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Volume 26 Toronto, Feb. 5, 1914 Contents of this issue on page 285

The Canadian Engineer

A weekly paper for engineers and engineering-contractors

RAILWAY CROSS TIES

SUITABLE WOODS — NATURE OF MECHANICAL WEAR — PROTECTION — THE VALUE OF TIE PLATES — TYPES USED BY VARIOUS ROADS

By J. L. BUSFIELD, B.Sc., A.C.G.I., A.M. Can. Soc. C.E.

IN the construction and maintenance of a railway the cross tie is in itself an almost insignificant item, but when one considers the fact that the railways in Canada have to face an expenditure of over 10 million dollars per annum on ties alone, they have a bearing on the economics of railway management of much greater importance than would at first appear possible. This expenditure is one that is increasing every year. The statistics are not yet available for the year 1913, but the amount actually spent on ties by the steam and electric railways of Canada was $5,540,769 in 1911, and $9,373,869 in 1912, an increase of 69%, so that there is no doubt but that the figure for 1913 will be well over the $10,000,000 mark.

The causes of this large increase are many, but the most prominent are: (1) The larger number used; (2) increase of cost per tie; (3) increased use of the more expensive hardwood ties, and (4) the shorter life of ties. Analyzing these items separately, the first needs little comment as the increase is a natural one due to the growth of railway mileage; a small proportion of this item is also accounted for by item (4), namely, the shorter life of ties.

The increased cost per tie is mostly caused by the greater demand and diminishing supply. Some years ago the supply was so unlimited that practically no ties were imported into Canada, and the railways could obtain very nearly all they might require from points in close proximity to their own lines, thus reducing the cost of haulage. But in recent years the available supply has become reduced and localized so that the railways have had to import ties to quite a considerable extent, large quantities of southern hard pine being brought over 1,500 miles from Louisiana and Georgia. In 1912 the value of imported ties was approximately $1,700,000, or 20% of the total expenditure of Canadian railways on ties. The average cost per tie of all the ties used in 1911 was 39c., and in 1912, 44c., and with the prices prevalent during 1913 there is little doubt but that there will be a similar increase in the average price for the year just passed.

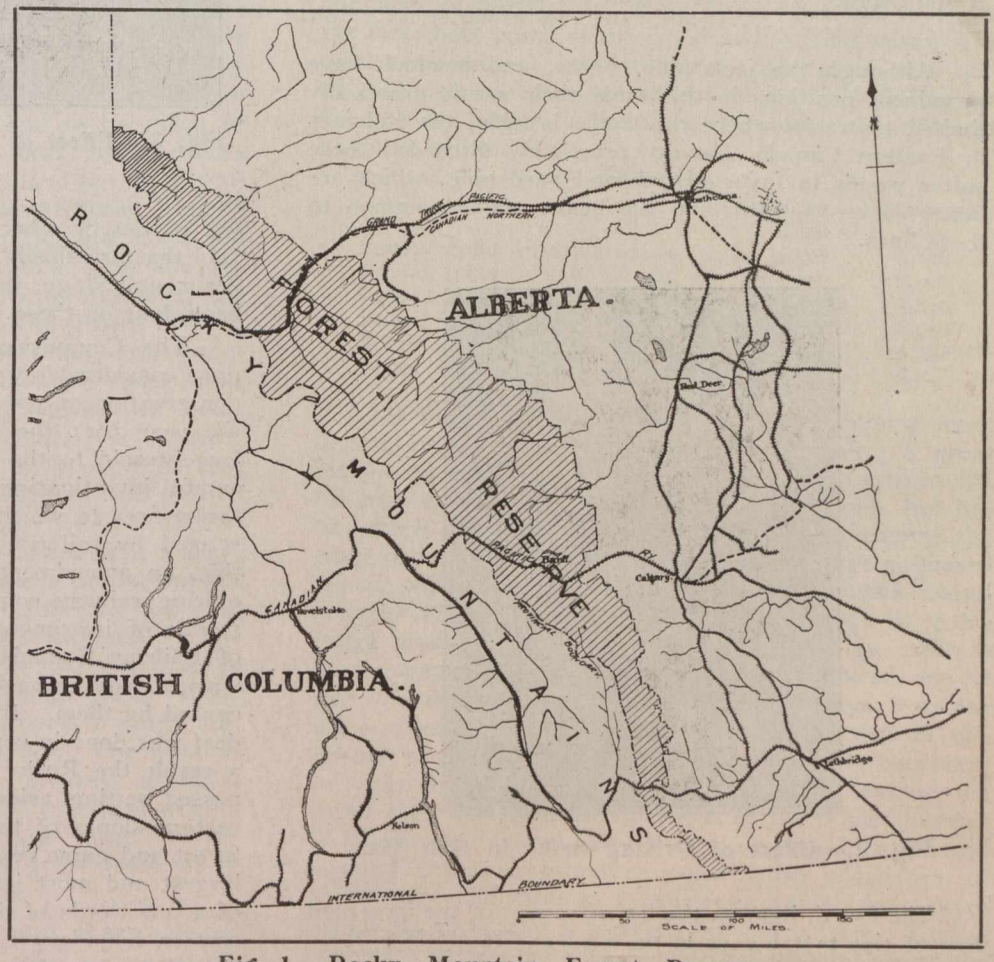

Fig. 1.—Rocky Mountain Forest Reserve.

There has been a steady increase in the use of hardwood ties to replace the softer kinds previously used. At one time there were more cedar ties used than any other kind, but in later years the number used has fluctuated considerably, while there has been a steady increase in the number of hardwood ties used, such as the oak and hard pine. In 1911 the percentages of these two kinds were 1.0 and .003 respectively of the total

number used of all kinds, while in 1912 these percentages increased to 4.4 and 3.1 respectively. There are about 19 different kinds of wood used for ties in this country and Table I. gives the approximate percentage of each kind used.

Table I.

Kind.	Properties.	Percentage.
Jack pine	Light, soft and durable	36.5
Cedar	Light, soft and durable	15.6
Douglas fir	Hard, strong and durable	10.2
Hemlock	Light, soft, not strong or durable, brittle	9.1
Tamarack	Heavy, strong, hard and durable	8.5
Western larch	Heavy, strong, hard and durable	5.6
Oak	Tough, hard, strong	4.4
Eastern spruce	Light and soft	3.9
Hard Pine	Hard, tough, elastic and durable	3.1
Chestnut	Light, soft, not strong	1.2
Beech	Very hard, strong, tough, not durable	0.5
Western cedar	Light, soft and durable	0.4
Maple	Tough, heavy, hard and not durable	0.2
White pine	Soft, uniform and durable	0.2
Birch	Heavy, strong, hard	0.2
Red Pine	Heavy, strong, not durable	0.1
Balsam fir	Soft, light, not durable	0.1
Western spruce	Soft, light, not strong	0.1
Elm	Heavy, hard, very strong	0.1

Although the jack pine, cedar, and hemlock have prominent positions in this table their use is practically limited to tracks where the traffic is light, the railways in Eastern Canada having practically discarded these softer woods in favor of oak and hard pine, which are better able to withstand the heavy traffic common to these lines.

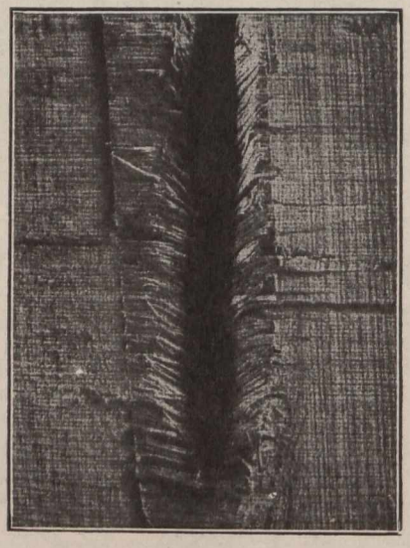

Fig. 2.—Effect of Driving Spike in Oak Tie.

The fourth item on the list of causes of the increased cost of ties to railways is the shorter life of ties. This at first may not be apparent, but it is nevertheless true; the actual time it takes for a tie to decay is no less to-day than it was in the past unless the decay is hastened by some extraneous cause—and that is what actually happens. As the traffic and tonnage over a track increases, so does the rail cutting and mechanical wear of the ties, and once the wood fibres are damaged in this way vegetable decay sets in much quicker, and the life of the tie is shortened by this decay, as well as by the mechanical disintegration.

As is naturally to be expected, both the railways and the governments are doing a great deal to counteract this tendency of increased expenditure on ties and timber, and briefly summarized, the following are the methods adopted for this end: Government legislation and conservation of forest lands; the maintenance of suitable tree plantations by railways; the reduction of mechanical wear by screw spikes, tie plates, etc.; the chemical treatment of ties to prolong their life; and the

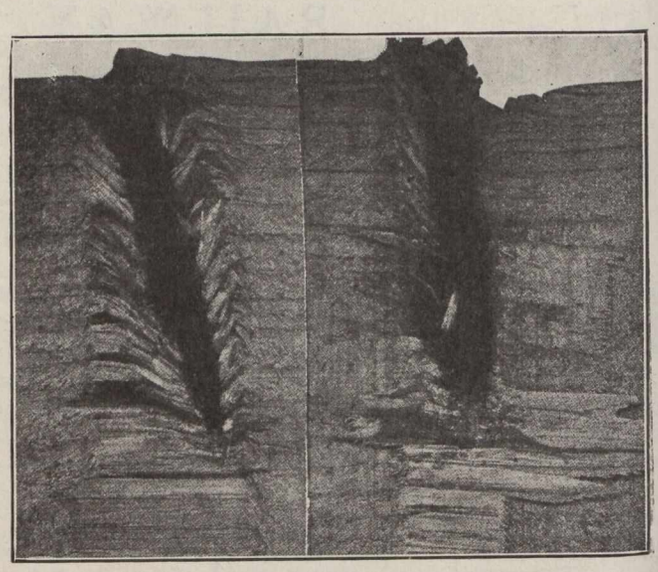

Fig. 3.—Effect of Spike on Tie After One and Three Years' Service.

use of ties of other materials than wood. It might be said that practically all these methods are still in the experimental stage, but it is of interest to note what has been done on these lines.

The Commission of Conservation of Canada has done considerable work in the past few years towards the conservation of the timber supply of the Dominion. In the year 1911 the attention of the Commission was largely paid to the prevention of forest fires, and from careful investigation it was found that about 34% of the forest fires to which causes could be assigned had been started by railway locomotives. As a direct result of this, an amendment was made to the Railway Act requiring railway companies to establish and maintain a service of fire rangers whenever so ordered by the Board of Railway Commissioners, and also requiring the railways to pay damages within certain limits for any fires caused by them. In addition to this legislation, a great deal was done in connection with forest reserves, and as a result the Rocky Mountain Forest Reserve Act was passed setting aside 17,900 sq. mi. in Alberta on the eastern slopes of the Rocky Mountains for a perpetual forest and game reserve. This national forest being the largest and most important in the Dominion, is worthy of a few words of description. As shown in Fig. 1, the eastern boundary is approximately defined by a line at elevation 4,000 ft., the western boundary is determined by the Interprovincial boundary, and the reserve rises to the west to peaks as high as 10,000 ft. The timber line is at an elevation of about 7,000 ft. The most useful trees found in this tract are the Engelmann spruce, the Douglas fir, and the Lodgepole pine. The Engelmann spruce is a tree with a light, soft wood, not very strong and found only in high altitudes. The Douglas fir is of the same species as some of the largest trees in the world, but does not reach such a size in the national

park as elsewhere. They average about 150 ft. high and 3 to 5 ft. in diam. The wood is usually very hard and strong and is useful for ties as well as for heavy construction work, piles, etc. The Lodgepole pine is a very rapid growing tree, has a strong wood and is used a great deal for all kinds of construction purposes.

A number of the larger railways of the United States have been carrying out experiments with plantations of their own on their outlying and other lands. In Table II. is given some of the work done and the cost of planting the trees.

Table II.

Railway and Location.	Kind of Trees.	First cost per 1,000.	Cost of planting per 1,000.
A. T. and S. F. at San Deguito, Cal.	Eucalyptus	—	—
C. B. and Q., Ottumwa, Iowa	Catalpa	$10.00	$20.00
Pennsylvania, various	Locust and Red Oak	5.00	5.00
L. and N., various	Catalpa, Walnut, Locust, Poplar	5.00	23.00
D. L. and W. In N. J. and N. Y.	Yellow Locust	23.00	12.00
G. H. and S. A., Texas	Catalpa	16.70	12.00
Southern, Wolf Trap, Va.	,,	19.40	7.80
Mich. Cent., various	,,	—	—
N. and W., Ivor, Va.	,,		—
S. A. and A. P. Ry., Skidmore, Tex.	,,	12.65	10.46
St. L. and S. F., Farlington, Kan.	,,	11.60	27.10

It will be noticed that the catalpa, locust and eucalyptus (or red gum) trees are the ones most favored for the railway plantations. These are trees which were until recently little known or used, but owing to many kinds of trees which were formerly quite plentiful, becoming more or less scarce, attention had to be given to those trees which would give the best results under artificial conditions. These trees all have the same property of very rapid growth. On the Atchison, Topeka and Santa Fe Railway ranch at San Deguito, Cal., 500 trees are planted every year of the blue gum and eucalyptus species. This tree is a native of Australia, but is successfully reared in California. It grows in low, swampy ground and also equally well in dry, arid mountain plains. It needs a warm climate as the young trees cannot withstand more than 2 or 3 degrees of frost. Freshly cut, the wood is pale in color, heavy, hard, durable, and very difficult to split. It is expected that by the time the trees are 20 yrs. old, they will yield 8 ties per tree, in addition to a quantity of by-products. The catalpa tree is a native of the Mississippi Valley, but has been naturalized in many other localities east of the Rockies. The wood is coarse, brittle and not very strong, but is very durable in contact with soil. The trees grow from 40 to 60 ft. in height and 3 to 6 ft. in diam., with well formed trunks and large white, faintly mottled flowers. The yellow locust trees are widely cultivated in the States east of the Rockies. The wood is tough, durable, and unequalled for torsional strength. It has been classed in the first rank of American woods. The trees develop very rapidly but are subject to the depredations of insect borers. They grow from 50 to 70 ft. in height and 2 to 3 ft. in diam.

Protection of Ties From Mechanical Wear.—Many experiments have been made and remedies suggested for eliminating the damage done to a tie by such external agencies as the spike, rail-cutting, etc. When an ordinary cut spike is driven into a tie the wood fibres are broken, torn and generally disrupted. At the time the spike is first driven the damage is comparatively small, but as time passes decay sets in with greater rapidity and the tie becomes rotten around the spike. In Fig. 2 is illustrated the effect on an oak tie of driving into it an ordinary cut spike. In Fig. 3 is shown the resulting effects after one and 3 years' service. One method of obviating this damage to the wood structure of the tie is to bore a hole in the tie slightly smaller than the spike itself, so that when the spike is driven in the usual way there will be practically no damage to the wood fibres. The resisting power of a spike driven into a bored tie is very close to that of a spike driven in the ordinary way. (See Table III.). The comparatively small amount of damage that is done to the tie by a spike driven into a bored tie is shown in Fig. 4. Another method which has been largely experimented with is the substitution of a screw spike for the ordinary cut spike. The screw spike is being adopted as a standard by some of the railways in the States to be used in conjunction with tie plates. The screw spike can be used either as a direct fastening to the tie, or, as is almost invariably done in Europe, it can be screwed into a wooden plug or "dowel" first screwed into the tie. The question of the advantage or disadvantage of the dowel is one on which there is considerable difference of opinion, but the tests show that the screw has a greater holding power when used in conjunction with the dowel than when driven directly into the tie. Since the advent of chemically treated soft wood ties, the hardwood dowel has a distinct advantage of distributing the strain over a large area of the soft wood and also permitting the preservative chemical to reach the innermost pores of the wood at the point where it is most required. A standard screw spike used with and without a dowel is illustrated in Fig. 5. Table III. gives the holding power, as obtained by tests, of different kinds of spikes.

Table III.

	Mean. Lbs.	Maximum. Lbs.
Square spike in unbored tie	4,558	6,826
Round spike in unbored tie	2,478	6,066
Square spike in bored tie	4,082	5,810
Round spike in bored tie	4,108	6,940
Screw spike in bored tie	6,916	10,842
Screw spike in oak dowel	8,170	9,724

Tie Plates.—The use of tie plates is becoming more general on all the larger railways every year. A great many experiments have been made in order to determine the best type for use under varying conditions, but unlike track rails, the tie plate has not yet reached the stage of being standardized by any of the large engineering or railway institutions, and one well-known manufacturer of tie plates, who started with about 2 or 3 different styles, is now manufacturing 40 or 50 different kinds, some of them so similar that when placed side by side it is difficult to pick out the original plates from the more recent innovations. There is a great deal of difference of opinion on all the different points necessary to make an ideal tie plate. For instance, taking the under side, there are the questions of the proper number of flanges, their depth, position, and whether they should be longitudinal or transverse, or whether some form of claw is not preferable to a flange; or again, some advocate a tie plate with a perfectly smooth bottom. Taking the upper surface without considering the problem of the shoulders there are the questions, should it be smooth or corrugated, channelled or bossed? Even with regard to the spike holes there are points of difference in the standards of almost every railway.

