, M.Sc., 1922, McGill Univ.; 1922-23, senior lab. asst., Mines Branch, Ottawa; 1923 to date, with the Bell Telephone Company as follows: 1923-25, asst. field engr., 1925-26, district plant engr., 1926-30, engr., gen. engrg. dept., 1930-35, outside plant engr., Eastern Area, 1935 to date, outside plant and transmission engr., Eastern Area.

References: R. V. Macaulay, L. L. O'Sullivan, T. C. Thompson, J. L. Clarke, G. A. Wallace.

ECKERT—SIEGFRIED, of 61 Sixth Ave., Verdun, Que., Born at Neuruppin, Germany, April 11th, 1907; Educ., Mech. Engr., Technical College of Strelitz, Germany, 1928; 1922-25, ap'ticeship at Ruppiner railway shops, Neuruppin; 1926 (summer), work at Aircraft Company, Stralsund; 1927, with the Junkers Aircraft Works; 1928-29, designing engr., at Minimax Perkeo, Neuruppin, distribution plans for Foamite for oil tank fields, plans of pumps and apparatus, etc.; 1929-30, with the Solex Co., Montreal; 1930 to date, asst. engr., Canadian Laco Lamps Ltd., Montreal, Photo electric photometry, candlepower distribution of luminaries, lamp testing, machine design.

References: J. L. Busfield, J. G. Hall, R. E. Heartz, G. R. MacLeod, E. Klein.

GORDON—HARRY J., of 3597 St. Urbain St., Montreal, Que., Born at Montreal, Nov. 30th, 1901; Educ., B.Sc. (E.E.), McGill Univ., 1923; 1921 (summer), Hollinger Gold Mines; 1923-24, testman, Can. Gen. Elec. Co. Ltd.; 1924-25, dftsman., Toronto Hydro Electric System; 1925-26, dftsman., T. E. Murray Co., New York; 1926-27, designer, Stevens & Wood, New York; 1928-29, sales engr., English Electric Co., Montreal; 1929-30, sales engr., Electro Dynamic Co., New York; 1930-33, mgr. and asst. sec'y., Rao Engineering Co. Inc., New York, electrical contracting and engrg.; April 1936 to date, sales engr., Fred Thomson Co. Ltd., Montreal, Que.

References: C. Thomson, A. Walker, J. H. Hunter, C. V. Christie, G. A. Wallace, J. F. Plow, G. S. Davis.

HENRIKSON—GUNNTHOR JOHN, of Selkirk, Man., Born at Selkirk, Sept. 3rd, 1912; Educ., B.Sc. (E.E.), Univ. of Man., 1936; 1930-36, during summer months, clerk, meter reader, linework, constrn., Winnipeg, Selkirk & Lake Winnipeg, Rly.

References: E. V. Caton, E. P. Fetherstonhaugh, N. M. Hall, G. H. Herriot, A. E. Macdonald, J. F. Cunningham.

HEROUX—GEORGES, of 387 St. Roch St., Three Rivers, Que., Born at Three Rivers, July 27th, 1910; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1934; 1935 to date, asst. city engr., Three Rivers, Que.

References: B. Grandmont, J. E. Fleury, J. A. Hamel, J. F. Wickenden, J. H. Fregeau.

JARRELL—GORDON JAMES, of Fergus, Ont., Born at Port Hope, Ont., Oct. 18th, 1911; Educ., B.A.Sc., Univ. of Toronto, 1934; 1935-36, time study, and Jan. 1936 to date, inspection, responsible for all gears and worms, Beatty Bros., Fergus, Ont.

References: R. W. Angus, E. A. Allcut, T. R. Loudon, W. S. Wilson, R. E. Smythe.