The purpose of a tie plate is to distribute the load from the rail over a larger area of the tie than that covered by the base of the rail in order to reduce the abrasion of the tie by the cutting of the rail; to prevent decay of the tie from the same cause; and also to assist

in keeping the track to gauge and line on curves and places where there is a tendency of the rails to spread. By fulfilling these requirements the tie plate has the great advantage that it enables a comparatively soft tie to be used to advantage in places where the traffic is heavy, and in addition to this it will also prolong the life of a hardwood tie. A sub-committee of the American Railway Engineering Association devoted a great deal of time to the special study of this subject and took measurements of the actual abrasion of ties in service with and without tie plates. The opinion formed by this sub-committee was that flanged tie plates of suitable design, width and thickness, and properly applied on

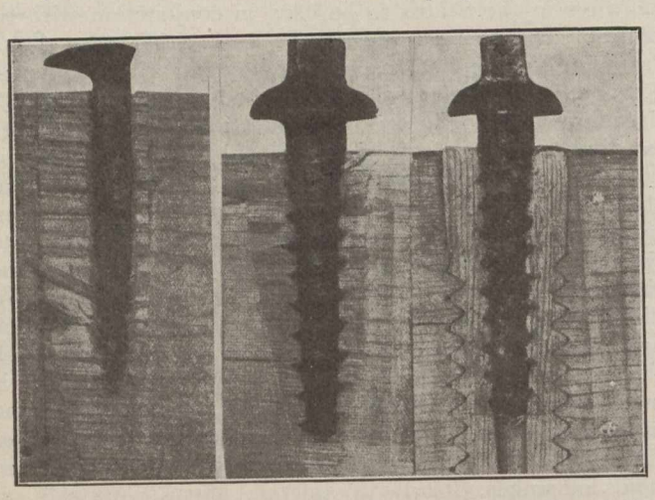

Fig. 4.—Cut Spike in Bored Tie. **Fig. 5.—Screw Spike in Bored tie (left) and With Dowel (right).**

tangents as well as on curved track will lengthen the life of cross-ties to 2 or even 3 years, and in the meantime the track will have been maintained in better surface and line and at less cost than could have been done without the plates. The averages of the results obtained of measurements of the abrasion of ties by rail-cutting are given in Table IV.

Table IV.—(White Oak Used for Ties Throughout) Abrasion of Ties by 85-lb. A.S.C.E. Rail, Without Tie Plates.

Alignment.	Traffic.	Age.	Outside edge of base of rail.	Inside edge of base of rail.	Remarks.
Tangent	Heavy	7 to 8 yrs	3/4 in.	3/8 in.	Single track
,,	,,	8 yrs.	1/4 in.	3/8 in.	East Bd. track
Curve (slag ballast)	Light	—	3/8 in.	3/8 in.	Inner rail, yard track, outer rail tie plated, no abrasion.
Tangent	Heavy	5 yrs.	1/2 in.	1/4 in.	East Bd. track
,, (gravel ballast)	,,	6 yrs.	1-1/16	5/8 in.	——
5 deg. curve	Heavy	—	3/4 in.	3/16 in.	Inner rail, outer rail tie plated, no abrasion.
2 ,, ,,	Light	—	5/8 in.	1/2 in.	Fast Pass. trains
1 ,, ,,	,,	—	1/2 in.	3/8 in.	,, ,,
Tangent	,,	—	1/4 in.	1/8 in.	,, ,,
8 deg. curve	,,	—	3/8 in.	1/4 in.	Tie plate on opposite ends of ties, no abrasion.

The requirements of a tie plate in general are as follows: The plate must be rigid enough to equally distribute the rail load over that part of the tie which it covers. If the plate is too thin it will buckle and the load will be transferred to the tie through a thin strip of metal the same width as the base of the rail, and the value of the plate for distributing the load will thus become nil. The tie plate must be rigidly held to the tie so as to prevent dirt and water collecting between it and the tie, and a great many railways favor the plate being so well embedded into the tie by means of flanges or claws so as to assist in the lateral displacement of the rail. In the case of flanges being used they should be deep enough to grip the wood but they should not be so deep as to damage the wood fibres, and when the flanges are placed longitudinally they help very considerably to make the plate rigid and the thickness can consequently be reduced.

In Table V. reports to the American Railway Engineering Association have been compiled to give a general idea of the different standards adopted in 1913 by the larger railways of the continent. A great deal of the variation is in the minor details and it must be borne in mind that what is suitable for one purpose would be absolutely unsuitable under different conditions. It is probable, however, that more universal standards will be adopted in the near future.

Table V.

Railway	Type of plate	No. of holes	Outside dimens. of plate
			Ins.
A. T. & S. F	Pronged or corrug'd, transverse flange*	4	9x7½
Al. Cent. & Hud. Bay.	Sellers patent	4	8½x6–80-lb.
B. & O.	Various	3	9x7–100-lb.
Bangor & Aroostock.	Claws	2	8½x5½–80-lb.
Boston & Maine	Longitudinal flange	5	8¾x5–85-lb. 9x5–100-lb.
B. R. & P.	Claws	4	9x7.
C. C. C. & St. L.	Longitudinal flange	4	8½x6–90-lb.
Chicago & Gt. West'n.	Longitudinal flange	4	8¾x6⅜.
Chicago & Alton	Corrugated and Sellers	3	6½x6–80-lb.
C. & N. W.	Corrugated Sellers pat. bottom	2	9x6–100-lb.
C. B. & Q.	Sellers pat., also transverse flange	2	9x6–100-lb.
Can. Pac. Ry.	Sellers pat., also corrugated	4	8½x6½–80-lb.
Denver & Rio Grande.	All types	4	8½x5–80-lb.
Frisco Lines	Longitudinal flange*	4	8¾x6½–80-lb.
Gt. Northern	Transverse flange	4	8½x6½–90-lb.
Grand Trunk	Longitudinal flange	4	9x6–100-lb. 8¾x5–80-lb.
Ill. Cent.	Flat bottomed	4	8¾x5⅜.
Lehigh Valley	Transverse flange	3	9x7–100-lb.
L. & N.	Claw	2	8x6–90-lb. 7½x6–80-lb.
Long Island	Longitudinal flange	4	9x6–100-lb. 8x6–80-lb.
Miss. Pac.	Flat, and corrugated	4	
Mich. Central	Transverse flange*	3	9x6–100-lb 9x5–100-lb
Northern Pac.	Longitudinal, for tans. and curves less than 3 deg.	3	8½x6–90-lb.
Northern Pac.	Pronged for curves over 3 deg.	2	8½x6–90-lb.
Norfolk & West'n	Longitudinal flange	4	9½x6–100-lb.
New York Cent.	One Longitudinal flange	4	9x6–100-lb. 8½x6–80-lb.
National of Mex.	Flat bottomed	4	
Pennsylvania, East	Transverse flange	6	13½x7–100-lb.
Pennsylvania, West	Pronged	4	9x7–100-lb.
Philadelphia & Read'g.	Flat bottom	4	10x7.
Pittsburgh & Lake E.	Flat bottom*	4	8½x7.
Rock Island Lines	Flat with screw spikes, trans. flange, with cut spikes*	4	9¼x6¼–100-lb
T. & North Ont.	Sellers patent	4	8½x6.

*Cut spike and screw. In all other cases cut spikes only.

From this table it will be seen that the great majority of railways are using a tie plate with some form of a flange, corrugation or claw which penetrate the wood of the tie, in preference to the smooth bottom plate. It has been claimed that a plate with a flange tends to break and check the tie, but the common experience seems to be rather to the contrary provided the plate is properly seated to the tie. There have been a great many cases put on record where ties with flanged plates have been removed from the track in a state of decay, but the

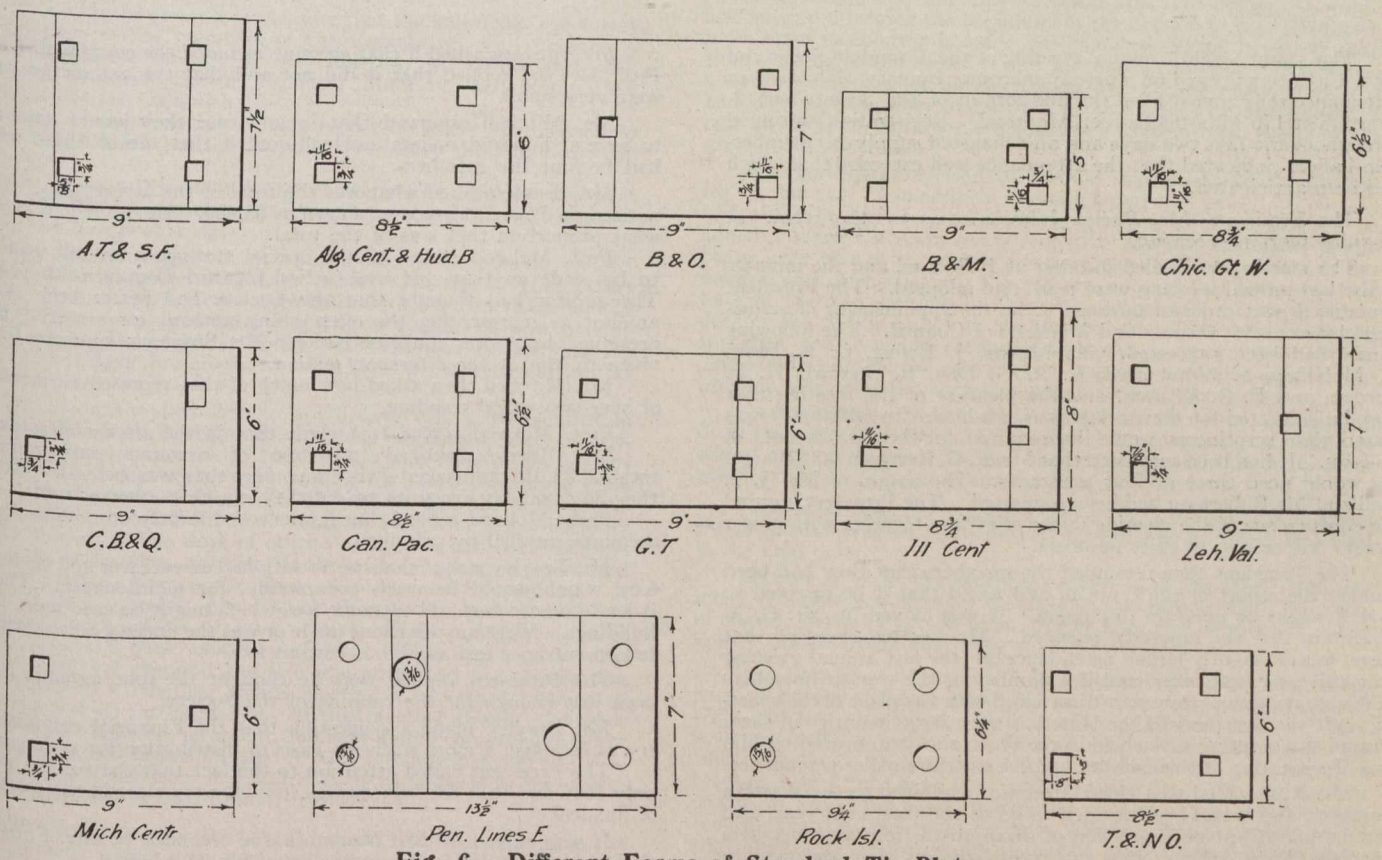

Fig. 6.—Different Forms of Standard Tie Plates.

portion under the plate has been no worse than the rest of the tie, and in many cases it has been found to be in ever better condition. Advocates of the transverse flange claim that the longitudinal flange does not give the necessary resistance to lateral displacement of the plate, whereas the transverse flange will give a big resistance to lateral displacement and at the same time the flanges do not need to be deep enough to damage the tie. On the other hand, it is claimed that the longitudinal flange causes less damage to the ties, adds greatly to the buckling strength of the plate, and at the same time keeps the plate seated to the tie well enough to provide the necessary lateral resistance. It will be noticed that the Sellers patent tie plate is mentioned frequently in Table V. This plate is rolled from wrought iron, the top has a shoulder in order to relieve the spikes of the lateral pressure of the rail. At the other end of the plate the top slopes down slightly in order to drain any water off its surface; to give the plate a grip on the ties it has corrugations running diagonally across its bottom surface. They are of moderate depth, as shown in Fig. 7, with the idea of enabling them to compress and grip the wood fibres without splitting open the tie, and admitting water and dirt. The plate takes sufficient hold on the wood surface to keep the track to gauge without pressure on the spikes.

In considering the relative merits of different tie plates the financial side of the question must not be overlooked. It stands to reason that the cost of the tie plate itself must not be so great as to negative any saving on the cost of the tie. It is difficult to put an actual value in dollars and cents on the services of the tie plate in keeping the track to line and gauge, but at the same time the plate should increase the life of the tie to such an extent as to pay for its own cost, provided it is properly designed and applied.

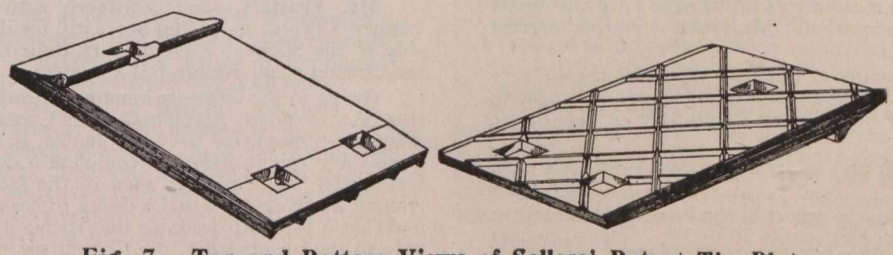

Fig. 7.—Top and Bottom Views of Sellers' Patent Tie Plate.

[The question of the preservation of ties by chemical treatment and the use of ties of other materials than wood will be dealt with in subsequent articles.—Editor.]

CANADIAN SOCIETY OF CIVIL ENGINEERS

DETAILED REPORT OF THE PROCEEDINGS AT TWENTY-EIGHTH ANNUAL MEETING, HELD IN MONTREAL, JANUARY 27, 28 AND 29TH — RETIRING ADDRESS OF MR. PHELPS JOHNSON — REPORTS FROM THE VARIOUS BRANCHES, ETC.

The twenty-eighth annual meeting of the Canadian Society of Civil Engineers opened on Tuesday morning, January 27th, with an attendance that almost filled the auditorium of the Society's headquarters at 176 Mansfield Street, Montreal. Registration continued throughout the first two days and an exhausted supply of membership badges indicated that the attendance well exceeded that which had been anticipated.

The President, Mr. Phelps Johnson, was in the chair at Tuesday morning's session.

The meeting was called to order at 10.30 a.m. and the minutes of the last annual meeting were read and adopted. The President announced next order of business to be the appointment of scrutineers for votes for Officers and Members of Council. The following names had been suggested, viz., Messrs. J. Ewing, G. E. Fiset, R. McKillop, S. Blumenthal, V. A. G. Dey, B. Stewart, H. P. Borden, and B. O. Eriksen, and the pleasure of the meeting that they be delegated for the work was ascertained. In addition it was stated that scrutineers would be required for the amendments of by-laws. It had been suggested that Mr. E. C. Kerrigan take charge. He would need three or four assistants. The names of Mr. J. S. Hall and Mr.Robertson had been suggested. The President secured the concurrence of the meeting in the selection, together with power to add one or two to their numbers.

The President then reminded the members that they had been handed the report of the Council, and asked that it be received so that it might be open for discussion. It was moved by Mr. G. A. Mountain that the report be received. Mr. Leofred observed that there was a slightly larger attendance at the last annual meeting than this year, and wondered if a number of the western members were absent because they were dissatisfied with the place of this meeting. At the last meeting, he stated, a very large majority of them wanted the meeting to be held in the West, and it appeared to him that the ignoring of their wishes had caused the smaller attendance.

Mr. Rust stated that this matter was explained to the Western members, and it had been decided to go to the West next year, and that he had heard no expression of disapproval from any members from the West. They were perfectly satisfied that the Society should meet out there next year, and were not dissatisfied with the arrangements.

The President added that the action of the Council in not going to the West this year had met with the entire approval of the Victoria branch. At the time the post card vote had been proposed and sent out no one considered the fact that there would, perhaps, be two new transcontinental railway lines in operation to the coast next year, and it was not considered that the San Francisco Exposition would be in progress together with an Engineering Congress.

Report of Council.—The meeting then received the report of the Council. It was moved by Mr. Rust and seconded by Mr. Butler that the report be adopted.

Mr. Brayley asked if this report included the financial statement. Prof. McLeod replied that it was only as far as page 17 of the report that was then under consideration. Mr. Rust's motion carried and the report was adopted.

The President then announced that the report of the Library Committee was before the meeting and asked for any comment in connection with the report of the Library Committee or the House Committee.

Moved by Mr. Marceau and seconded by Mr. Brown that the report be adopted.

The President brought up the report of the Financial Committee to be found in the same pamphlet (pages 26 to 30). The statement of revenue and expenditure was on Pages 26 and 27; assets and liabilities on Pages 28 and 29, and on Page 30 was given the cost of the new building up to date.

Moved by Mr. Papineau and seconded by Mr. Lawrence that the report be received. It was then opened for discussion.

Mr. Brayley asked the meaning of the $5,000 on Page 26 of the assets and requested that it be explained.

Prof. McLeod explained that the Society had that much cash in the bank bearing interest. If it were put in the ordinary current account it would not be bearing interest.

Mr. Brayley asked if that account included the commuted fees. Prof. McLeod replied that it did not and that the commuted fees were very small.

Mr. Mitchell observed that in any case they would amount to several hundred dollars and enquired if that meant those who had become life members.

Mr. Brayley asked what was the total of the arrears fees. He noticed on Page 26 they were shown as $5,000. He desired to know what proportion that was of the total.

Prof. McLeod stated that a special statement would require to be made on that. It was carried forward from year to year. The auditor had thought that the Society had better keep that amount as representing the outstanding amount for arrears. He presumed an answer could be had for Mr. Brayley's question and given to him at the afternoon session.

Mr. Mitchell then asked how much of that represented arrears of over two years' standing.

Prof. McLeod agreed to include that in the afternoon return.

Mr. Brayley noticed an item of accounts outstanding, totaling $3,036, and asked if that was more than was general. Were they 30 or 60 day accounts, or did they run over a longer term?

Prof. McLeod replied that it was based largely on outstanding accounts entailed by printing.

Mr. Brayley stated that the Society had arrears fees and current fees, which would be used, presumably, for maintenance. Then it had advance fees and entrance fees which might be used more for buildings. Were any divisions made or was the Society being operated on entrance fees as well as current fees?

The President replied that he thought the total revenue had been just enough for the running of the Society.

Mr. Brayley made a suggestion that the Financial committee try to establish a more scientific basis of distribution for next year.

The President called attention to the fact that the surplus was only $646 and that the Society was running very close in the matter of finances.

It was moved by Mr. Mountain and seconded by Mr. Francis that the report of the Finance Committee be adopted.

Committee Reports.—The President then announced the next business as the reception and adoption of reports of Committees on Track, International Electrotechnical Commission, Reinforced Concrete, Sewage Disposal, Conservation and Testing Laboratories.

Prof. McLeod observed that it was customary for the chairmen of committees to present these reports, but that he had a telegram from Mr. Safford, Chairman of the Committee on Track, that he could not be present.

Mr. Francis, Chairman of the Committee on Concrete and Reinforced Concrete then presented the report of that committee re standard specifications for concrete and reinforced concrete, with the following letter of transmittal:

Mr. Francis.—In accordance with the instructions of the Council I beg to hand you herewith, for discussion by the membership of the Society, a preliminary draft of Standard Specifications for Concrete and Reinforced Concrete.

Owing to the immense amount of work involved in the preparation of a Standard Specification for Concrete and Reinforced Concrete, the Committee has been unable, in the time at their disposal since their appointment, to complete a document with which they feel entirely satisfied. In view of the fact, however, that the last Annual Meeting expressed a desire to have a standard specification, and that it is highly desirable that such a document should be available to the membership, the Committee recommends the adoption of the draft now submitted, after it will have been discussed by the membership.

At the same time the Committee respectfully requests that it be continued for another year in order that the work may be perfected, and that further knowledge may be obtained regarding shear action in beams. Should the request be granted, Mr. Morssen has kindly consented to make a number of test specimens upon which Professor Brown and Professor MacKay have been good enough to undertake to experiment, in order that this subject may be more fully understood.

In submitting this draft I should like to call attention to the personnel of the Committee, which is composed of engineers in various branches of construction. It contains representatives of McGill University, University of Toronto, Ecole Polytechnique and the University of Manitoba, as well as those engaged entirely in concrete and reinforced concrete construction, in steel construction, in bridge work and in private practice.

In the course of our work, upon which a great deal of time has been spent both in private and in committee meetings by many members, very liberal use has been made of all the latest authoritative documents on the subject, not only in the English tongue but in French and German. In addition the Committee has been most fortunate in having Mr. Morssen search also the Austrian and Swiss literature.

It is with the greatest of pleasure that I acknowledge the hearty co-operation of the members of the Committee, and particularly the indefatigable interest of Mr. Mattice, Mr. Monsarrat, Mr. Morssen, Professor Brown, Professor MacKay, Mr. Rolph, Mr. Gillespie and Dr. Galbraith.

[For a complete copy of this report members are referred to Pages 198-203 of January 22nd, 1914, issue of The Canadian Engineer.)

Mr. Francis then moved that the report be received, and that the Committee be continued until next annual meeting with instructions to make a final report.

Mr. Brown suggested an amendment, if acceptable to Mr. Francis, viz., that the committee confer with similar committees of other engineering societies, especially with the American Society of Civil Engineers and Institution of Civil Engineers, now making investigations along similar lines, with the idea of unifying the work, and making it universally wide in scope, thereby getting the best results.

Mr. Francis replied that he would have very great pleasure in including Mr. Brown's suggestion with the motion if it were practicable, but that the committee had already made use of the reports of the other societies which were working for a long time along these lines. The Committee adopted their symbols, and had done everything possible to make the work conform with what other societies had been doing. The work of other Committees had been followed as closely as possible, not only in America, England, Ireland and Scotland, but in France, Germany, Austria, and Switzerland. It would be impracticable, Mr. Francis thought, to have a complete document ready inside of many years. These committees were composed of the most eminent engineers. They had a great deal of money at their disposal and this committee had not. Following the assumption of the last annual meeting it had merely presented the present draft for discussion. If this meeting allowed the work to go on, Mr. Morssen, as stated, had very kindly consented to make a series of special beams for the McGill Laboratories and the Professors of the University had stated their willingness to test them.

A discussion by Mr. Elmont followed:—

Mr. Elmont.—Mr. President, I would like to suggest that the specifications, which now deal comprehensively with both plain Concrete and Reinforced Concrete, should be arranged in such a way in the final draft, that the specifications for Concrete and those for Reinforced Concrete would be completely separated.

If they were bound in one pamphlet and the Reinforced Concrete specifications printed first, it would only be necessary to print in full a few sections for plain Concrete; while further information could be given by references to corresponding sections in the reinforced concrete specifications. As plain concrete and reinforced concrete structures are so widely different, I think that the specification would gain in clearness and practicability by this separation. A contractor who had to build a mass concrete structure according to this Society's specification for concrete structures, would, under the arrangement mentioned, find all the requirements his work had to meet under its own heading and concisely defined.

If it should be decided that it was desirable to separate the specifications, I would further suggest that the reinforced concrete specification be prefaced by a responsibility clause in accordance with the general practice followed by engineering societies.

As the specifications are arranged at present, Section 1, for instance, applies to all structures in which concrete is used. Undoubtedly, only Portland Cement should be used for reinforced concrete, but where economical conditions and the nature of the structure allow, it appears to me, that natural or slag cement should not be prohibited. This could be mentioned in the concrete specification, while the reinforced concrete specification would only permit Portland cement.

In Section 3 it is stated that the fragments of the crushed stone shall pass a circular hole 2½" in diameter. The maximum size for reinforced concrete is given in Sections 56 and 57, while it seems correct, also, to place these figures under Section 3 of "Materials." I would suggest, that instead of giving the maximum size of 2½", which, it might be stated, might quite properly be exceeded in a number of structures, that the maximum size depends upon the nature of the structure. It would, perhaps, be well to mention some of the structures in which the size must not exceed 2 or 2½".

As called for in Section 6, it is, no doubt, preferable that only fresh water should be applied to reinforced concrete, until further experiments have been made to determine the influence of the salt water, but for many mass concrete works, salt water is quite permissable.

With regard to the other paragraphs of the specification, I would like to submit that the headings "Method of Calculation" on Page 10, "Unit Stresses" on Page 12, and "General Requirement in Design" on Page 16, should be arranged as subheadings under a general heading called "Design."

The title of Section 19 might with advantage be changed to "Assumptions for Calculation" as they apply to all reinforced concrete design, and not only to beam and slab design. I would also suggest changing the beginning of the Section to read "Unless a more exact calculation is made, the calculation shall be based upon the following assumptions"; and placing Section 30, which is also a mere assumption, for the calculation, as "g"; also leaving out the 2nd, 3rd and 4th lines under "d", as these lines do not contain a new assumption, but simply a logical conclusion from the premises given in this Section.

The 2nd line of Section 20 I would suggest should be changed to, "A slab at the compression side of a beam may be.....", and after the last word in the first paragraph, might perhaps be added, "When the main reinforcement of the slab is parallel to the beam, only half of the above given widths should be taken as an integral part of the beam. I would recommend that the three first lines of the 2nd paragraph of Section 20 be left out, as in many designs the slab is placed at the bottom side of the beam over the supports, and so would not agree with the paragraph as it stands. The same would be the case if there was no reinforcing in the compression side over the supports, which is not impossible.

In reference to Section 21, I would submit to the Committee, if, in the interest of the public safety, it would not be advisable to adopt some regulation for flat slabs, perhaps in line with those given in the building code for the City of Cleveland.

Section 23 does not state the size of the test piece from which the ultimate strengths are determined; this will no doubt be added in the final draft.

Section 31 gives the physical properties of the steel reinforcement, but does not mention the chemical requirements. They are, of course, generally agreed upon, but as they can be given in a few lines I would submit that they should be stated.

The first line of Section 33 states that "not more than three parts of sand shall be added to one part of cement"; this applies to plain concrete structures, the mortar in reinforced concrete work is determined by Sections 36 and 37. The requirement that the mortar shall not be less than 1:3 is a rather severe one, mixtures 1:4:8 or even 1:5:10 have been and are being used with satisfactory results in numerous cases, where the stresses in the concrete are insignificant, i.e., the main point is weight. For all structures of any importance advance tests should be made compulsory in order to determine the voids and the proper mixture of the aggregates.

In Section 45 it is stated, that "the foundations shall be at least as large as the dimensions on the approved drawings." I would suggest that these words should be left out. Someone might think that this does not apply to the other parts of the structure.

Section 43 deals with the reinforcement in columns. As all experiments bear out the importance of a proper spacing of the ties and the hooping, I would recommend that it be said that the ties should not be spaced farther apart than the diameter of the column, and in no case should they be spaced more than 12", and that the hooping in columns, where it is allowed for in the calculation, should not be spaced more than 1-8 of the diameter and never more than 2½".

The concrete in slabs shall, according to Section 60, be deposited continuously with the concrete in the beams. As far as I am aware, no experiments or practical results prove the urgent necessity of this method of procedure, while numerous experiments plainly indicate that the slab can be concreted when the stem of the beam has set, without any detriment to the united action of slab and beam or to the transmission of shear forces at the joint. If the Committee decides to change this section it should be pointed out, as a matter of precaution, that the web reinforcement should be anchored carefully both in the slab and at the bottom of the beam, and that the joint must not be too smooth and must be thoroughly cleansed before depositing the concrete for the slab.

Some very good measures to avoid failures in reinforced concrete work are established by the regulations given in Section 63, the greater part of the failures which have occured being undoubtedly due to too early removal of the forms. Only a few other societies' reinforced concrete specifications contain such detailed rules as we will secure. Some specifications make a distinction between slabs and beams over and under 10 or 15-foot span. This, I think, is worthy of imitation, now that we are using slabs without beams, resting only on columns of as much as 20 or even 25-foot span, and simply supported reinforced concrete beams have reached the 100-foot mark.

Mr. Elmont closed his remarks by suggesting that the allowable stress of reinforced concrete be reduced. Using concrete of 1-2-4 mix—with hard limestone, the strength had been given as 2,000 pounds. It had been suggested that 30 per cent. be taken, which would give a stress of 600 pounds to the extreme fibre. This made a concrete structure so heavy that it is almost prohibitive.

Mr. Lawrence stated that this was a big subject and that the committee had been working on it a comparatively short time. He suggested that the matter be taken up in Montreal as well as by each of the branches, and that the discussions be turned over to the committee to sift as they saw fit and to make any changes that they might think wise in the specifications. They could report to the membership at large during the year. He felt that it would be unwise to adopt the specification as it stood.

Mr. Mitchell stated, as a member of the Toronto branch, that members were very anxious to discuss the specification in Toronto, but that copies had arrived in Toronto a very short time ago, so that they had had no opportunity. He thought that if the branches could take up the matter as suggested it would be a very great benefit.

The President inquired if there was any further discussion on the subject, and if Mr. Francis' motion covered the point.

A motion was then made by Mr. Francis, seconded by Mr. Morssen: That the draft report as submitted be received; that the discussion thereon be submitted by the branches to the committee with instructions to report to the council, and that the committee be continued until next annual meeting with instructions to make a final report.

Mr. Lawrence inquired if the report would be sent to all the members or would it be left over until next year.

The President replied that it appeared to him to be a matter for the Council, and as soon as they deemed it wise, it be put into form and sent out as a pro tem specification to report progress.

Mr. Lawrence thought that it could be safely left to the incoming Council and that the report should be placed in the hands of the membership before next year. The motion was then carried.

Owing to the non-arrival of the chairmen of the committees on Sewage Disposal and Conservation, the reception of the reports, in order at this point, was postponed until later on.

Concerning the report of the Committee on Testing Laboratories, the President, as a member of that committee, stated that all it had found to do had been to go once or twice to the Government and to represent the desirability of having testing laboratories.

Mr. Rust stated that he had met Mr. Keefer, the chairman, in New York, and he had said he would not be able to attend. Mr. Rust suggested that the committee be continued and that an occasional call be made upon the Government.

The President observed that there was a suggestion that the committee should be discontinued, and that the council take up the matter with the Government; whereupon Mr. Rust intimated that the matter could be left to the discretion of the council. It was then moved by Mr. Rust and seconded by Mr. Brown that the committee be discontinued and the matter left in the hands of the Council.

REPORT OF BOARD OF EXAMINERS.

The report for the Board of Examiners was given by Mr. MacKay. He remarked that four examinations had been held annually in former years with only a small number of candidates in attendance. During the past year examinations had been held only in May and November. The table in the report shows the number of candidates in each subject, also the number who passed and the number who failed. Two-thirds of the candidates of the whole passed. There had been only one or two candidates present on the primary subjects, i.e., for the membership of juniors. The standard so far adopted had been, he considered, rather easy and the examiners had given the candidates every opportunity and those who failed were certainly too weak to come under the definition as to those who were to be admitted to the Society to be qualified in design as well as practice engineering work.

A large number of men had been accepted on the presentation of certificates from their institutions. The majority of these certificates had come from Europe, largely from England and Scotland, although some had come from continental Europe. There had been great difficulty in such cases in maintaining the standard, because they had come from every sort of institution from a night school to institutions of very good standing indeed. In every case the committee had tried to give the benefit of the doubt to the candidates coming in. The board felt that these certificates should come before the educational committee since they were now in the position of saying who should be sent to examination and who should examine them. It would be more satisfactory to the board if some other party looked after the candidates, and the board could then entirely restrict its work to that of examining.

COMMITTEE APPOINTED RE GENERAL CLAUSES IN SPECIFICATIONS.

As other reports were not ready it was decided to postpone the reading of reports and hear any other matters which might be introduced. Mr. French, therefore, brought up the matter of having general clauses in regard to specifications.

Mr. French said that it would be well for the Society to appoint a committee to govern these specifications. In specifications there were certain things which were common to all. The members might readily call to mind clauses of a simple nature, and his experience had been that there was a wide variety to be met in such clauses. There was evidently a field of usefulness for a committee to consider the matter. He thought that the study of general clauses would be of great benefit to engineers.

Upon the suggestion of the President, Mr. French moved that the matter of appointing a committee to consider the matter of general clauses in specifications be left with the Council. The motion was seconded by Mr. Thomlinson.

The President remarked that formerly the matter of specifications and contracts had been taken up by each department and questioned whether it was practicable to make any specific rules.

Mr. Butler stated that in the province of Quebec the statutes protected the owner sufficiently, whether the engineer and contractor were covered by specifications or not. The province threw upon the engineer and the contractor or architect, as the case might be, the full responsibility for any defect that might develop within five or ten years the exact time having slipped his memory. He knew of a case which had gone to the Privy Council. It was held that the contractor had the onus upon him of knowing the defects of the foundation which were not exposed. This was the spire of St. James Cathedral. In every state of the United Stattes except Louisiana, and in every province in Canada except Quebec, the obligation was upon the contractor. He thought it would be of assistance if the Society could establish some sort of a standard in regard to specifications.

Mr. Francis expressed his belief that it would be very difficult to make a comprehensive specification to include all the trades with which an engineer had to deal. However he thought it would be an excellent thing for a committee to engage in the work of drafting special clauses.

A motion was put by Mr. French that the Council appoint a committee to consider the drafting of uniform general clauses in specifications and contracts which might be used by the profession in conjunction with specific clauses suited to the particular work on hand. He added that if the Society appointed a committee and made a report of their findings, that report would be of great assistance to the engineer in writing up his specifications. He had experienced trouble in writing up specifications, having left out clauses, or at other times put in a great deal more than was necessary.

Mr. Mitchell was inclined to believe that it was a very large order. He felt in favor of the matter being investigated, but was doubtful whether a committee could bring in an actual draft, particularly in a year's time. He understood the motion to say: "Consider the drafting of such a condition." He thought that if such a committee brought in a report on the advisability of the matter for next annual meeting, it would be all could be expected, and then at that meeting the recommendation of a general character which they had made could be discussed and then, if it was thought wise, the committee could be continued to carry on the details.

Mr. French agreed that this was a larger order, but it seemed to him that if a committee were appointed to consider the advisability of the matter and to report to the society at the next annual meeting little progress would have been made. The only thing to do would be to try; and it would be very much better for the committee to make an honest attempt to draw up such general clauses, unless the difficulties were such that they could not be surmounted. If the work progressed satisfactorily no member would begrudge the necessary time to make the trial complete.

The President asked Mr. French if it was his wish that this committee be appointed at the meeting or that it be left in the hands of the council; whereupon Mr. French expressed no preference in the matter. He merely desired to bring it to the attention of the Society. Mr. French's motion then carried.

Mr. Brown, managing engineer of the Mount Royal Tunnel, brought up the matter of giving the members an opportunity of seeing the tunnel on Thursday afternoon at 3 o'clock. Instructions were given for everyone to

prepare for a walk of two miles under Mount Royal, and not to expect to find the tunnel in any way dry.

Mr. White, Chairman of the Committee on Conservation, had arrived, and, at this stage read his report on Conservation. (See Page 204, The Canadian Engineer, for January 22nd, 1914). It was adopted, with the exception of the last six paragraphs., i.e., down to "Federal Government." Opposition to the passing of the report in toto was raised by Mr. Butler, who objected to the references to denatured alcohol, as not being along the lines of the Society. He objected to its undertaking to prescribe the policy for the Government with respect to alcohol. He expressed similar feelings in connection with the report's reference to sawdust utilisation.

Mr. White, very willingly, agreed that the portion objected to be dropped, whereupon his motion to adopt the report was seconded by Mr. Mitchell, and carried.

A motion was then put by Mr. Mitchell, which read as follows:

"That this Society commends the work of investigation being done by the Hydro-Electric Commission of the Province of Ontario, with respect to the control of the Grand River, and expresses the hope that the Commission will continue similar investigations throughout the province;

"That the Council communicate this resolution to the Commission."

Mr. Dion objected on the ground that the Hydro-Electric was not only a Commission, but was engaged with private interests. He thought it unwise for the Society to take any definite interest..

Mr. Mitchell contended that the purport of his motion was entirely in accord with the policy of the Society, and felt that it should commend such scientific investigation of great value to the public.

Mr. Coutlee remarked that it was rather difficult to make a recommendation other than a very general one, adding in a jocular manner that such commendation could not very well exclude the Ottawa River work, which brought loud applause from all members familiar with his connection with the same. Mr. Coutlee occasioned further smiles by his remarks concerning the Grand River and his suggestion that the vote of commendation be sent to those who live along its banks.