KELLY—WILLIAM HENRY, of Buckingham, Que., Born at Montreal, Que., Dec. 23rd, 1893; Educ., B.Sc. (Civil), McGill Univ., 1916; 1909-15, constrn. of scows, tugs, dredges, for father's firm, W. H. Kelly Co.; 1916-17, mining and transporting magnesite ore; 1917-18, asst. engr. on research and efficiency engrg., hydrographic surveying; 1918-19 overseas, Lieut., Can. Engrs.; 1919-21, dfting and designing plant layouts, concrete, etc., Riordon Paper Co.; 1921-22, contract for constrn of retaining wall, Dept. Public Works, Ottawa; 1922-23, President, Canadian Construction Co. Ltd., highway, gen. contracting and logging; 1923, instr'man., rly. location, Singer Mfg. Co.; 1923-24, contract for logging operations, Singer Mfg. Co.; 1924-25, contract for highway constrn.; 1925-26, asst. to town engr., Temiskaming, Que.; 1926, contract for stripping quarries; 1926 27, contract for supplying gunite gravel; 1927-28, supt., W. I. Bishop Co., tractor hauling, etc.; 1928-30, contract for bridge timber, James McLaren Co.; 1930-31, contract for highway constrn.; 1931-32, installn. of waterworks, Town of Calumet; 1932-33, installn. of water supply system; 1933-36, truck logging operations, roads, etc., and at present engaged in logging operations by truck, including bldg. of roads and bridges, for E. M. Nicholson.

References: D. W. McLachlan, R. deB. Corriveau, A. B. McEwen, H. Kennedy, J. A. E. Gohier.

LAUGHTON—JAMES ALEXANDER, of Brandon, Man., Born at Brandon July 29th, 1909; Educ., B.Sc. (C.E.), Univ. of Man., 1935; 1927-29, chainman, C.P.R.; 1921-31, clerk, C.P.R. constrn.; Summer 1932, chairman, Manitoba Govt. Land Survey; At present, engr., Canadian Brown Steel Tank Co. Ltd., Brandon, Man.

References: J. A. McCoubrey, G. H. Herriot, J. N. Finlayson, T. C. Macnabb, J. F. Cunningham.

McRAE—IAN F., of 156 Douro St., Peterborough, Ont., Born at Vancouver, B.C., July 24th, 1904; Educ., 1919-21, Vancouver Technical School; 1920-23, elect'l and mech'l. engrg. course, Chicago Engrg. Works (Correspondence); 1924, drill engr., Hammond Cons. Gold Corpn., Nome, Alaska; With the Can. Gen. Elec. Co. Ltd., Peterborough, Ont., as follows: 1925-27, test course; 1927-30, engrg. dept., switchboards; 1931 to date, asst. engr., switchboard section, in charge of design low tension oil circuit breakers, metal clad switchgear.

References: L. DeW. Magie, E. R. Shirley, R. L. Dobbin, A. B. Gates, H. R. Sills, V. S. Foster, W. C. Cruthers, S. E. M. Henderson, W. E. Ross, C. E. Sisson, B. Ottewell, A. L. Dickieson, W. T. Fanjoy.

ODELL—RUSSELL KENNETH, of Ottawa, Ont., Born at Ottawa, Sept. 15th, 1891; Educ., Private tuition, Ottawa. Royal Naval College, Greenwich, England, 1916; 1908-09, technical clerk, 1909-16, i/c Lands Divn., Railway Lands Branch, Dept. of the Interior; 1916-19, Overseas—Royal Navy (Navigation Officer on H.M. Ships engaged in escort, anti-submarine, and mine-sweeping duties); 1919-30, asst. director, Natural Resources Intelligence Service, Dept. of the Interior Duties: To assist the Director and supervision of work of employees of that Service; to supervise economic and industrial surveys and to advise upon problems arising therefrom; to make special investigations and studies regarding natural resources development and to advise in the establishment of policy; to devise methods for the further development and utilization of the natural resources of Canada; to assume, during the absence of the Director, responsible charge of the activities of the Service; and to perform other related work; 1930-33, asst. director, National Development Bureau, Dept. of the Interior; 1933 to date, chief development divn., Bureau of Economic Geology, Department of Mines, Ottawa, Ont.

References: F. C. C. Lynch, G. J. Desbarats, R. W. Boyle, C. M. Pitts, A. K. Hay.