Col. Anderson did not think there was anything wrong in the procedure. It was not a question of the work. It seemed this Commission had done some scientific work as well as commercial work and that the motion was commending the scientific part of it.

The President called for a rising vote upon the motion, but it was lost.

The meeting then adjourned until the afternoon, the visiting members going to the Windsor Hotel, where they had a delightful luncheon as the guests of the Montreal members.

The meeting adjourned until 3.30 p.m.

TUESDAY AFTERNOON SESSION

The President announced that there were two additional reports on hand, one from the Cement Committee and one from the Sewage Disposal Committee. No member of the Cement Committee was present at the time to read the report, whereupon the President submitted two recommendations, one that the Council should select two general subjects out of the ten for first consideration and report. The second was in view of the volume of work done, and indicated that the membership should be increased from three to ten. The President then inquired if it was the pleasure of the meeting that the committee be continued, and that its recommendations be left in the hands of the incoming Council. Affirmed unanimously.

The President then called attention to the report of the Sewage Disposal Committee, observing that Mr. Chipman, a member of that committee, was present and intimating that the meeting would be pleased to hear from him. The report being brief, the secretary was asked to read it. Mr. Chipman then formally presented it to the Society.

The President inquired if it was the desire of the committee that the matter be left in abeyance, but Mr. Chipman, as a third member of the committe, felt hardly in a position to say. Mr. Johnson remarked, however, that it was rather important that the meeting take some action. Col. Anderson then moved that the report be adopted, and that the committee be retained.

Mr. Leofred rose to remark that this work was becoming more and more important, and thought the House of Commons was hardly prepared to meet the growing agitation. It would need a great deal of further study to see to what extent the towns were in a position to make a decision. He referred to the city of Verdun as bearing out his remarks. There was a liability of towns by reason of their inability to cope with the situation, and their inability to arrive at any decision on the matter, suffering severely through lack of proper knowledge and enormous expenditures. There was no question but that the matter required a great deal more study and investigation, and there was, in his opinion, no lack of work for this committee.

It was moved by Col. Anderson, and seconded by Mr. Mountain, that the committee be continued, with power to increase their membership. Carried.

It was then moved by Mr. C. H. Mitchell at the request of the president, and seconded by Mr. Francis, that the report of the committee for Cement be left until the next meeting.

COMMITTEE ON IMPROVED ENGINEERING SERVICE.

Col. Anderson, as a member of that Committee, and in the absence of its Chairman, stated that the idea of the Committee was to approach the Government with the intention of having the Engineering Service put on a more permanent basis, and that it be established with promotion and super-annuation. Most of the engineers in the employ of the Dominion Government were temporary employees. Reports had been made to the late Government with regard to this matter, and the Committee had been promised that the question should be taken up by the legislation. But since that time the Government had changed and it was necessary to begin the work over again. The present Government, especially the Minister of Public Works, had received the Committee very cordially, and had promised that the matter should be taken up in Parliament, but up to the present no action had been taken. It was very desirable, however, that the Engineering Service of the Government be put on a much better footing.—Applause.

Mr. Leofred remarked that if anything was to be done it would be well for a delegation to go to Ottawa to try and accomplish the aim in Colonel Anderson's remarks. The motion that the Committee be continued was carried unanimously.

The President announced the next report as that of the Educational Requirements Committee, and asked Mr. Marceau, the Chairman of that Committee, to submit his report.

Mr. Marceau stated that there was very little to report, and it was moved and seconded that the Committee be continued.

Mr. Johnson then took up the report on Steel Bridge Specifications and upon motion by Mr. Duggan, seconded by Mr. Butler, it was decided that this committee be also continued.

Upon taking up the remaining reports, that from the Committee on Rails, Mr. Mountain, as a member of the Committee, stated that it had done a lot of good work, but was not yet prepared to make a final report. They desired that it be continued, and wished to add the names of Mr. Butler and Mr. Stewart. These gentlemen, having consented to act, the motion was seconded by Mr. Rust and unanimously carried.

Mr. McLeod announced that at the request of Mr. White, the Chairman of the Committee of Conservation, the members of that committee meet Mr. White at the adjournment of the afternoon session.

While on the matter of committees, Mr. Mitchell proposed the formation of a Committee on Cast Iron Water Pipes and Specials. A report had been submitted by a committee some four years ago, but since that time it had not been worked upon either by the American Society of Civil Engineers or by our own Society. There had been found, however, matters in which improvement could still be made by other societies ,and they were making further studies. Mr. Mitchell, therefore, thought it was incumbent on the Society to do so as well. He proposed that a committee beformed to report at the annual meeting next year, and suggested the names of the following gentlemen:

Messrs. T. C. Irving, Jr., Chairman: Newton J. Ker, A. Currie, F. H. Pitcher, C. H. Mitchell, F. X. Leofred, C. L. Fellowes, and others.

Mr. Pitcher seconded this motion.

Mr. Irving moved that the committee appoint its own chairman, and Mr. Leofred, in seconding Mr. Irving, said he thoroughly agreed that the committee appoint its own chairman.

Mr. Mitchell, on a reminder from the Chairman that the minutes contained a ruling to this effect, said he would be quite willing to alter his motion to read in accordance with the bylaws.

Mr. Johnson then stated that the resolution as moved was that a committee be formed for Cast Iron Water Pipes and Specials composed of the afore-mentioned gentleman, and it was carried unanimously.

Col. Anderson then stated that if there was nothing before the meeting he would like to bring forward the resolution, following up what he had said with regard to the work done by Government engineers. He remarked that he had sent this notice of motion in to the Society over a month ago, expecting it would be sent out in printed form to the members. Continuing, Colonel Anderson said that he did not know if it was necessary to say much about the matter, as every engineer knew these facts, and the attention of the Government should be called to remedy the defects. The Dominion had good facilities at its disposal for obtaining the best results, but the fault appeared to be with the Government itself; there was absolutely no way in which a Government engineer could find out what plans were avail-

able in other Government departments, and this, in itself, was a very great defect. As Colonel Anderson had before stated, the committee had reported to the late Government, and it was now time for the present Government to have it turned up and more action taken with regard to it.

Mr. Butler remarked that the whole of the questions involved in the survey was in the hands of the Department of Militia and Defence, and that they might be prevailed upon to take up the matter, and if possible put into effect the recommendations made by the Commission.

Mr. White, in replying to Colonel Anderson's references to the Government methods in matters pertaining to engineering generally, said it was simply a question of convenience. He was of the opinion that if the Canadian Government could be induced to establish an Engineering Corps, there would be no question then as to the establishment of the engineers in the employ of the Canadian Government.

The Chairman then announced the next order of business to be the reading of the reports of the branches.

REPORTS OF THE SOCIETY'S BRANCHES

CALGARY BRANCH FORMED

The first step toward the formation of the Calgary branch was taken in 1912, when Mr. J. T. Child invited a few of the members of the Society, living in Calgary, to meet in his office in the City Hall on July 2nd, to discuss the advisability of forming a branch in Calgary. While those who attended this meeting (six in number) were heartily in favor of forming a branch in Calgary, no definite steps were taken until March, 1913, when a circular letter, bearing the names of J. T. Child, H. B. Muckleston and F. H. Peters, was sent to all the members of the Canadian Society of Civil Engineers residing in the vicinity of Calgary, asking them to attend a meeting in the Government Irrigation Office in the old Post Office Building, on March 12th, 1913. This meeting was attended by nineteen corporate members and one student, all of whom were in favor of starting and signified their willingness to support a branch in Calgary. By-laws were adopted, temporary officers elected and subscriptions started at this meeting. Shortly after a formal application was forwarded to the Parent Society and the Calgary branch became a fact. Another meeting was held in the Government Irrigation Office on June 21st, 1913, and at this meeting the following officers were elected to act until the Annual Meeting in December:—Chairman, H. B. Muckleston; Secretary-Treasurer, P. M. Sauder; Executive Committee, H. B. Muckleston, F. H. Peters, A. S. Dawson, E. L. Miles and P. M. Sauder.

Owing to the fact that a very large percentage of our members are engaged in work which takes them out of the City during the summer and fall, no regular programme was attempted during the summer, but a club room has recently been rented and it is expected that a regular programme of meetings, at about two weeks intervals, will be carried out during the winter and spring.

Messrs. T. E. Robinson and P. J. Jennings represented this branch at the Annual Convention of the Western Canada Irrigation Association, in Lethbridge, on August 4th, 5th and 6th. last, while Messrs. H. B. Muckleston, F. H. Peters and P. M. Sauder, of this branch, represented the Parent Society at this Convention.

H. A. Moore, General Manager of the Calgary Power Company, extended an invitation to the members of the branch to visit the new dam and power plant under construction at Kananaskis Falls, which a party of thirty-two accepted on November 29th. This trip was both pleasant and interesting.

The annual meeting was held on December 6th. The Secretary-Treasurer's report at that time showed the total receipts to date (subscriptions only) as $300.00, total disbursements $31.00 and balance in the bank $269.00. The chairman and secretary-treasurer were re-elected to serve another year and together with F. H. Peters, A. S. Dawson and G. Romanes, form the Executive Committee for 1914.

The year was closed by a dinner at 6 p.m., on Decmeber 30th, at which J. S. Dennis, Assistant to the President of the Canadian Pacific Railway Company and a member of the Council of the Canadian Society of Civil Engineers, was the guest of honour and gave a very interesting address on "Early Surveys and Surveyors of Western Canada." Respectfully submitted,

P. M. SAUDER, Secretary-Treasurer.

Calgary, January 10th, 1914.

FEW PAPERS AT KINGSTON

The following is all the report I have to make for Kingston:

The Annual Meeting of the Kingston branch was held on Jan. 23rd, and the following officers were elected for the current year: Chairman, Alexander Macphail; Sec.-Treasurer, L. W. Gill; Executive Committee, L. Malcolm, J. B. Cochrane and G. C. Wright.

On account of the small membership of this branch, there is not much incentive to the writing of papers for branch discussion. Consequently only a limited number of meetings were held during the past year. Most of these meetings were called primarily for the discussion of proposed amendments to the by-laws of the Society.

Respectfully submitted,

L. W. GILL, Sec.-Treasurer.

Kingston, Ont., Jan. 26th, 1914.

OTTAWA'S SPLENDID REPORT

On behalf of the Managing Committee of the Ottawa Branch we take pleasure in submitting the following report for the year 1913 namely:

Annual Meeting.—This was held as usual at the beginning of last October, and resulted in the election of the following officers for the season of 1913-14, namely: Chairman, G. A. Mountain; Managing Committee, M. F. Cochrane, F. J. Delaute, W. J. Dick, Alex. Gray and W. S. Lawson; Secretary-Treasurer, A. B. Lambe.

The standing Committees were afterwards struck as follows, namely: Entertainment, W. J. Dick (Chairman), G. G. Gale and John Murphy.

Papers, Alex. Gray (Chairman), F. C. Askwith, W. S. Lawson and R. F. Uniacke.

Library, F. J. Delaute (Chairman), Valmore Denis, N. J. Slater and J. C. Stewart.

Rooms, M. F. Cochrane (Chairman), W. F. McK. Bryce, K. M. Cameron, and G. B. Dodhe.

The district Councillors are C. R. Coutlee, Ottawa, for 1911-12-13; D. McPherson, Ottawa, for 1912-13-14; S. J. Chapleau, Ottawa, for 1913-14-15.

The District Representative on the Nominating Committee is James White, Ottawa.

Membership.—Quite a number of changes have taken place during the year, as our members are constantly coming and going, but, except in the Student and Ottawa Associate classes, the net results are slight gains, as will be seen from the following table.

	January 1913	January 1914
Hon. Members	3	3
Members	49	51
Associate Members	112	116
Ottawa Associates	25	24
Juniors	12	15
Students	82	28
Totals	283	237

We much regret having to record the death during the year of three members, namely, Messrs. E. Jodoin, H. F. Cole and R. W. Farley, and the permanent diasblement of an Ottawa Associate Mr. James Fyfe.

Papers and Meetings.—Our Papers Committee has been very fortunate in being able to present before the branch a number of most valuable addresses, many of which have been of interest to not only our own members but also to quite a large section of the general public. This has produced in several instances attendances far too large for our own rooms, in which cases we have been favored with the use of the Carnegie Library or the Normal School. The following is the list of papers given before the Branch in 1913, namely:

"Town Planning," Mr. N. Cauchon, Ottawa.

"Underground Conduit Construction," Mr. A. A. Dion, Ottawa.

"A Holiday Trip to the Panama Canal," Mr. J. Murphy, Ottawa.

"Waterways versus Railway Transportation," Mr. James White, Ottawa.

"Railroad Signalling," Mr. R. F. Morkill, Montreal.

"Street Railway Track Construction," Mr. R. M. Hannaford, Montreal

"The Coquitlam Dam," Mr. G. R. G. Conway, Vancouver.
"Economic and Social Effects of Transportation," Dr. Adam Shortt, Ottawa.
"Automatic Cab Signalling," Mr. H. A. Dupre, Ottawa.
"Economics of the Panama Canal," Mr. James White, Ottawa.

Many of the above addresses were illustrated by lantern slides, and, as has already been stated, all were well attended, the average number lately present being close to one hundred, several of the audiences containing a fair proportion of ladies. The Meetings are held on the first and third Thursdays of each month throughout the winter season, namely from October to March inclusive.

Our Managing Committee meets regularly at 1 p.m. on the first Monday of each month, with special meetings as are from time to time found necessary.

Entertainment.—The Entertainment Committee this season organized for the Branch a most delightful Dinner, held on December 4th at the Chateau Laurier, one hundred and fifteen being present. As a further means of promoting mutual acquaintance among our members a system of monthly lunches has also been inaugurated.

Library.—This is gradually working into fairly good shape, the Branch having been the recipient of quite a number of books, to the donors of which we are much indebted, and the Reading Room being equipped with all the more prominent engineering magazines.

Rooms.—These remain as heretofore, because, while it is fully recognized that they are not entirely suitable for our purpose, our funds have not permitted us to contract for larger premises. It is hoped, however, that we will not only be able to get larger and better quarters in the near future, but also to equip them with a lantern, blackboard, etc.

In the meantime we are under many obligations to the authorities of the Normal School and Carnegie Library for having so kindly loaned us their meeting rooms when ours were inadequate to hold our audiences, to the Conservation Commission for the frequent use of their lantern, and to the Ottawa Electric Company for special services from which to operate it.

Finances.—The furnishing of our rooms has, up to the present, made serious inroads into our income. but we are now substantially clear of that account, and so expect that in the near future we will be able to provide somewhat more liberally for some other pressing necessities of the Branch.

American Society of Civil Engineers.—As you are aware, the above Society honoured Ottawa by making this City the meeting place for their 1913 Summer Convention. Through the energy of a Committee, of which Mr. C. H. Keefer was Chairman and Mr. S. J. Chapleau, Secretary, the local members of the American Society and the Ottawa Branch of the Canadian Society, assisted by very kind and generous support, financial and otherwise, from the Dominion Government, and by many private contributions, were able to provide what was universally conceded to be most excellent entertainment for the four hundred odd members and guests of the American Society who came to the Convention.

All of which is respectfully submitted:

GEO. A. MOUNTAIN, Chairman; A. B. LAMBE, Sec.-Treasurer.

Ottawa, January 10th, 1914.

QUEBEC REPORTS PROGRESS

The Council of the Quebec Branch of the Canadian Society of Civil Engineers presents the following report on the work of said branch during the year 1913:

Roll of the branch:—At present, the membership stands as follows: Members, 20; Associate Members, 38; Associates (branch), 2; Juniors, 12; Students, 23; Total, 95.

Annual Meeting:—The Annual Meeting of the Quebec branch was held on January 20th, 1913, under the Presidency of Mr. L. A. Vallee. The following officers were elected for the year 1913:—President, A. R. Decary; Secretary, A. Amos; Councillors, J. F. Guay, S. S. Oliver and H. Ortiz.

The past-presidents are A. E. Doucet, P. E. Parent and W. D. Baillarge.

Meetings:—The Quebec branch held 10 Business Meetings during the year 1913. Papers, etc., submitted by the Council of the Society and by the different branches were discussed. The proposed amendments to the By-law No. 8 were unanimously disapproved by the Quebec branch. This branch is of the opinion that the Annual Meetings of the Canadian Society of Civil Engineers should be held at its Headquarters. One conference on Good Roads and Road Construction was made by Mr. Gabriel Henry, Chief Engineer of the Provincial Department of Highways. This conference was most interesting and greatly appreciated; the president in proposing a vote of thanks to Mr. Henry, expressed the desire that the example given by this gentleman should be followed by all the members of the Quebec branch.

A. R. DECARY, President; A. AMOS, Secretary.

Quebec, January 17th, 1914.

TORONTO HELD ANNUAL MEETING ONLY

The executive of the Toronto Branch begs to present herewith the Annual Report for the year 1913. The services of a very active and able worker in the interests of the Society were lost when Mr. Parker Kemble left last February to take up his residence in Cincinnati, Ohio. He was on the Executive of the Branch and it was due to his efforts that our Library is in its present satisfactory condition.

A card index has been prepared, under the direction of the Library Committee of the Engineers' Club, of the combined libraries of the Toronto Branch, The Association of Ontario Land Surveyors, and the Ontario Association of Architects. These books are all located at the Engineer's Club and will by this means be accessible to all members of the three societies. Reference is also made on the cards to technical books on the shelves of the Toronto Reference Library and of the University of Toronto Library, so that excellent opportunity is afforded for consulting the authorities on almost every subject.

The membership of the Toronto Branch this year is as follows: Members, 42; Associate Members, 102; Associates, 8; Juniors, 28; Students, 35; Total, 315.

These figures represent the names on the roll in October 1913, and show an increase over the figures for 1912 of 16 corporate members, 1 associate and 6 juniors, and a decrease of 8 students.

This last figure is very much to be deplored in Toronto, where 100 new men are registering in Science each year, and the present Executive begs to suggest to the officers for the following year that some special means be adopted for reaching the younger men, and interesting them in the work of the Society. The formation of an Association of Students, as is done in connection with the Institution of Civil Engineers, would, no doubt, serve this purpose. Papers could be read by the students and trips of inspection made that would prove to be of great interest and benefit.

The lack of interest in the meetings by the members has been responsible for the fact that no papers were read before the Branch this year, and it is hoped that papers of sufficient interest to attract a good attendance at the meetings in the coming year will be secured. The officers for the year 1914-15 are: Chairman, A. F. Stewart: Hon. Sec.-Treas., J. S. Galbraith: Executive Committee, J. G. G. Kerry, C. H. Mitchell, Prof. P. Gillespie and E. A. James (ex officio).

Respectfully submitted,

E. A. JAMES, Chairman; A. B. GARROW, Hon. Sec.-Treas.

Toronto, January 20th, 1914.

VANCOUVER DID GOOD WORK

The present membership of the Branch is 146, distributed as follows: Members, 42; Associate Members, 74; Associates, 1; Juniors, 11; Students, 18.

During the year the Branch has held twelve meetings besides the meetings of the Convention of the British Columbia Members, held here on the 12th and 13th December. The following papers were read:

"The Pulp and Paper Industry in B. C.," by C. H. Vogel.
"The Burrard Inlet Joint Sewerage Scheme," by A. D. Creer,
"The Outlook for Mining in B.C.," by C. E. Cartwright.
"Some Public Works and Explorations in B.C.," since 1880. by F. C. Gamble.
"Modern Methods in the Manufacture of Portland Cement," by H. K. G. Bamber.
"Coquitlam-Buntzen Hydro-Electric Development." by G. R. G. Conway.
"Stave Falls Hydro-Electric Development," by R. F. Hayward

At the meeting of January 20th, the following officers were elected: Chairman, G. R. G. Conway; Vice-Chairman, L. G. Robinson; Secretary-Treasurer, F. P. Wilson; Executive, C. E. Cartwright and W. A. Clement; Auditors, A. D. Creer and H. P. Archibald

At the meeting of April 21st new by-laws were adopted. The by-laws increased the Executive Committee from five to seven, the date for the election of officers was changed to May, the retiring officers to hold office until the opening meeting in October. Messrs. C. G. DuCane and A. D. Creer were elected to fill the vacancies on the executive, and it was decided that the present officers should hold office until October, 1914.

The second annual dinner was held at the University Club on March 29th. About one hundred and ten members and guests were present. During the summer months, the following excursions were arranged by the branch, and many of the members attended: May 10th, to Coquitlam Dam, through the courtesy of the Vancouver Power Co.; June 6th, Special train over Saanich Railway, provided by the couetrsy of the B. C. Electric Railway, to Bentwood Bay, where the Steam Turbine Plant was examined, and to Bamberton, where the members were shown over the new

plant of the Associated Cement Co., through the courtesy of Mr. Bamber, Managing Director of the Company; July 12th, to the Stave Falls Power Plant, through the courtesy of the Western Canada Power Company; Sept. 27th, to the Lake Buntzen Power Plant, by the courtesy of the Vancouver Power Company.

Yours faithfully, J. R. GRANT, Acting Secy.-Treas.

Vancouver, December 31st, 1913.

VICTORIA MEMBERSHIP GROWING

During the past year our Branch held 10 meetings with an average attendance of 18 and the following papers were read, viz.,

February 13th. "Some Engineering Works in B.C." (first section). Illustrated with lantern slides. F. C. Gamble, Vice-President.

November 13th. "Some disregarded stresses at joints and ends of steel in reinforced concrete construction." H. A. Icke.

December 11th. "A cellular method of vibrated reinforced concrete construction." J. B. Holdcroft.

Our membership increased from 62 to 82 but owing to the removal of 2 corporate members from our district, the net total stands at 80, distributed as follows: Members, 16; Associate Members, 29; Juniors, 8; Students, 4; Assoc. of Branch, 23; Total, 80.

All our Branch Associates are engineers who have applied for admission to Can. Soc. C. E. At the annual meeting held on December 11th the following officers were elected for 1914:

Chairman, F. C. Gamble (re-elected); Vice-Chairman, D. O. Lewis; Treasurer, A. E. Foreman (re-elected); Secretary, R. W. Macintyre (re-elected); Executive, the above officers with L. W. Toms and E. H. Harrison; Auditors, H. A. Icke and F. A. Richardson

With a view to developing the social side of the profession, receptions are being held in the Club rooms during the winter months, and attended by members and ladies. The year's programme closed with 2nd annual convention of B.C. members in Vancouver on December 13th. It is our intention to keep a register of all engineers belonging to the Branch who are available for employment, giving record and qualifications in each case. From this a list will be compiled and forwarded to the Provincial Government and municipal bodies in B.C.

Respectfully submitted,

R. W. MACINTYRE, Secretary.

Victoria, January 1st, 1914.

E.E. AND M.E. SECTIONS AT WINNIPEG

The Manitoba Branch of the Canadian Society of Civil Engineers begs to submit the following annual report for the year 1913. The officers for the year 1913 were as follows:

Chairman, J. G. Legrand; Executive Committee, W. A. Duff, D. A. Ross, W. L. MacKenzie and Frank Lee; Secretary-Treasurer, E. Brydone-Jack.

Meetings.—The following papers were read and discussed at the regular meetings of the Branch:

"Some Facts Concerning the Panama Canal," by J. G. Sullivan.

"The Use of Asphaltum in Protecting Levees and Railway Embankments," by Mr. Percy.

"The Auxiliary Steam Plant of the Winnipeg Electric Railway," by D. A. Ross.

"Steam Power Plant for Mechanical Department Yards at Divisional Points," by H. Lorimer.

The attendance at these meetings averaged about thirty. There is a total membership of the Branch of two hundred and eighty-three, classified as follows: Members, 33; Associate members, 101; Associates, 1; Juniors, 9; Students, 89; Local Associates, 50;

At the first of the year an electrical section of the Branch was formed which held meetings independently of the regular meetings of the Branch. At these meetings the following papers were presented.

"Physical Characteristics and Source of Illumination," by E. P. Fetherstonhaugh.

"Engineering Aspects of Illumination," by J. G. Glassco.

"Economics and Aesthetics of Illumination," by H. N. Ruttan.

"Recent Developments and Electrical Operation of Coal Docks" by F. H. Farmer.

"The Diesel Crude Oil Engine," by C. F. Bowring.

"Electric Heating from the Economic Stand Point," by Wm. Aldridge.

"Underground Cables," by M. B. Stewart.

"Comparison of British and Canadian Practice in the Distribution of Electrical Energy," by E. V. Caton.

There was a demonstration of resuscitation from electrical shock given by Mr. Aldridge at one of the meetings.

A mechanical section of the Branch was also formed at the end of the year, but no meetings were held prior to December 1st, 1913.

The Branch has co-operated with the Western Canada Railway Club and secured a room in the Industrial Bureau Building, where the members can have access to engineering periodicals, and where the nucleus of a library is being established.

At the annual meeting held on December 4th, the following officers were elected for 1914: Chairman, E. Brydone-Jack; Executive Committee, Frank Lee, W. L. MacKenzie and D. A. Ross; Secretary Treasurer; G. E. Bell.

The annual dinner was held on December 16th, 1913, in the Fort Garry Hotel, at which about ninety members and guests attended. The treasurer's report showed a balance in hand at the end of the year of $645.89.

Yours truly,

G. E. BELL, Secretary-Treasurer.

Winnipeg, January 7th, 1914.

The report of the Quebec Branch was the first on the list. The Secretary presented the report, which was received and adopted.

Mr. Leofred, in seconding the motion that the report be adopted, said he regretted there were no officers of the Quebec branch to read the report.

The report of the Ottawa branch was then submitted to the meeting by Mr. Dick. It was proposed and seconded that this report be received and adopted.

The Secretary then read the report of the Kingston branch. A remark was made as to whether a branch of this kind is doing enough work to warrant their receiving back a part of their funds.

Mr. Coutlee strongly opposed such criticism of these smaller branches or suggestions that they should be cut off, but that wherever there was a number of men in a branch of the Society, it was always best to give its members the benefit of that branch's work and the facilities at the Society's disposal. He did not think that any branch should be cut off under any pretext whatever.

The next report was from the Toronto branch and was read by Mr. J. S. Galbraith, the newly elected secretary-treasurer, in the absence of the chairman and the secretary for 1913.

Moved by Mr. T. C. Irving, Jr., and seconded by Mr. C. H. Mitchell, that the report be received and adopted. Carried.

It was then remarked, by way of criticism, that, according to the report the Toronto branch had hardly done sufficient work during the year to warrant giving them $575 out of the funds. According to the report all they had done was to elect officers and compile a card index. Mr. T. C. Irving, as an officer of the Toronto branch last year, ex-officio, stated that the branch was not in the position of the Ottawa and other branches. The Toronto branch did not have to have house committees, or an annual dinner, for the reason that the Engineers' Club had an annual dinner. Regarding the library, of which so little is said in the report, he regretted very much that the chairman had not seen fit to elaborate on the books added to the library. He thought they had in the Toronto branch the latest and most modern books on engineering.

Mr. Leofred remarked that the branches would undoubtedly show better results a little later on. Patience should be displayed.

Mr. Irving, then stated that it was proposed next year to build a new Engineers' Club in Toronto, and that money would likely be needed to be spent by the Toronto branch on the library and in arranging to make the headquarters of the branch in the new Engineers' Club. He remarked that the branch, in his estimation, should be congratulated instead of being criticized upon its large surplus.

Mr. Chipman rose to defend the Toronto branch. It had not, perhaps, given as good an account of itself as the Society had a right to expect, during the last few years, but there had been disadvantages in Toronto. With respect to finances it was his opinion that each branch had a right to spend its money in any way it deemed best fit in accordance with the by-laws of the Society. Toronto was husbanding its resources with a view to co-operating in the future with the Engineers' Club.

Prof. Haultain remarked that the Toronto members regretted the neglect which was apparent, but that they were "turning over a new leaf." There had been 44 members at the last annual meeting—more than at any previous annual meeting in years, and more, in fact, than the total attendance at the past several annual meetings. Interest was being warmly renewed and they were thankful to have $575.00 to begin with.

Mr. Harkom thought that there was one point which had not been fully considered, and that was the encouragement of the branches all over the Dominion. He strongly recommended that the Society should do all in its power to encourage its branches.

The Secretary then read the report of the Manitoba branch, which was duly accepted.

After the reading of the reports from the Calgary and the Vancouver branches, it was duly proposed and seconded that they be received and adopted. Carried.

The Secretary, after reading the report from the Victoria branch, said that in the matter of the last two reports he had in hand a somewhat voluminous report of that convention for the benefit of this meeting, and desired to know if those present would like it read.

Mr. Rust said he thought there was hardly any necessity, as it would take too much time. He knew they were very successful and very interesting, he having been present at the convention.

After much discussion an original motion respecting the report of this convention as well as the several amendments, were withdrawn, and it was eventually accepted, on the motion of Mr. Johnson, that the report be read Wednesday afternoon at 3 o'clock.

The presidential address was then delivered, the Secretary assisting because Mr. Johnson had a severe cold.

The address was received with much applause and appreciation, which was suitably acknowledged by the President.

PRESIDENTIAL ADDRESS

Remarks of Retiring President Had to be Brief Unfortunately Owing to Bronchial Attack

Gentlemen,—It is decreed by custom that a retiring President of the Society shall make an address. A good number of my predecessors in the office, following what was probably to them the line of least resistance, have given you a paper on some engineering topic.

I considered following this course, but abandoned the idea for the reason that it seemed impracticable to treat in a satisfactory way a problem in bridge construction without the aid of diagrams and lantern illustrations.

A general review of the progress made in the different fields of engineering, or a review of the more important works that have been carried out in Canada, are both beyond my limitations. I shall, therefore, speak to you only on Society matters, and I am the more ready to do this for the reason that at our last annual meeting and later in published correspondence, complaint was loudly voiced that the Society was not doing enough for its members, and the Officers and Council of the Society did not escape serious criticism.

The objects and purposes of the Society are in its Charter stated to be, "to facilitate the acquirement and interchange of professional knowledge among its members."

It seems evident that this basic purpose of the Society can best be achieved by having enrolled in its membership a large proportion of the able and active engineers of the country, by the interchange of thought and of experience at its meetings and particularly by the reading, discussion and circulation of papers on important and interesting works or investigations.

The Society was organized 26 years ago by a few of the then prominent engineers of Eastern Canada. The movement met with the enthusiastic support of most of the Engineers then in active practice, and at the time of the first annual meeting in 1888 there were 225 members and 65 associate members, or a total corporate membership of 290. From that date the number has steadily increased until we have at present the time 622 members and 1,313 associate members, or a corporate membership of 1,935. A few of these members, less than 40 in all, have come in under the Quebec Act, and a few more in this Province have joined almost under compulsion because of the Act, but the large majority have joined without pressure and without special solicitation, evidently because they considered membership in the Society beneficial and that to belong to it gave them a standing in the profession and in the community that otherwise they would not have.

While the growth of the Society in numbers has been very satisfactory, there has been no corresponding growth in the enthusiasm of its members, as evidenced by attendance at the meetings, by the preparation and contribution of papers, or of discussion on the papers submitted, but rather the reverse. The first eight years of the Society's history there was an average corporate membership of 378 and an average of 13 papers per year were submitted, read and published. The last 18 years the average corporate membership has been 921 and the average number of papers per year, again 13. In the first 8 years a paper was presented by one member out of 29. During the last 18 years we have had one paper for each 71 members. During the last 3 years we have had one paper for each 132 members.

Real enthusiasm cannot perhaps be worked up to order, but we can all do our duty, and I would call your attention that following our election we have all agreed "to promote the objects of the Society so far as in our power", and "to present to the Society an original communication" (meaning a paper) "or some scientific work for the library."

I fear a great many members have so far overlooked this pledge and hope for a great increase in the number of papers in the near future. I would particularly urge that the younger members prepare and submit papers describing the work on which they are engaged, or of which they have good knowledge, and this as much for their own sake as for the good of the Society, for the presentation of a paper of merit will go a long way toward giving them a professional standing they cannot well gain in other ways. A good paper need not necessarily be based on a large and important work, or even a successful one, for failures are often the source of very valuable information.

In connection with the complaint that the Society has not been doing enough for its members, it will be interesting to inquire what other Societies of similar nature are doing for their members. The Societies which at once come to mind for comparison are the Institution of Civil Engineers of Great Britain and the American Society of Civil Engineers. Both of these Societies have been long established and have a large membership, both have accumulated valuable properties and have annual surplusses of revenue over ordinary expenditures greater than our entire gross revenue. With ample means at their command and with able management it would seem that we may reasonably expect to find these Societies rendering their members every obvious useful service.

The British Institution of Civil Engineers publishes and distributes to its members four volumes per year, each volume containing the reports of the meetings that have been held since the last issue and a list of those admitted as students or as members, or transferred from one class to another. The papers read at the meetings and the oral and written discussions thereon are published, as well as a number of "selected papers" which apparently have not been read and discussed but are considered worthy of publication. A good part of each volume is devoted to "Abstracts of Papers in Scientific Transactions and Periodicals," a typical volume devoting over 100 pages to short reviews of 170 selected articles. The abstracts in the volume examined bear the initials of thirteen different reviewers, and this suggests that the work is not done by the Secretary's staff, but by writers familiar with engineering subjects, specially engaged for the work.

The American Society of Civil Engineers publishes in pamphlet form ten volumes of proceedings per year, each containing brief reports of the meetings of the Society and of the Board of Direction, which corresponds to the Council of the Society, the names of members elected and transferred from one class to another, a list of additions to the library with a synopsis of the contents of the more important books and gives a list of recent engineering articles of interest, reviewing for this purpose more than 100 publications. Each volume also contains a number of original papers with the discussions thereon.

It will be seen that both of these Societies not only publish their transactions more frequently than our Society, but go to considerable expense in keeping their members advised as to recent engineering literature.

Aside from their activity in this direction I am unable to find that these older and larger Societies do their members any service which we are not endeavoring to do for our members, and it is to be borne in mind that these Societies are financially able to do for their members every useful service considered desirable.

Neither of these Societies has branches or divisions corresponding to our own, though there are a number of local "Associations of Members of the A.S.C.E." in various parts of the United States which hold regular meetings and read and discuss papers as do our Branches. These associations have Charters approved by the Parent Society but receive no financial assistance from it.

Apparently the only useful suggestions we can get from the practice of these two older Societies are the desirability of more frequent reports to the membership, and keeping the members advised of current engineering literature, the latter a matter of considerable expense which the finances of the Society have not heretofore permitted.

The criticisms made at our meetings and in correspondence have as a rule been very general and with few specific suggestions. There seems to be a feeling that the officers and the Council are not doing all they should, that they are not keeping the members well posted, that the Council is not fairly representative of the different districts, and that it would be well if its members were younger and more enthusiastic and if they served shorter terms.

The remedy for these faults, if they exist, is in the hands of the membership at large, for it can make and alter By-laws, can designate the Nominating Committee, and can elect Councillors, and through them control the policy of the Society.

Some of the members, I believe a very small proportion, evidently feel strongly that the Society should interest itself in the troubles of its individual members, with the Municipalities and Corporations employing them, and particularly that the Society should take active steps to keep out so-called Alien Engineers, and conserve Canadian business for the members of the Society.

I can conceive of no course so sure to discredit and disrupt the Society as to adopt Labor Union methods,and interfere in the disputes of engineers with their employers.

I agree that Canadian work should as a rule be done by members of this Society, but pressure to this end can best be exerted by the local members and branches, and I feel strongly that except in connection with works handled direct by the Dominion Government, the Society should not officially intervene.

On the whole I consider the complaints that have been made to have little support in existing conditions and believe that the Society has in the past done for its members about all that could reasonably

be expected. I do think, however, that the members of the Society have in great measure failed to do for the Society and for themselves all they should and believe they can hereafter, by taking a more active interest in it, by contributing and discussing papers, by attending meetings of the Society and Branches, by paying more attention to the applications for membership and advising the Council in regard thereto, and in other ways, make the Society of use to themselves and at the same time promote its interests.