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

HOWRIGAN—CLYDE PAIGE, of Bakersfield, Vt., Born at Bakersfield, Aug. 13th, 1879; 1901-05, with the Oregon Short Line R.R.; 1905-09, chg. of field work, location, N.Y.N.H. & H. Rly.; 1909-12, res. engr., constrn., N.Y.N.H. & H. Rly.; 1912-15, resident, location and constrn., C.P.R.; 1915-20, engr. and supervising, Fraser Brace Engrg. Co.; 1920-22, asst. supt., Ontario Hydro-Electric; 1922-30, eng.

supt. and asst. supt., Fraser Brace Engrg. Co.; 1930-33, supt., St. Louis Sec., Beauharnois Power Constrn.; 1933-34, private practice, designing town water supplies, Aluminum Co. of Canada; 1935-36, layout of excavation equipment in British Guiana; At present, manager, Aranka Gold Mines, British Guiana, So. America. (*A.M. 1917.*)
References: M. V. Sauer, J. H. Brace, F. H. Cothran, D. Hillman, J. F. Guay, R. E. Heartz, J. B. D'Aeth, H. G. Acres.

ASKIN—ROBERT J., of 524 Red River Rd., Port Arthur, Ont., Born at Arcola, Sask., June 29th, 1898; Educ., B.Sc., Queen's Univ., 1923; 1914-19, Canadian Car and Foundry Co., engrg. dfting., designing, machine shop and foreman erector; 1922 (summer), Fort William Paper Co., field engr., paper mill constrn.; 1923 (summer), engrg. estimates and design, Dominion Engineering Works, Lachine; 1923-26, Fort William Paper Co., engr. i/c mill efficiency, boiler house tests, quality of products, mill tests and operating engrg. problems; 1926-28, res. engr., 1928-31, chief engr. and asst. mgr., and 1931-33, mgr., Fort William Paper Co.; 1934 to date, mgr., Thunder Bay Paper Co., Port Arthur, Ont. (*St. 1922, A.M. 1926.*)
References: H. G. O'Leary, P. E. Doncaster, G. H. Burbidge, G. R. Duncan, R. B. Chandler.

FOR TRANSFER FROM THE CLASS OF JUNIOR

COBBOLD—ROBERT JAMES, of 344 Hillmorton Road, Rugby, England., Born at Childe-Cokefold, Blandford, Dorset, England, Dec. 31st, 1901; Educ., Associate, City & Guilds of London Institute, 1929; 1919-24, indentured ap'tice, Drake & Graham, London, England, Elect'l. & Mech'l. Contrators; 1924-26, in charge of work for same firm; With the Can. Gen. Elec. Co. Ltd., Peterborough, Ont. as follows: 1929-30, test course; 1930-31, in charge of induction meter test; 1931-32, production dept., in charge of machines, A.C. and D.C.; With the English Electric Company as follows: 1932 33, production dept., in charge A.C. and D.C. machines, Stafford; 1933-34, sales engr., at Sheffield and Nottingham works; 1934-35, asst. to production mgr. on electric plant equipment, at Stafford; 1935 (Jan.-July), supt., progress dept., on water turbines, steam turbines, Diesel engines, Rugby; At present, asst. engr. in charge outside erection of water and steam turbines, Diesel engines, Rugby, England. (*Jr. 1930.*)
References: L. DeW. Magie, E. R. Shirley, W. M. Cruthers, V. S. Foster, A. B. Gates, B. Ottewell.

McILQUHAM—WALTER SCOTT, of 2301 Beaconsfield Ave., Montreal, Que., Born at Lanark, Ont., April 4th, 1896; Educ., B.Sc., Queen's Univ., 1923; 1922, Geol. Survey party, Dominion plane table work; 1924-25, field inventory, Bell Telephone Company of Canada; 1925 to date, engr., hydraulic dept., Dominion Engrg. Works, Ltd., hydraulics, design, estimating. specifications. (*Jr. 1926.*)
References: H. S. Van Patter, C. E. Herd, F. M. Wood, J. G. Notman, H. G. Welsford, H. A. Crombie.

FOR TRANSFER FROM THE CLASS OF STUDENT

FRANCIS—JOHN BARTEN, of Montreal, Que., Born at Saint John, N.B., May 2nd, 1909; Educ., B.Sc. (E.E.), McGill Univ., 1930; 1928 (summer), power house constrn., Shaw. Engrg. Co., Shawinigan Falls, Que.; 1929 (summer), distribution dept., Shaw. Water & Power Co. Thetford Mines, Que.; 1930 (6 mos.), distribution dept. of same company at Sorel; 1930-32, test course, General Electric Co., Schenectady, N.Y.; 1933 (9 mos.), dftsman., Imperial Oil Refineries, Montreal East; 1934-36, engr., Canadian Industries Ltd., Montreal, Industrial application of heat, light and power. (*St. 1928.*)
References: C. V. Christie, I. R. Tait, H. C. Karn, C. H. Jackson, G. A. Wallace, R. H. Mather.

FRASER—RALPH PERCY, of 107 Tache Ave., Norwood Grove, Man., Born at Winnipeg, Man., Sept. 22nd, 1905; Educ., B.Sc. (E.E.), 1931; Summer work: chainman, Winnipeg Electric Co.; 1926, concrete inspr., Manitoba Power Co.; 1927, chainman and concrete inspr., Manitoba Power Co.; 1928-29, rodman and concrete inspr., C.N.R.; 1930, testman, Students Test Course, Can. Gen. Elec. Co.; 1931-32 and 1932-33, instructor, electricity and maths., Winnipeg Evening School Classes; 1932-33, asst. elect'l. instructor, Kelvin Technical High School, Winnipeg; 1933-35, occasional staff, Winnipeg Public School Board; 1935-36, ap'tice floorman, substation operation dept., and Jan. 1936 to date, junior voltage tester, light and power dept., Winnipeg Electric Company, Winnipeg, Man. (*St. 1930.*)
References: T. C. Main, E. V. Caton, G. H. Herriot, H. L. Briggs, L. M. Hovey.

JEHU—LLEWELLYN, Jr., of 3-B Riverside Drive, Lachine, Que., Born at Montreal, Aug. 28th, 1906; Educ., B.Sc., 1930, M.Eng., 1934, McGill Univ.; 1926-29 (broken service 1 yr. 7 mos. in all), tracer and dftsman., Dominion Bridge Co.; 1930 (June-Dec.), junior hydrographer, Dept. of Marine, Ottawa; 1930 to date, designer of plate work, storage and pressure vessels, boilers, etc. with Dominion Bridge Company, except for about 15 mos doing research work in connection with post graduate course. (*St. 1928.*)
References: F. P. Shearwood, F. Newell, A. S. Wall, R. S. Eadie, R. E. Jamieson.

KING—PETER CAMPBELL, of Kingston, Ont., Born at Collingwood, Ont., Sept. 20th, 1907; Educ., B.Sc., Queen's Univ., 1931; 1924-26, laying out foundations and concrete forms, gen. constrn., Roger Miller & Sons, Toronto; Summer 1929, constrn. foreman, Nelson River Constrn. Ltd., Toronto; 1930-31, constrn. supt., with same company; 1931-32, constrn. supt., Eastern Constructors Ltd., Montreal; 1932-34, engr. City Gas & Electric Corpn. Ltd., Three Rivers, Que.; 1935 to date, laboratory instructor in hydraulics and general engrg., Queen's University, Kingston, Ont. (*St. 1928.*)
References: A. Gibson, A. A. Young, H. M. Scott, L. F. Grant, W. P. Wilgar, D. S. Ellis, J. T. Lakin.