In conclusion I wish to point out one way in which it may be the Society can be of great use to members without engagements or desirous of changing their employment.

The suggestion comes through the Engineering News of the 21st of August last, which, in an article headed "Making Membership in an Engineering Society a Tangible Asset," states that the "Junior Institution of Engineers" in England, a Society of which I have no special knowledge, has undertaken the establishment of a permanent Engineers' Register which will give a complete record of the professional career of every member, the purpose being to form a sort of clearing house to assist members in improving their positions by systematically recording the particulars of their experience and technical training, and by effecting the introductions to engineering employers of members who possess such qualifications as may fit them for vacant positions. To establish and maintain a Register of this nature would involve considerable expense, and would require the hearty co-operation of all members. I think, however, the suggestions well worthy the serious consideration of the incoming Council.

(NOTE:—The attention of members of the Society is respectfully called to the fact that "The Information Department" of The Canadian Engineer has, for five years past, kept the very kind of records advocated by Mr. Johnson. The complete record of any engineer who cares to supply the necessary data concerning himself, is kept on file. This file is open for inspection to any employer whose desire to add to or change his staff is bona-fide. Great care must be exercised not to allow the personal data in this file to be shown indiscriminately. Through this Information Department upwards of three hundred engineers have secured or changed positions.

Should the incoming Council adopt Mr. Johnson's suggestion, and appoint a manager to conduct such a file as a department of the Society, The Canadian Engineer hereby offers to present to the Society the entire records of its Information Department, upon the assumption that the work, if undertaken by the Society, would be prosecuted with greater thoroughness than is possible for any technical paper.—EDITOR.)

WEDNESDAY AFTERNOON SESSION

The meeting opened at 3 o'clock with a good attendance. Mr. Johnson was in the chair.

The report of the Convention of the British Columbia branches was read in part by Prof. McLeod, bringing out the fact that the members of that province were not inclined to concur in spirit with the action of the Council in the matter of sending out information concerning the vote on by-laws.

The President explained this particular point to have arisen from the feeling on the part of the Council that some communication on its behalf should accompany the by-law which was being mailed to the members, relating to the establishment of a provincial division of the Society in British Columbia.

At the September meeting at which the by-law, proposed by the Council, had been brought up, there had been no difference of opinion concerning it excepting the question of financial aid from the funds of the Society. The form of the by-law was not objected to insofar as it incorporated the proposed association with the existing branches. The underlying idea was that the association thus formed should not supercede the branches but that the Society should communicate more directly with the branches than with the association.

The by-law which the British Columbia branches submitted later differed from that proposed by the Council, the British Columbia members apparently being under the impression that the Council's by-law rather ignored their wishes.

Mr. Johnson thought that, when the Council was considering the submitted by-law, it might possibly have been adopted had it not been for the fact that the Council's by-law had been passed by a large meeting. It was felt that the decision of this larger meeting should not have been upset by the smaller meeting.

As far as the Council was concerned, therefore, it had no alternative, said Mr. Johnson, but had sent out both by-laws. As they covered the same ground, it was deemed essential to call the attention of the members to the fact that they were by-laws dealing with the same subject. A clause inserted in the communication for this purpose had—in the opinion of the British Columbia members—influenced voters in favor of the Council's by-law and against their own. Hence their objection.

This situation was the subject of discussion during the greater part of the afternoon. At the outset several members inquired why the whole communication had not been read by the Secretary on Tuesday. Mr. Kennedy replied that it was largely the proceedings of the convention of the Vancouver and Victoria branches, containing papers upon such subjects as "The Training of Young Engineers," and "The Question of a Common Level Datum," and other matters quite removed from the subject under discussion. They were not read, because it was desired to confine the discussion to the main subject.

The action of the Council, in inserting the explanatory paragraph in the communication which had been sent out, was upheld. The paragraph itself was endorsed in sentiment by the members. The discussion reverted to conditions peculiar to the western provinces, and the importance of recognizing that the western members had a better conception of these conditions than eastern members, generally speaking, could possibly have. It digressed to the matter of qualification of candidates for membership, whereupon the President observed that the Council would be greatly assisted in the passing of applications by receiving whatever information members might be able to furnish regarding candidates. Several members emphasized the fact that the Council had to rely largely upon such assistance; naturally having no personal acquaintance with many of the applicants.

Returning to the chief subject under discussion, it was maintained that the Society should do all it could to further the interest of all its branches, and that those most distant from headquarters should particularly be given all possible co-operation. The efforts to restrict the membership to well qualified men were heartily commended, and it was recognized that the advice of members residing in the same province as the applicant is most valuable in this regard.

The widely scattering discussion experienced a concentrating effect from a resolution submitted by Mr. Kerry, which was afterwards amended by Mr. Harkom's motion, seconded by Mr. Dietrich, and adopted. (Upon further consideration, however, it was felt that the wording of this amended resolution conveyed an impression different than anything intended, and it was rescinded at Thursday morning's meeting. A new resolution with better phraseology was substituted.)

A communication from the Manitoba branch was the next subject for consideration, but discussion was postponed by motion.

Complying with a request made at the Tuesday morning session for further particulars of arrears fees outstanding at the end of 1913, the secretary presented the following information:

"For 1913 the unpaid subscriptions amounted, for members $1469; for associate members, $4,456; for associates, $85; for juniors, $530; for students, $384. Total, $6,944"

"Arrears for 1912 and previous years, members, $964; associate members, $3,907; associates, $125; juniors, $403; students $395. Total $5,794.

"Sum total of outstanding arrears is $12,709. It was estimated by the auditor that these were worth $5,000 as indicated in the financial report submitted Tuesday.

"The statement which should have accompanied the report as to the number of members was as follows:

"Quebec, 40 corporate members, 9 non-corporate members.
"Ottawa, 156 corporate, 45 non-corporate.
"Kingston, 14 corporate, 6 non-corporate.
"Toronto, 128 corporate, 81 non-corporate.
"Manitoba, 130 corporate, 80 non-corporate.
"Calgary 30 corporate, 5 non-corporate.
"Vancouver, 114 corporate.
"Victoria, 40 corporate, 8 non-corporate.
"Total, 638 corporate, 248 non-corporate."

Mr. Jamieson remarked that the statement showed a state of affairs that should not exist. It was a large amount of arrears. This same question had been brought up from year to year, and instead of improving it was getting worse. It seemed that members were carried on the list long after the age limit had expired.

The President suggested that if he referred to the report of the Council it would be found that 437 students were dropped from the list during the past year because of over age or non-payment of dues. Mr. Brayley suggested that the matter be taken up by the finance committee to see if there was room for improvement.

Upon motion by Col. Anderson, the meeting was adjourned.

EXCURSION TO BRIDGE WORKS

The excursion to the St. Lawrence Bridge Company's shops at Rockfield was attended by about 250 of the members, special cars for the trip having been placed at the disposal of the visitors by the Montreal Tramways Company.

Upon arrival a thorough inspection of the plant disclosed many very interesting features in its construction and in the facilities to be seen there for the fabrication of the superstructure of the Quebec bridge.

After completing the tour through the shops a luncheon was served by the Company in the Templet Shop, at which a number of addresses were given.

THURSDAY MORNING SESSION.

The President called the meeting to order at 10.20 a.m.

It was decided to re-consider the resolution submitted by Mr. Harkom at the Wednesday afternoon session, and after thorough reconsideration it was rescinded.

Mr. Kerry submitted the following resolution to take its place:—

"That this meeting has considered the resolution of the British Columbia Branches, objecting to the action of the Council in commenting on a proposed amendment to the By-laws, and is of the opinion,

"(1) That the Society welcomes any expression of opinion or advice from the Council concerning matters of general import with which the Society proposes to deal.

"(2) That it suggests that such opinion or advice be printed independently of the ballot to which it refers.

"(3) That the incoming Council be entrusted to further deal with the development of the branch and divisional system as part of the organization of the Society."

Mr. Ross, in seconding the motion, observed that it contained the substance of the previous resolution and in much better shape. Carried.

The Secretary read the report of the Gzowski Medal Committee, which was received and adopted. He then read the report of the Examiners on students' papers. The meeting agreed to award two prizes in the General Section.

The Secretary next submitted the report re the amendment of By-laws.

The amendments proposed with regard to By-laws Nos. 9, 20, 36 and 51 of the Society were adopted. The amendments proposed with regard to By-law No. 8 of the Society were rejected. The new By-law No. 56, proposed by the Council and by certain members resident in British Columbia, did not have the necessary two-thirds majority vote to carry. The existing By-law No. 56 to be renumbered 57 was adopted.

The Secretary read the report of the Scrutineers and election of officers and members of the Council.

The officers elected to serve on the Council are as follows:

President:—M. J. Butler, C.M.G., Montreal.

Vice-President:—R. A. Ross, Montreal.

Councillors:—Representing District No. 1.—Montreal and district within 25 miles:—J. M. R. Fairbairn and H. M. MacKay, Montreal.

Representing District No. 2.—Newfoundland, Nova Scotia, Prince Edward Island, New Brunswick and the United States:—R. McColl, Halifax.

Representing District No. 3.—Province of Quebec (outside of the Headquarters district), countries outside of Canada, Newfoundland and the U.S.A.:—A. R. Decary, Quebec.

Representing District No. 4.—Ottawa and the Province of Ontario east of and including Lindsay:—R. F. Uniacke, Ottawa.

Representing District No. 5.—The Province of Ontario west of Lindsay:—W. A. Bucke, Toronto.

Representing District No. 6.—The Provinces of Alberta, Saskatchewan and Manitoba:—F. Lee, Winnipeg.

Representing District No. 7.—The Province of British Columbia:—G. R. G. Conway, Vancouver.

The report was received and adopted.

At this juncture the retiring President, Mr. Phelps Johnson, rose and surrendered the Chair to the new President, Mr. M. J. Butler. There was loud applause on Mr. Butler's taking the chair. He remarked that he could only faintly express his appreciation of the very great honor conferred on him by asking him to succeed Mr. Johnson, and to accept the highest position in the Society.

The President then announced the next in order of business to be the election of members for the nominating committee. The Secretary read the results of the ballots.

The President inquired whether there was any further business to bring before the Society.

Mr. R. B. Rogers announced that he desired to bring before the Society a matter referred to in the late president's address, reading as follows:—"While the growth of the Society in numbers has been very satisfactory, there has been no corresponding growth in the enthusiasm of its members, as evidenced by attendance at the meetings, by the preparation and contribution of papers, or of discussion on the papers submitted, but rather the reverse."

Mr. Rogers thought that cognizance should be taken of this reference. It was a matter of vital importance, and should be thoroughly looked into. He moved that a committee be formed to consider means to increase the enthusiasm of the members in general throughout the Society, the committee to report in six months to the Council; and that their report be printed and sent to the members, the matter to be brought up at the next annual meeting.

This motion was seconded by Mr. Kennedy.

Mr. Francis, speaking at length against the motion, said he was not aware of such lack of enthusiasm. On the contrary he thought that the members were as enthusiastic as they ever were, and that he was rather surprised to hear the matter brought up.

A lengthy discussion followed, and in which many of the members, including the Chairman, took active part. Many suggestions as to the means for remedying the condition of affairs alleged by Mr. Rogers were offered. Mr. Odell very aptly remarked that he would suggest that each member constitute himself into a committee to enthuse himself! (Laughter and applause!)

The Chairman ruled that the matter be referred to the incoming Council and that it be left with them to appoint any necessary committees to deal with the question.

Upon motion, the meeting was adjourned.

HYDRO-ELECTRIC POWER-STATION AT CHESTER, ENGLAND.

A novel hydro-electric station was not long since put in operation on the River Dee at Chester, Eng. Nearly 1,000-h.p. of electrical energy is being derived from a waterfall whose maximum head is 8 feet. The station was built by the Corporation Electricity Supply Department, who had to face the fact that twice a year at least the tidal bore of the Dee would reduce the head of water to only a few inches. However, upon working out the prospects of the scheme, it was found not only that the tidal bore exerted its influence at mid-day and midnight, times when electricity is little in demand, but also that the available power was least during the summer months, also a time when the demand for electric power is lightest.

The station is built on the site of the old Dee mills, which existed since Norman times until 1910, when they were finally purchased by the Corporation and pulled down. It was thought that the usefulness of the water at the weir for power purposes was at an end; but, upon the suggestion of the city electrical engineer, the possibility of using the water-power for electricity supply was investigated.

The old weir is built diagonally across the river at the east side of the old Dee Bridge, and practically forms a channel to conduct the water to the power-station; and, in this channel, sluice-gates and a strainer-rack have been placed. Below the weir the river is tidal, so that a specially-designed plant has had to be adopted capable of working efficiently over a wide variation of head and, consequently, of speed. The amount of power developed at any time depends upon the height of the river above the weir, which is, of course, a function of the rainfall, and the height below the dam, which depends on the state of the tide. It is calculated that these two factors will give average heads as follows:—

	Feet.
December	4.5
January, February, and March	6.25
April, May, October, and November	7.5
June, July, August, and September	8.75

The Electricity Committee has undertaken that in the working of the installation the water in the river above the weir shall not be lowered more than 6 inches below the mean height of the weir.

The new station, which has already been constructed, has been furnished with an installation of machinery, which, it is estimated, will yield about 1,250,000 units a year at a cost including capital charge of somewhat less than .3d. (or 3-5 of a cent) per unit.

A higher horse-power than that developed by any other vessel in the world will be one of the features of the new battle cruiser "Tiger," which has been launched at Clydebank, Scot., recently. It is unofficially stated that the engines will develop shaft horse-power, which means a speed of at least 31 knots.

A METHOD OF STRENGTHENING ROOF TRUSSES.

A NOVEL method of strengthening the roof trusses of a large public building was recently carried out satisfactorily by a Toronto engineer. The trusses, which are Howe trusses with wood chords and diagonals, and steel verticals, were of fairly good general proportion and make-up. The connections were inadequate, however, and the trusses had sagged considerably. The problem was to effect repairs in place, without disturbing either the ceiling, hung from, and partly resting on, the bottom chords, or the roof trusses which rest directly on the top chords.

The trusses (see Fig. 1) are 60 feet in length with depth of 8 feet centre to centre of chords. Both top and bottom chords are of uniform section throughout, the top chord being 7½ x 11½ in. and the bottom one composed of 4 pieces 1¾ x 12 in. The bottom chords are not spliced and have in some places two joints close together, so that the net value of the bottom chord (and this is near the centre of the truss) is not more than 2 pieces 1¾ x 12 in., equal to 42 sq. in. The diagonals are 6 x 8 in. throughout and the verticals are of round rods, 1½ in. diameter, not upset. There are 8 panels, but only 3 loading points located at the centre and at quarter-points. At the quarter-points the rods project downwards, through the bottom chord, to which they are not fastened, to carry lower side panels of the ceiling. At loading points there the 8 x 8 in. posts, the rods passing through these.

Loading is on the top chord from the roof, and though apparently on the bottom chord from the ceiling joists, it was found to be carried fully by the top chord. The trusses sagged at the centre, to a maximum of 3½ in. Some of the diagonals were found loose, showing that they took no weight; the arching of the roof, tied by indirect cross joist system, evidently taking the load.

Reinforcing was effected mainly by means of two wrought iron suspender rods for each truss, the rods being 1½ in. square, with each rod in three parts, centre and two ends, attached to pins at top chord ends and held together by Cleveland turnbuckles engaging upset ends. The pins are 2 in. in diameter, with pin plates, one on each side of top chord, 10 x 12 x ½ in. The top chord is reinforced throughout by two pieces of 2 x 10-in. pine, one on each side, bolted on by means of ¾-in. through bolts, spaced, staggering about 2 ft. The bottom chords are spliced by means of 2 x 12-in. pine pieces attached with ¾ x 9-in. lag screws. The reinforcing rods take bearing at the loading points, on shoulders formed by 2 x 8-in. pine pieces, one on each side of the post. Two pieces, 2 x 6 in., one on each side of truss, form struts resisting the side thrust, due to inclination of the rods at the quarter-point supports.

The rods and other reinforcing material were put in place practically without disturbing anything, in the space between the ceiling and roof. The 6-inch play in the turnbuckle for adjustment enabled the straightening up of the trusses, i.e., elimination of sag, as far as desired.

After this was done the top chord reinforcing was completed and given good abutting joints throughout, all vertical rods drawn up tight and diagonals brought to bearing, so that, although somewhat indeterminately, both the old truss and the reinforcing system will do work, in carrying the loading.

Without prejudice, it may be said that this class of work, viz., reinforcing of a truss or other member of a structure after it proves inadequate to do the work assigned to it by the architect or builder, is not an uncommon experience with engineers. The rational method is to have a competent engineer design the structure in the first place.

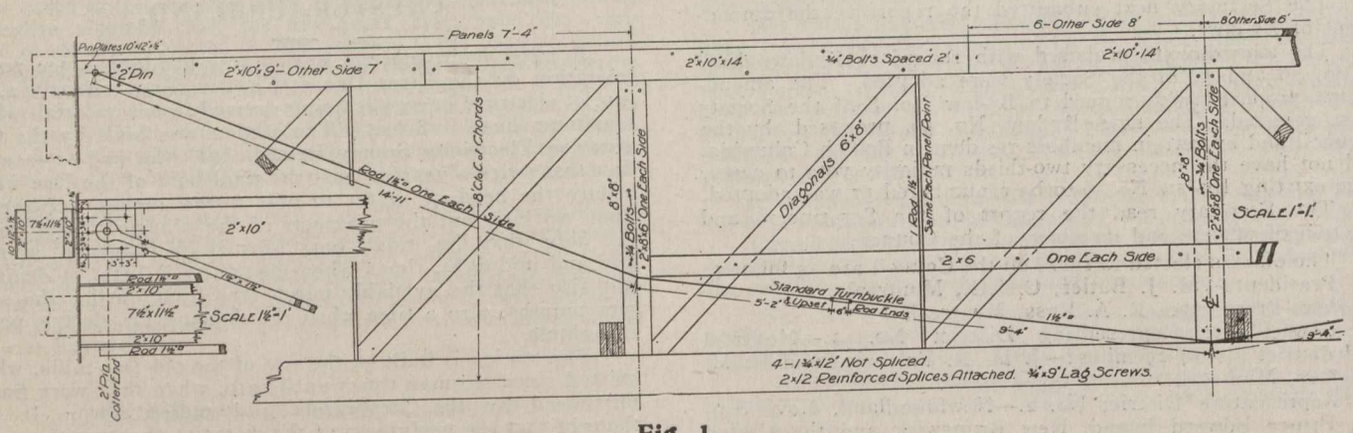

Fig. 1.