The High-Altitude Flying Record

Although an altitude exceeding 40,000 feet was reached by an aeroplane in Germany on May 26th, 1929, the actual figure being 41,795 feet, and although this figure was continually improved on in the following years until, on August 14th of this year Detré, in France, reached a height of 48,698 feet, the actual amount of investigation which has been carried out on the problem of flight at extreme altitudes is still small. The question of stratosphere flying is of importance from the point of view of the development of both military and commercial machines, and of aircraft instruments, while experimental investigation of the subject is likely greatly to add to existing meteorological knowledge. In view of these conditions, the Air Ministry, in 1934, decided to order a special aeroplane designed to operate at altitudes of 50,000 feet and over. Although the main purpose of this machine is to carry out an extensive research programme in connection with high-altitude flying, it was decided to attempt to surpass with it the record of 48,698 feet (14,843 m.) established in France on August 14th, by a Potez 506 aeroplane fitted with a Gnome-Rhone 14 K.R.S.D. engine. As is generally known, this attempt was successfully carried through recently, when Squadron-Leader F. R. D. Swain, flying the new Air Ministry machine, reached an altitude of 49,967 feet (15,230 m.), thus breaking the previous record by 1,296 feet (387 m.). According to the rules of the Fédération Aéronautique Internationale, it was necessary that, for the establishment of a new record, the previous figure should be surpassed by at least 300 m.

The order for the machine was placed with Messrs. The Bristol Aeroplane Company, Limited, in November, 1934, the design submitted by them and accepted being a low-wing monoplane fitted with a specially-supercharged Bristol Pegasus engine. It has been designated Bristol 138. In view of the necessity of employing the lightest possible structure, the machine has been built of wood throughout, with the exception of the engine mounting and cowling. The wing span is 66 feet, the overall length 44 feet, and the height to the top of the engine cowling 10 feet 3 inches. The mean chord is 8 feet 6 inches and at the root 12 feet. The weight empty is 4,391 pounds and loaded for the high altitude flight 5,310 pounds. The latter figure gives a wing loading of 8.53 pounds per square foot and a span loading of 1.22 pounds per square foot, both figures being lower than the maxima laid down in the specification . . .

The engine is fitted with two superchargers in series, the air in its passage from one to the other passing through a tubular air cooler. The four-bladed propeller is of wood, 12 feet 9 inches in diameter and of 14-foot pitch. There are two petrol tanks in the metal bay of the fuselage, the main tank holding 70 gallons, and the service tank, which is mounted above it, holding 12 gallons. The upper tank, which is supplied by a pump from the lower one, gives a gravity feed sufficient for fifteen minutes' flight. In view of the high degree of supercharge, with consequent high mixture temperature, the anti-knock value of the fuel used is of great importance. Based on previous experience, coupled with special laboratory investigation, a fuel known as S.A.F.4 was selected and used for the record flight. This has an anti-knock value considerably exceeding that of pure iso-octane.—*Engineering.*

Silent Trolley Cars

The new Brooklyn, N.Y., surface cars of the "PCC" type add but a whisper to the proverbial roar of the city, thanks to the use of rubber in a new way for the trucks and wheels. In the conventional type of car, steel rails and steel wheels, unimpeded by any deadening factor, originate the harsh noise which is magnified by the bass-drum-like interior of the vehicle.

A special study was made of the interior lighting of the cars; ventilation was also considered, and among the attractive features are ducts leading from the motors up to the sides of the car to insure clean air inside.

No discomfort in starting and stopping is experienced by the passengers, because of the increased number of resistance points. There are two hundred and sixty notches, or control stages, in the electric operation. A smooth acceleration of from four to four and three-quarters miles per hour per second is obtained—more than twice that of the conventional street car. In five seconds the new vehicle can attain a speed of almost 24 miles per hour, and it can reach 50 miles per hour in less than eleven seconds.

The car can be stopped in about 70 feet when it is going 26 miles per hour, the service braking rate being from four and a quarter to four and three quarters miles per hour per second, and the emergency rate from eight to nine miles per hour per second.

Three types of brakes are employed, operating in sequence from a single pressure on a foot pedal. A dynamic brake acts on the motors, a magnetic brake on the track, and air brakes on the wheels. The latter completes the stop and holds the car. There is no sudden jar when the car is stopped, but a quick and smooth slowing down, effectively insuring against skidding despite rail conditions.

Attention has been given to the interior of the car, insofar as comfortable seating and provisions for standing passengers are concerned. In place of the old time hanging strap, a series of specially bent vertical bars afford a secure hold to standing passengers but effectively keep them from interfering with those who are seated. Heat in winter is provided from resistors.

Operation of the new street cars is particularly safe and simple. The motorman employs a foot-brake and a foot-accelerator, and his hands are completely free.

The Work of the London Passenger Transport Board

The London Passenger Transport Board provides public means of conveyance for a population of some 9,500,000 persons, and in so doing carried 3,647,962,633 passengers during the year ended June 30, 1936. Of this total, 2,217,498,934, or 58 per cent., used buses or coaches, 983,012,848, or 27 per cent., trams; 467,869,687, or 13 per cent. railways; and 69,581,164, or 2 per cent., trolley 'buses. It will therefore be gathered that the Board plays an important part in the road traffic problem of the area, though it is estimated in the Annual Report for 1935-1936, which was published last week, that the number of public passenger service vehicles represented only about 14 per cent. of the total flow, as compared with 37 per cent. for private cars, and 21 per cent. for pedal cycles. However, a public-service vehicle provides at least 10 times the average traffic service of a private car, and about 18 times that of a cycle.—*Engineering.*

EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada

2050 Mansfield Street, Montreal

Situations Vacant

SALES ENGINEER. Hoisting and conveying machinery manufacturer has vacancy for aggressive sales executives in the provinces of Ontario and Quebec. Consideration will only be given to trained engineers not over 40 years of age, having previous selling experience in this line. Applications in writing giving full particulars of education, early training, sales records, territory most familiar with, and remuneration required, should be addressed to Box No 1318-V.

SALES ENGINEER, to solicit new business for an established engineering firm in Western Ontario. Must be well acquainted with architects and heating and steam plant engineers in tbe locality. Apply to Box No. 1398-V.

Situations Wanted

INDUSTRIAL ENGINEER AND SUPT. Age 31, A.M.E.I.C., with combined electrical, mechanical and steel industry experience. Experience includes design and testing of all types of industrial electrical equipment, supervision of production and cost reduction, heat treating of steel, time study application in several plants. At present supt. of modern factory. Apply to Box No. 132-W.

ELECTRICAL ENGINEER, B.Sc., E.E. Age 30. Completed C.G.E. Test Course; five years experience with power company utility work—substation and power house (steam) operation and maintenance, transmission and distribution line operation, maintenance and design. Industrial or utility work desired. Location immaterial. Available on short notice. Apply to Box No. 266-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

ENGINEER, A.M.E.I.C. Age 30. Single. Employed. Civil and mining experience, capable of designing and superintending construction of timber, concrete and steel structures, rock crushing and ore plants. Would consider position witb mining or engineering company designing and building mills. Apply to Box No. 431-W.

MECHANICAL ENGINEER, B.Sc. Age 31. Married. Last ten years includes:—Mechanical structural and reinforced concrete design in pulp and paper mills, industrial plants, hydro-electric, mine, sewers and sewage disposal plant construction. My experience also includes shop production, steam plant combustion, fuel analysing, inspecting, supervising and instrument work on industrial construction. Permanent position preferred. Apply to Box No. 521-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aerophotographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

ELECTRICAL ENGINEER, B.Sc. '28; M. Eng. '35. Two yesrs student apprenticesbip at Can. Westingbouse Co., including test and electrical machine design. Also about two years experience in operating dept. of large electrical power organization. Available on sbort notice. Apply to Box No. 660-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience witb prominent manufacturer, designing, heating and power boilers, boiler installations, coal and asb handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.Sc. Elec. '29, B.Sc. Civil '33. Jr.E.I.C. Age 29. Experience includes four months witb Can. Gen. Elec. Co., approximately tbree years in engineering office of large electrical manufacturing company in Montreal, the last six months of whicb was spent as commercial engineer. For tbe last year and a balf employed in electrical repair shop. Best of references. Apply to Box No. 693-W.

Situations Wanted

ELECTRICAL ENGINEER, B.Sc., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.Sc. (Univ. of N.B. '31), with experience as rodman and cbecker on railroad construction, is open for a position. Apply to Box No. 728-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B C. '30. Single, age 24. Sixteen months with the Allis-Cbalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER, M.Sc., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering. Read, write and talk French. Married. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

Employment Service Bureau

Enquiries during the past montb indicate that the greatest demand for engineers appears to be in tbe following general classifications:—

- Recent graduates in mecbanical engineering.
- Recent graduates in civil engineering.
- Young mechanical engineers.
- Sales engineers in all branches of engineering.
- Sales engineers speaking French.
- Engineers with pulp and paper mill experience in design, draughting and maintenance.