The statement of the Public Utilities Commission recently published, giving the condensed earning report of the Manitoba Government telephones for the 12 months ending November 30th, shows the revenue to have been $1,707,149.74; expenses, $1,269,909.90; net earnings, $437,239.84; interest charges, $406,975.20; and a resulting surplus of $30,264.64.

A cable sent from London to the New York Tribune not long ago reported the following in connection with a new invention in wireless science: "The newest development in wireless telegraphy was demonstrated at the exhibition of the Physical Society of London in the Imperial College of Science. This invention aims at the detection of direction from which a message comes. No one has yet discovered how to send wireless rays like a searchlight in any definite direction. They go out everywhere, but, even though they cannot be directed, it is just possible that a ship will be able to find out whence they come. This is done by a wonderful new instrument shown by the Marconi company.

According to the estimates which have been prepared by the Provincial Department of Mines, the total mineral production for the year 1913 will be slightly less than $30,000. The value of mineral products for the last year will be approximately $29,555,000, which is nearly $2,500,000 less than the production for the previous year. This decrease is due to a shortage of $1,600,000 in the coal mining industry occasioned by the labor troubles on Vancouver Island during the summer, and a shortage of about $656,000 from the metalliferous mines, due to a decrease of some $1,160,000 in the copper output and $25,000 in zinc which are, however, partly compensated for by increases in the output of gold, silver and lead.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of CIVIL, STRUCTURAL, RAILROAD, MINING, MECHANICAL, MUNICIPAL, HYDRAULIC, HIGHWAY AND CONSULTING ENGINEERS, SURVEYORS, WATERWORKS SUPERINTENDENTS AND ENGINEERING-CONTRACTORS.

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Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00	$1.75	$1.00

ADVERTISING RATES ON REQUEST.

JAMES J. SALMOND—MANAGING DIRECTOR.

HYNDMAN IRWIN, B.A.Sc., EDITOR. A. E. JENNINGS, BUSINESS MANAGER.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main 7404, 7405 or 7406, branch exchange connecting all departments. Cable Address "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 1008, McArthur Building. Phone Main 2914. G. W. Goodall, Western Manager.

Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor.

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

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Published by the Monetary Times Printing Company of Canada, Limited, Toronto, Ontario.

Vol. 26. TORONTO, CANADA, FEB. 5, 1914. No. 6

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RETROSPECT OF THE 28th ANNUAL MEETING.

The attendance of members at the recent Annual Meeting of the Canadian Society of Civil Engineers was probably the most representative in its history. There were in attendance prominent engineers from all portions of Canada and not a few from across the border to the south.

There was noticeable a distinct effort on the part of the Officers and Members of Council to restrict the proceedings to matters of first importance to the profession and its development.

Of the reports submitted, the most important was that in relation to Reinforced Concrete. No final action could, of course, be taken on a first consideration of the report. It will be referred to the branches of the Society, and to the membership at large, for discussion and at the next Annual Meeting it should be in form for adoption. It will constitute an advance on the present progress of the art which all concerned will, we are assured, greatly welcome.

The most prominent feature of the meeting was perhaps an indication of the desire on the part of the Council to get into more intimate touch than has hitherto been possible with the needs of its members. The recent effort to amend the by-laws in such shape as would advance the status of the profession generally in Canada will be noticed by anyone reading carefully the general remarks in the Report of Council, and it is to be regretted that while the membership at large undoubtedly favor the proposal to establish Provincial Divisions, the circumstances referred to elsewhere intervened to prevent the attainment of that end.

The recommendation that the business meeting of the Society should be held at headquarters is doubtless one which will commend itself to the business instincts of the engineering profession, while all will heartily approve of the proposal to develop the feature of summer meetings. The undertaking to hold such a meeting on the Pacific Coast at the earliest opportunity is one which will be heartily endorsed by all the members. This excursion would follow as closely as possible the opening of one or both of the new transcontinental routes and will be held in conjunction with the Panama Exposition and the series of engineering conventions to be held in San Francisco in 1915.

While, as always occurs in healthy growing institutions, there were some minor differences of opinion which developed as between members holding different points of view, the feeling was again and again expressed of hearty appreciation of the work of the Council of the Society and its efforts towards the consolidation of the profession as a whole.

The address of the retiring President, which we publish in full on another page, deals to a greater extent than is usual with Society affairs and we commend it to all members for serious reading.

THE QUESTION OF PROVINCIAL DIVISIONS.

It will be noticed from our report regarding the result of the ballots for amendments to by-laws of the Canadian Society of Civil Engineers, canvassed at the recent Annual Meeting, that an effort to establish Provincial Divisions within the Society was not successful. This failure seems to have been due to the disinclination of the British Columbia members, who mainly advocated

the proposal, to accept the by-law in regard to Provincial Divisions drawn up by the Council. The alternative by-law submitted by the British Columbia members differed from that proposed by the Council in minor matters only, the chief of these being that the British Columbia members desired to impose a fee of $1 on all members resident in the Province.

While we do not wish to enter into a discussion as to the merits of a proposal to establish Provincial Divisions, it would undoubtedly have been an act of wisdom on the part of those desiring them to have refrained from giving the membership an opportunity to split their votes, and the first effort should have been limited to a decision as to the principle involved, leaving the adjustments of details to the future. A resolution adopted at the close of the meeting recommitted this matter to the Council, and the question will no doubt be put, possibly in a modified form, before the membership with a view to amending the by-laws at the next Annual Meeting.

LETTERS TO THE EDITOR.

Ottawa Water Supply—Reply to Mr. Pitcher.

Sir,—In your issue of January 15th Mr. F. H. Pitcher, of the Montreal Water and Power Co., argues that the City of Ottawa might better filter and pump the Ottawa River water instead of putting in a gravity water supply from the Gatineau Lakes.

Mr. Pitcher argues that a filtration plant of the mechanical gravity type can be put in for $550,000, and that by erecting this proposed plant the city would save $7,450,000 out of a proposed $8,000,000 expenditure.

Granted that he is right in his estimate of the cost of the filtration plant, his cost comparison takes no account of the cost of operation and maintenance of the proposed filtration apparatus over that of the proposed gravitation system; neither does it take account of the cost of operation, depreciation and maintenance of pumping machinery.

DONALD F. McLEOD,
Town Engineer.

New Glasgow, N.S., January 19th, 1914.

* * * *

The Billings Bridge at Ottawa.

Sir,—I read with interest the account of the proposed highway bridge for the City of Ottawa in *The Canadian Engineer* of January 29, 1914. Permit me to offer some kind criticism concerning the same.

It seems a shame to build a bridge with the steel work built to good heavy specifications and to have such a light floor slab. The floor slab is given as 4½ in. deep and apparently about a 4-ft. span.

Considering the specification of the Ontario Highway Board, which is regarded as good general practice, the slab holds good for only a 1-ton motor truck loading, if we assume that the wheel load is distributed over an area of 2 x 2 ft. (which is really too liberal an assumption). A 1-ton motor truck (Gramm) weighs 4,500 lbs., which, with the live load of 2,000 lbs., totals 6,500 lbs. The dead load is distributed equally over the four wheels while the live load is carried on the rear wheels. This gives a rear wheel load of 2,125 lbs. A 5-ton truck (not an uncommon load nowadays) gives a rear wheel load of 7,600 lbs., which would necessitate a slab of 5 in. effective depth if we assume the 2 x 2 ft. distribution, or 8 in. if we assume a distribution of 1 x 1 ft. (which is more nearly the actual condition).

The question of modern loading for highway bridges is one that demands the attention of all designing engineers. There was a time when the road roller produced maximum stresses, but to-day we have operating upon our highways many motor trucks that produce much larger stresses than the largest road roller. The bridges must be built heavy enough for these trucks or we will impose upon our country a grave barrier to progress.

A BRIDGE ENGINEER.

Toronto, January 31st, 1914.

* * * *

Inquiry re Ice Pressures, and Flow of Water in Pipes and Chambers.

Sir,—Kindly allow me through the columns of your valued paper to obtain the following information:

What is the best formula as used in modern practice where very close computation is necessary for:

(1) Flow of water in pipes of various materials as required for water supply and power development inclusive of small pipes to penstocks attaining 20 ft. in diam.?

(2) Flow of water in channels inclusive of small sewers to water conduits attaining 20 ft. diam., the latter with only the necessary head to produce full bore flow?

Ice Pressure.—Having ascertained from particular conditions existing on a river as to probable maximum amount of ice in cu. ft. which can come down in mass, also the velocity of approach:

(3) What is the formula for finding the pressure exerted per sq. ft. on a vertical surface such as a solid dam or pier? Is the centre of pressure located at the centre of gravity of ice sheet?

(4) What is the formula for the pressure against the same surface exerted during the formation of ice per sq. ft., which would be the only pressure caused by ice on a large storage reservoir or dammed lake?

(5) Must allowance be made for the total pressure exerted by a season's formation or only for amount of ice formed during the maximum period of lowest temperature prevailing?

(6) What is the crushing strength of the best average ice formed on Canadian rivers?

(7) Are there any reliable works dealing with ice pressure and where can they be procured?

Any information on the above will be deeply appreciated.

AN ENQUIRER.

Montreal, January 24th, 1914.

Concerning the annual banquet of the Canadian Society of Civil Engineers, "La Patrie," Montreal, had the following to say:—"The Canadian engineers who had their annual banquet last evening are men of actions and not of words. They made this evident in their very excellent and very brief speeches. There was not one speech of more than five minutes' duration and each speech produced a better impression than the windy eloquence to which we are accustomed under similar circumstances."

FIXED CARBON TEST AS APPLIED TO ASPHALTS

SUMMARY OF ARGUMENTS PRO AND CON THAT HAVE APPEARED IN THESE COLUMNS—A LETTER FROM FRANCIS P. SMITH, PH.B.,M.A.S. C.E., A PROMINENT CONSULTING CHEMIST AND TESTING EXPERT

Sir,—The extended discussion in your columns on this test has greatly interested the writer and it occurs to him that at this time a resumé of the arguments for and against this test may be of value to your readers. He considers it only fair to state at the outset that in his opinion it is purely an identification test and has nothing whatever to do with the fitness or unfitness of an asphalt for paving purposes

In order to intelligently discuss the matter, it is first necessary to understand clearly just what this test really is. In his own experience he has found that there seems to exist considerable confusion in the minds of a number of engineers on this subject. In many instances it has been confounded with the free carbon test used in the examination of coal tars, although in reality it is a totally different test. In order to clear this matter up, even at the risk of repeating much that has already been said, the writer begs to call attention to the definitions of these two terms which have been adopted by the Committee on Nomenclature of the American Society for Testing Materials. These definitions are as follows:—

Free Carbon in tars is organic matter which is insoluble in carbon disulphide.

Fixed Carbon is the organic matter of the residual coke obtained by burning hydrocarbon products in a covered vessel in the absence of free oxygen.

It is evident from the foregoing that *free carbon* exists as such in tars. It can be isolated and determined by the simple process of dissolving the tar in carbon disulphide. By this treatment the free carbon, which is held in mechanical suspension in the tar and exists as a very fine powder resembling lamp black, remains unaffected by the solvent and may be filtered out and weighed.

The *fixed carbon*, on the other hand, is determined by burning the material in the absence of air in a prescribed way and for a fixed and arbitrary period of time. The mixture of coke and ash left is then weighed and the amount of coke determined by burning it off until nothing but the ash is left. After deducting the weight of the ash, the per cent. of coke is calculated on the basis of the pure bitumen contained in the material under examination.

The coke obtained in this manner is, of course, procured entirely by burning the material and does not exist at all in the original substance. Take, for instance, any pure asphalt and it will dissolve completely in carbon disulphide. If it contained any coke, this coke would not dissolve and yet when the same asphalt is burned under certain conditions coke will be formed just as it is formed by the incomplete combustion of coal. The fixed carbon test was originally devised solely for the examination of coal and for the purpose of showing approximately what proportion of carbonaceous material available for the production of heat will remain after the lighter and more volatile hydrocarbons have been burned off. This is concededly a useful and important test for solid fuels but all modern paving specifications contain special provisions to prevent the burning of bituminous paving mixtures *so that it is hardly logical to consider them as coming under a fuel classification.*

The asphalts used in the paving industry differ quite widely in their composition and are really very complex materials containing a large number of constituents. To a large extent these constituents are the same in all asphalts but the relative proportions of them differ. These constituents may be divided into two classes; viz., impurities and pure bitumen. The impurities consist of mineral matter (sand, clay, etc.) and vegetable matter (twigs, sticks, etc.). Those which constitute the cementing material, (i.e., the pure bitumen), and which determine the value of the asphalt, are termed hydrocarbons, and these different hydrocarbons, when burned, yield varying amounts of coke or fixed carbon. The amount of fixed carbon produced by burning the asphalt will, therefore, vary in accordance with the kind and proportion of the different hydrocarbons present in the asphalt. For this reason the determination of the amount of fixed carbon in connection with other tests is of use in the laboratory in determining the source or origin of an asphalt.

If we knew just what hydrocarbons or combination of hydrocarbons were best suited for paving purposes the most we could do would be to determine theoretically what the fixed carbon content of an ideal paving asphalt should be. As a matter of fact, the identification of all these various hydrocarbons is not possible in the present state of our chemical knowledge and even if this difficulty were removed, we know from past experience that certain hydrocarbons which by themselves are worthless for paving purposes form, when combined with other hydrocarbons, some of our best paving asphalts. For instance, a paraffine flux which is low in fixed carbon would be useless by itself as a paving material and yet when combined with one or more suitable hard asphalts forms an asphalt cement such as has been successfully used in laying millions of square yards of asphalt pavement. Even with the good and bad hydrocarbons all identified, the question of their various combinations would make it mathematically impossible to theoretically predetermine useful limits for the fixed carbon contents of suitable refined asphalts or asphalt cements for paving work, as we would find both good and bad asphalts included in these limits.

In a large majority of cases asphalt cements are made by fluxing hard asphalts with a suitable flux. It frequently happens that refined hard asphalts which show over 15% of fixed carbon will, when fluxed into an asphalt cement of proper consistency and quality for use, show less than 15% of fixed carbon. Is the ban to be placed on them also or are they to be considered as coming within the approved class? It would certainly appear to the writer as being more logical to apply the fixed carbon test to the asphalt cement than to the refined asphalt. If the requirement is to apply to the refined asphalt alone, what is to prevent the manufacturer from fluxing the hard asphalt to a point where it shows less than 15% of fixed carbon and where its consistency is but slightly be-

low that required for paving work and designating the fluxed material as a refined asphalt? If all the theoretical and practical objections previously noted are to be disregarded, it is at least evident from the foregoing that if any limit is to be set as to the fixed carbon contents of an asphalt or asphalt cement the only proper and just data for determining such a limit is that which has been obtained from pavements laid with the various asphalts then and now in use. In this connection the following table, showing the amounts of fixed carbon found in the more commonly used paving asphalts and fluxes, will be of value:—

Bermudez	12 to 14 %
California	9.5 to 18 %
Cuban (Mariel)	13 to 14 %
Gilsonite	15 to 25 %
Grahamite	40 to 55 %
Mexican	15 to 19 %
Texas	13 to 16 %
Trinidad	10 to 13 %
Paraffine fluxes	2.5 to 4.0%
Semi-asphaltic fluxes	5.0 to 7.0%
Asphaltic fluxes	6.0 to 9.5%

Taking the asphalts which show less than a maximum of 15% of fixed carbon, we find that these include Bermudez, Cuban (Mariel), and Trinidad. The service record of all of these asphalts is sufficiently good to place them in the accepted class.

We next have the class in which the minimum fixed carbon falls below 15% and the maximum above 15%. These include California, Gilsonite, Grahamite, Mexican and Texas. The writer has had a very long and intimate acquaintance with the manufacture of California asphalts and the laying of pavements with them since the very earliest days of the industry. It is true that in the early days some California asphalt was produced showing 18% and even higher of fixed carbon. It must be remembered, however, that several grades are and were manufactured, some of them for paint and varnish purposes and these latter were much harder and necessarily higher in fixed carbon than the grades manufactured for paving purposes. In a number of cases when stocks ran low, as they frequently did in those days, the hard asphalt was shipped and used for paving work. The writer, moreover, has laid a number of pavements with just such asphalts and where they had not been cracked to such an extent as to destroy their solubility in fluxes and their cementing value, the pavements laid with them gave just as good results as those laid with asphalts lower in fixed carbon. In many cases the high percentage of fixed carbon contained in those California asphalts manufactured for varnish and paint purposes have been misleadingly quoted against California paving asphalts in general as showing their unfitness for paving purposes and the lack of care used in manufacturing them. It is history, however, that these very same carelessly manufactured asphalts, often showing high fixed carbon, proved so great a commercial success in the paving industry that the interests controlling the so-called natural asphalts attempted to control them in one vast organization. Since about 1895 gradually increasing amounts of pavements have been laid in the United States and elsewhere with California asphalt until at the present time there are many millions of square yards of pavements of this character in existence which are giving good service. There is no doubt but that a considerable proportion of the California asphalt manufactured between the years 1895 and 1900 showed over 15% of fixed carbon, but the writer is in a position to state positively that, having in mind the state of the art at that time, the average of these pavements gave just as good satisfaction as the average of the pavements laid during the same period with other asphalt showing less than 15% of fixed carbon.