If your experience is in any one of the above classifications, why not register with The Institute's Employment Service Bureau. Our list of men available for positions is greatly reduced in number.

RADIO AND ELECTRICAL ENGINEER, B.Sc., '31, Jr.E.I.C. Single. Age 29. One year and a half actual field experience in power and lighting equipment. Extensive work in telephone and radio layouts in switchboard and installation depts. Particularly interested and experienced in sales and traffic work in telephone and radio company. At present supervisor over sales and service of radio and electrical company. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, B.Sc. '29, A.M.E.I.C. Married. One year building construction. One year hydro-electric construction in South America, eigbteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

PLANT ENGINEER or SUPERINTENDENT, capable of supervising all phases of industrial plant operation, graduate electrical, eleven years diversified industrial experience including test course, four years on large Quebec industrial development, on construction and operation, also six years with prominent consulting firm supervising electrical and mechanical engineering projects. Age 31, single. Apply to Box No. 795-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

Situations Wanted

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

ELECTRICAL ENGINEER, graduate 1929, E.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 32, married. Two years in pulp mills draughting and designing additions, maintenance and plant layout. Three and a half years in the Toronto Building Department, checking and designing for steel, reinforced concrete and ordinary structures. One and a half years as transitman and draughtsman on road location and maintenance work. Available at once. Location immaterial. Apply to Box No. 899-W.

CIVIL ENGINEER, B.Sc., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements Available at once. Apply to Box No. 950-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. B.Sc. (Man. '23), A.M.E.I.C. Married. Ten years specialized experience in the practical use of magnetic, electrical and mechanical instruments for the prospecting, surveying and mapping of mineral, oil and gas lands. Five years experience with telegrapb, telephone and radio equipment. Capable of giving instruction in theory and practice in these lines and in college physics. Available on short notice. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.Sc.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

ENGINEER, with twenty years experience in industrial, pulp and paper mill, and general engineering and design. Age 41. Last five years chief engineer of paper mill making newsprint specialties and toilet tissues. Apply to Box No. 1246-W.

ELECTRICAL ENGINEER, B.Sc. '34 (Univ. of N.B.), S.E.I.C. Age 21, single. Desires any kind of electrical work. Will consider any location. Apply to Box No 1262-W.

ENGINEER AND DRAUGHTSMAN, Jr.E.I.C., age 33, married. Diplomas from Mtl Tech. Inst. in R.C. and Structural Design. 11½ years experience in civil engineering, draughting and instrument work. Tbis includes 7 years with M.L.H. & P. Cons. as field engineer on construction and maintenance of gas mains. Present location Montreal. Available at once. Apply to Box No. 1326-W.

CIVIL ENGINEER, M.E.I.C. Married. Age 38. Twenty years experience in organization, design and estimating, and cost accounting. Active service in France. Apply to Box No. 1367-W.

ENGINEER SUPERINTENDENT, A.M.E.I.C., R.P.E., Que. and Alta. Age 47. Married. Twenty years experience as engineer and superintendent in charge of hydro-electric, industrial, railroad, and irrigation construction. Specialized in rock excavation and suction dredging. Intimate knowledge of costs, estimating and organizing. Available immediately. Apply to Box No. 1411-W.

CIVIL AND ELECTRICAL ENGINEER, Univ. of Man. '35 and '36. S.E.I.C. Experience in irrigation and mapping. Available at once. Location immaterial. Box No. 1418-W.

CIVIL ENGINEER, B.Sc. 1910, A.M.E.I.C. Married. Twenty-six years experience on heavy construction work, both field and office; rails, roads, power bouse, hotels, bridges, etc. Location immaterial. Available at once. Apply to Box No. 1470-W.

SALES ENGINEER, M.E.I.C. Age 50. Married. Several years in combustion and general machinery lines. Estimating and layout work (mechanical and electrical). Speaking French fluently. Executive ability. Apply to Box No. 1482-W.

Institute Committees for 1936

FINANCE

P. L. Pratley, *Chairman*
J. B. Challies
A. Duperron
F. Newell
J. L. Busfield

LIBRARY AND HOUSE

E. A. Ryan, *Chairman*
J. L. Clarke
W. G. Hunt
J. H. Landry
H. W. Lea

LEGISLATION

R. E. Smythe, *Chairman*
S. Young

PAPERS

R. L. DOBBIN, *Chairman*

PUBLICATION

H. Cimon, *Chairman*
J. A. Duchastel
A. A. MacDiarmid
P. L. Pratley
H. L. Trotter

PAST-PRESIDENTS' PRIZE

C. N. Monsarrat, *Chairman*
D. E. Blair
J. M. R. Fairbairn
J. A. Heaman
J. A. Wilson

GZOWSKI MEDAL

W. P. Copp, *Chairman*
A. F. Baird
A. R. Chambers
I. P. MacNab

LEONARD MEDAL

A. O. Dufresne, *Chairman*
A. D. Campbell
F. A. Gaby
H. F. Haanel
F. V. Seibert

DUGGAN MEDAL AND PRIZE

C. M. Goodrich, *Chairman*
W. A. Duff
C. R. Young

PLUMMER MEDAL

A. G. Fleming, *Chairman*
L. M. Arkley
W. L. Malcolm
H. J. Roast
N. C. Sherman

STUDENTS' AND JUNIORS' PRIZES

Zone A (Western Provinces)

H. N. Ruttan Prize

E. V. Caton, *Chairman*
H. J. McLean
S. Young

Zone B (Province of Ontario)

John Galbraith Prize

R. L. Dobbin, *Chairman*
F. Smallwood
J. A. Vance

Zone C (Province of Quebec)

Phelps Johnson Prize

(English) P. L. Pratley, *Chairman*
F. Newell
E. A. Ryan

Ernest Marceau Prize (Province of Quebec)

(French) A. B. Normandin, *Chairman*
H. Cimon
B. Grandmont

Zone D (Maritime Provinces)

Martin Murphy Prize

H. W. McKiel, *Chairman*
H. S. Johnston
G. A. Vandervoort

CONSOLIDATION OF ENGINEERING PROFESSION

G. McL. Pitts, *Chairman*
J. B. Challies
A. B. Crealock
A. R. Decary
G. J. Desbarats
F. A. Gaby
R. E. Jamieson
C. C. Kirby
O. O. Lefebvre
R. F. Legget, *Secretary*

BOARD OF EXAMINERS AND EDUCATION

H. M. White, *Chairman*
E. P. Fetherstonhaugh
J. N. Finlayson
N. M. Hall
J. W. Sanger
W. Walkden

SEMICENTENNIAL

J. L. Busfield, *Chairman*
R. L. Dobbin
A. Cousineau
F. S. B. Heward
R. Findlay
J. M. Fairbairn

HONOUR ROLL AND WAR TROPHIES

Col. A. E. Dubuc, *Chairman*
Fraser S. Keith
Brig.-Gen. G. E. McCuaig

RELATIONS WITH NATIONAL SOCIETIES

John Murphy, *Chairman*
R. W. Angus
A. B. Cooper
A. B. Crealock
J. M. R. Fairbairn
H. J. Roast

COMMUNICATIONS

G. A. Wallace, *Chairman*
J. L. Clarke
S. T. Fisher
W. A. Steel
J. H. Thompson
H. J. Vennes

WESTERN WATER PROBLEMS

G. A. Gaherty, *Chairman*
C. H. Attwood
Charles Camsell
L. C. Charlesworth
T. H. Hogg
O. O. Lefebvre
C. J. Mackenzie
S. G. Porter

PUBLICITY

J. M. Fairbairn, *Chairman*

DETERIORATION OF CONCRETE STRUCTURES

R. B. Young, *Chairman*
G. P. F. Boese
C. L. Cate
A. G. Fleming
O. O. Lefebvre
J. A. McCrory
C. J. Mackenzie
J. H. McKinney
C. N. Simpson
R. M. Smith
E. Viens