Mexican asphalts normally run higher in fixed carbon than do most others. Pavements laid with this type of asphalt have been in use in Mexico, Canada and the United States for upwards of five years. A careful physical and chemical examination of them proves that they possess all of the qualities which are necessary and essential for laying a first-class asphalt pavement. They are almost 100% pure bitumen, are higher in ductility and cementing value than any others excepting the California, and are less susceptible to changes in temperature than any other paving asphalt of recognized quality. From the above data and the fact that they are produced by the same approved and time-tested methods and with the same care used in manufacturing the best California asphalts, which have proven so successful, the writer is convinced that there is every reason for including them in the list of paving asphalts of the highest quality.

Many thousand square yards of successful asphalt pavements have been laid with asphalt cement manufactured from Gilsonite. It is a fair statement to make that if the present price of Gilsonite were not so high, it would be much more widely used at the present time in the paving industry. Most of the Gilsonite available for paving purposes will show considerably in excess of 15% of fixed carbon. When fluxed with California residuum, the asphalt cement so produced will in most instances show less than 15% of fixed carbon. The service tests of pavements laid with asphalt cements of this character are undoubtedly sufficiently good to include them in the preferred class of paving asphalts. The use in the paving industry of asphalt cements made from Grahamite, which is very high in fixed carbon, has been limited, but a number of excellent pavements have been laid with this material.

Much of the so-called Texas asphalt as present upon the market will show less than 15% of fixed carbon. Occasional shipments of it, however, will run up to 16% or slightly over. Chemical and physical examination of the shipments showing over 15% of fixed carbon, together with the service records of pavements laid with them show that the high fixed carbon material is just as good as the low fixed carbon material. In fact, it is impossible to detect any difference between them. It would appear to be clear from the foregoing that, based on service tests alone, there is no reason for inserting a fixed carbon clause, or, if inserted, limiting it to a maximum of 15%. Such a maximum would limit the asphalts admitted to Bermudez, California, Cuban, Texas and Trinidad. Practically all of the present-day output of California asphalt would be admitted, together with a large proportion of the so-called Texas asphalt. Gilsonite, Grahamite and Mexican asphalts would be excluded. At the present time but small quantities of the first two asphalts are used in the paving industry, but the volume of Mexican asphalt produced in this country is very large and increasing very rapidly. From a commercial standpoint, its competition with Bermudez and Trinidad asphalts is more serious than that of any other asphalt. At the present time it is admitted under all of the standard open specifications now in force in the United States in most of the largest cities, so that it is reasonable to assume it to be of good quality. From the municipal standpoint, it is

exceedingly important that free and open competition in standard asphalts should be encouraged and maintained. From this point of view, it would be unfortunate indeed to bar out what is admittedly one of the most important factors in the asphalt situation to-day. The Mexican oil fields are concededly one of the largest, if not the largest, which have ever been developed and their supply is practically inexhaustible.

The old and artificial brand standard of judging quality is rapidly disappearing and in an attempt to preserve it in a manner which can not readily be detected, a large number of tests are being advocated under the plea that they are necessary ones. As a matter of fact, most of these tests are purely identification tests and are intended to limit the asphalts admitted under them to certain brands. It is well that municipal engineers should understand this matter thoroughly and be warned against it and only accept tests in their specifications which have been proven to be quality tests and essential in determining the actual paving value of an asphalt. It would appear, therefore, that the chief effect of a 15% fixed carbon clause would be to exclude Mexican asphalts. The authors of most of the articles which have appeared in your pages agree that asphalts produced from Mexican oils should normally show a high fixed carbon content. The strongest advocates of the fixed carbon test agree that its chief influence is to prevent an undue amount of condensation or cracking from taking place. In all asphalts produced, either by nature or man, a certain degree of condensation has taken place. It is only where this condensation is excessive that any objection can be raised to it. Asphalt manufactured from Mexican oil with all the care and precaution that years of experience has proved to be necessary will normally show over 15% of fixed carbon. From this standpoint, therefore, its exclusion is unjustifiable. From the laboratory standpoint its physical and chemical characteristics show it to possess in the highest degree the properties which have been found to be desirable and necessary in a paving asphalt. As to service tests, since 1911 over thirty thousand tons have been sold for sheet asphalt paving purposes in Canada and over sixty thousand tons in the United States. Disregarding entirely the favorable results of these service tests and the fact that it is being freely used in open competition with all other asphalts by most of our largest cities and in many municipal paving plants, it is unreasonable to assume that any such quantity of it could have been sold if it were an inferior asphalt. Contractors would have refused to bid upon it and assume maintenance guarantees. The strong inference is, therefore, that the opposition to its use is purely a commercial one.

One of the arguments which have been used in favor of the fixed carbon test is that while it may bar out certain good asphalts, it safeguards a municipality by insuring the use of only such asphalts as are suitable for paving purposes. From the standpoint of the fixed carbon test only this is not true. A great many blown asphalts which are not recognized as being suitable for paving purposes show less than 15% of fixed carbon. In fact, it is probably fair to state that taking 15% of fixed carbon as the dividing line, there are more poor asphalts showing less than 15% of fixed carbon than there are poor asphalts showing more than 15% of fixed carbon. It is apparent, therefore, that the fixed carbon test *per se* is not sufficient to insure a good paving asphalt, but that this can only be done in connection with other tests. If these other tests are sufficient to exclude the large number of poor asphalts showing less than 15% of fixed carbon, it is certainly logical to assume that these same tests will be sufficient to exclude poor asphalts showing more than 15% of fixed carbon. From this standpoint alone there would appear to be no reason why a fixed carbon test of any kind should be included in a specification for paving asphalt.

Certain points have been raised in the articles which have been published in your pages which appear to the writer to call for further comment. In discussing Mr. Pullar's paper,* the writer wishes it to be distinctly understood that as a whole his experience confirms most of the facts stated by Mr. Pullar, but that he is not in accord with the conclusions drawn by him from these facts.

Mr. Pullar, in his article, states that the ductility test in the hands of different chemists gives more widely varying results than does the fixed carbon test. The writer and his partner have probably had a greater experience with this test than anyone else and he thinks it only fair to state that when the standard method is followed the variations stated by Mr. Pullar are far too great. Assuming, however, for the sake of argument, that the ductility of the same sample was reported by two different chemists as 90 cms. and 70 cms., respectively, both of these results are so far above the usual minimum requirements for ductility that the sample would be unhesitatingly accepted as passing the requirements in this respect.

As a matter of fact, the variation in different results on the ductility test is no greater than on the fixed carbon test and all the widely known and used standard paving asphalts have a ductility far in excess of the usual minimum limit given by specifications (20 cms.), so that the allowable variation would not work a hardship on any of them or cause them to be excluded. This is shown by the following table giving the average range of ductility for cements of 50 penetration made from the asphalts mentioned in the previous table of fixed carbon contents:

Bermudez	40 to 70 cms.
California	90 cms. and over
Cuban (Mariel)	20 to 30 cms.
Gilsonite	20 to 50 cms.
Grahamite	15 to 30 cms.
Mexican	50 to 100 cms. and over
Texas	50 to 100 cms. and over
Trinidad	35 to 60 cms.

The writer has gone into the matter of the ductility test at the present time more especially because this test is employed in almost all specifications and amply guards against all undue blowing of asphaltic products.

In this connection Mr. Pullar quotes tests on a number of blown products made from Ohio and other oils. In the first place, blown products of this class are not generally considered as suitable for paving purposes and certainly not when made from Ohio oil *per se*. Products of this character would not be admitted under any of the standard paving specifications. The instances cited would, therefore, appear to have little or no bearing upon the value of the fixed carbon test for paving specifications. As a matter of fact, it is easier and cheaper to produce a blown asphalt from Mexican oils which will show less than 15% of fixed carbon than it is to produce from them a paving asphalt of good quality and high ductility that will normally contain from 15 to 17% of

*"The Value of the Fixed Carbon Test."—*The Canadian Engineer*, November 13th, 1913.

fixed carbon. If the ductility test in the usual open type of specifications were eliminated and the fixed carbon test substituted, any manufacturer could cheaply and easily make an inferior product from Mexican or other oils that would meet the specifications. This could, of course, be prevented by introducing a number of additional tests, but why cumber the specifications in this way and make them still more difficult for the average engineer and contractor to understand when a ductility test answers every purpose?

Mr. Pullar further states that a poor quality of fluxing oil will show up by high fixed carbon in a fluxed asphalt. This statement requires very considerable modification. For many purposes fluxes made from asphaltic oils are superior to those made from paraffine oils and yet the former are higher in fixed carbon. A relatively high fixed carbon in a fluxed asphalt would, therefore, in many instances indicate a better product than a low fixed carbon. Where the fluxed bitumen was a very hard one and was only partly soluble in a paraffine flux and wholly soluble in an asphaltic flux, Mr. Pullar's statement would, of course, be entirely correct, but when the hard asphalt was equally soluble in both kinds of fluxes and relatively the same amount was used in each case, the product made with the asphaltic flux would show the higher fixed carbon.

The writer strongly disagrees with Mr. Pullar that the majority of so-called open specifications are so faulty as to permit the use of undesirable material. It is his experience that under them better asphalts are being supplied than for years past and that the practice of dividing bituminous material into various classes is a cumbersome, confusing and useless one. His views on this particular subject are quite fully set forth in a previous issue of your paper; page 175, Jan. 15th, 1914.

Much has been written against the so-called "cracking" of an oil during the manufacturing process and that this necessarily injures the paving value of the asphalt and that this also is shown by the fixed carbon test. The writer is of the opinion that so long as the essential physical qualities of the product are not injured, cracking *per se* is not necessarily injurious. This may appear to be a somewhat revolutionary doctrine, but in many instances he and others have successfully used cracked products so long as their stability and cementing value had not been injuriously lowered, and in the early days of the paving industry practically all the fluxes were cracked products and they often formed 25% of the asphalt cement used.

Coal tar has long been successfully used in the paving industry and it certainly is a much cracked product, notwithstanding which it will retain its original consistency longer than asphalt and is certainly equal to it in cementing value, even though it frequently shows 30% or more of *fixed carbon.*

Mr. Kirschbraun's article* is an exceedingly able and interesting one. The writer believes, however, that his formula (based on the crude used) for determining the allowable amount of fixed carbon in an asphalt does not sufficiently take into consideration the variation in fixed carbon contents produced by different methods of distillation. This is indicated by the California asphalt mentioned by Mr. Pullar as containing only 9.5% of fixed carbon against the normal range of 11 to 14% in asphalts made from the same class of crude. His table on page 803 of your journal illustrates that a California "B" grade asphalt showing 16.3% of fixed carbon may be converted into a bright ductile cement showing only 12.6% of fixed carbon by the use of a suitable flux. This accords with the writer's experience. No other tests are given on the cement by Mr. Kirschbraun, but the writer has made similar cements which were in every way suitable for paving use and has employed them in laying pavements which were in every way successful and permanent. This shows that when combined with a suitable flux, asphalts which have been cracked in distillation and have a high fixed carbon test, are not necessarily injurious or unfit for paving *providing they have the other necessary qualities of stability and cementitiousness.* Where one type of crude is being used and the same process of distillation is employed, the fixed carbon test will undoubtedly check up variations in the handling of the stills and it is concededly valuable for that purpose, as is also the carbon tetrachloride test. At times one of these tests will show variations which the other will not. Mr. Kirschbraun states: "It is apparent that the best practice should limit this action (condensation) to the minimum and that specifications should control this by a fixed carbon limit within which the product will retain to a useful and permanent extent the qualities necessary for pavement and road construction." Possibly the writer misunderstands Mr. Kirschbraun, but he fails to see how this could be done practically. First, we have the variation due to different crudes; second, the variation due to different approved methods of refining upon the same crudes; third, the influence of various fluxes on the asphalt cement; and fourth, the determination in each particular case of the amount and kind of condensation which is harmful. If the allowable percentage of fixed carbon is to be regulated in accordance with the qualities necessary for road or pavement construction, why not specify the permissible limits in these respects and omit the at least doubtful and variable fixed carbon requirement? The ductility test will always detect lack of cementitiousness due to improper manipulation or any other cause. Hence it accomplishes all that has been claimed for the fixed carbon test without any unfair discrimination.

Mr. Kirschbraun, in his letter appearing in your issue of January 29th, proposes that the minimum theoretical fixed carbon value characteristic of an asphalt of a given penetration made under ideal refining conditions should be determined by a laboratory run, the idea being to establish a fixed carbon standard for products made from a particular crude. Laboratory methods differ as much as do producing methods on a large scale and for this reason alone the proposition seems to the writer to be impractical. It also involves the assumption that any degree of condensation in the commercial product in excess of that produced by the laboratory method employed is harmful. This argument, if carried to the extreme, would involve the use of distillation processes conducted under less than atmospheric pressures, which the writer believes to be in most cases entirely unnecessary. In his own experience asphalt produced in this way has at times been found inferior to that produced in a commercial manner with a very considerable degree of condensation, in that the product made under diminished pressure was susceptible to changes in temperature to an undesirable extent.

Mr. Kirschbraun suggests an alternative clause in which he places a maximum of 13% of fixed carbon and a sliding scale whereby any increase in the fixed carbon contents shall be compensated for by an increase in the solubility of the material in carbon tetrachloride. This appears to the writer to be an attempt to use what he

*"Fixed Carbon Depends on Crude."—*The Canadian Engineer,* December 4th, 1913.

considers tests of very questionable value to counterbalance each other.

Reverting again to the California asphalt mentioned by Mr. Pullar as containing only 9.5% of fixed carbon and assuming this to be a paving asphalt of high grade, why should any other California asphalt made from the same crude be permitted to have as much as even 13% of fixed carbon? Here, again, the question of the refining processes used becomes a very important matter in determining the allowable amount of fixed carbon, and no matter what limits as to fixed carbon and carbon tetrachloride solubility are determined upon, it becomes necessary to revert to other tests to safeguard the material to such an extent that the value of the fixed carbon test itself appears negligible.

Mr. Kirschbraun also suggests that if the chemist has no faith in the carbon tetrachloride test, this solvent might be replaced by carbon disulphide. The writer fails to see how this latter solvent could be of any value unless the material had been so far decomposed as to coke it. The products made from paraffine base oils are admittedly entirely unsuitable for paving purposes and yet these are the lowest in fixed carbon. Products made from asphaltic crudes of any sort are always higher in fixed carbon than those made from paraffine crudes. On this ground alone, therefore, it would appear to be more logical to limit the minimum amount of fixed carbon permissible in an asphalt than the maximum amount. In any event, other tests are required to determine the fitness of an asphalt, and, as previously stated, if these other tests are sufficient to discriminate between the good and bad materials having less than 15% of fixed carbon, it would appear that these same tests were also sufficient to discriminate between the good and bad materials having over 15% of fixed carbon. Why, therefore, use the fixed carbon test at all? From the standpoint of the inspecting chemist, the fixed carbon test undoubtedly has a certain value, but to introduce it properly into a specification so as not to discriminate against certain materials and yet have the provision of any use appears to the writer to be impracticable. He believes that a clause inserted in the ordinary open type specifications to the effect that all shipments of material shall be fully equal to the established standard and recognized quality of that particular brand will prove to be all that is necessary provided that the requirements as to cementing value or ductility, purity, susceptibility to changes in temperature and stability under heat are sufficiently high.

The writer agrees with Mr. Kirschbraun that the fact that the fixed carbon test was originally devised for the examination of coal does not necessarily mean that it is of no value in the examination of other materials, such as asphalts. He does not believe, however, that the authors of some of the articles which have appeared in your pages have objected to the fixed carbon test as applied to asphalts solely on the grounds of its origin. It appears to him that in view of the fact that the fixed carbon test as applied to coals is of value in judging them from the fuel standpoint, unless good and sufficient reasons are advanced to show that this test when applied to asphalts conclusively determines something entirely different, i.e., their suitability for paving purposes, it is wholly pertinent and logical to show that a test which has only been proven to measure fuel value has no place in an asphalt specification.

Mr. Law's paper* clearly shows the variations in results obtained by different chemists with the fixed carbon test and points out the cause for many of them. He also points out the absurdity of rejecting a material for being a few tenths of a per cent. in excess of specification requirements when the limit of accuracy of the method employed is less than the excess upon which the rejection is based.

Mr. Richardson's letter* ignores details entirely and proceeds upon the broad, and (to him) satisfying, assumption that all asphalts showing more than 15% of fixed carbon are inferior or experimental. This, the writer contends, is wholly unjustifiable and is not borne out by the experience gained during the past 15 years in the paving industry. It can not, therefore, be considered a very valuable contribution to the present discussion. Millions of square yards of pavements made with "residual pitches," as he terms them, have been and are being laid by his own company and others, and the results have proved that they are fully equal to pavements laid with the so-called natural asphalts which he advocates. Gilsonite has also been used in the laying of many successful pavements and much of this material shows over 15% of fixed carbon. So far as stability is concerned, all of the good asphalts made from asphaltic petroleum are more stable under heat than one of the asphalts which he advocates so strongly.

FRANCIS P. SMITH.

New York, January 31st, 1914.

*"Fixed Carbon Test Empirical."—*The Canadian Engineer*, November 20th, 1913.

*"Fixed Carbon Limitation."—*The Canadian Engineer*, December 18th, 1913.

MINERAL PRODUCTION OF ALBERTA FOR 1913.

As Alberta is the province with the greatest coal resources in all Canada, so it is developing rapidly as a producer of coal, the output for the year being estimated at about 3,500,000 tons, or nearly half the production of Nova Scotia, the oldest and largest coal-producing province. During the year thirty new coal mines were opened. The International Coal and Coke Company was the largest producer of both coal and coke, and distributed $30,000 a quarter in dividends, being equivalent to 1 per cent. per quarter. The Canadian Coal Consolidated Company, of Frank, was practically closed down this year, the production amounting to 13,958 tons. The Hillcrest Collieries at Hillcrest produced over 300,000 tons. The city of Lethbridge runs the Lethbridge City Mine, which produced about 21,750 tons. The Diamond Coal Company closed down their mine on June 1st, up to which time the mine had produced 17,503 tons. The mines in the North and through the Yellowhead Pass experienced a quiet year.

The production for the year is estimated as follows:—

Coal, 3,500,000 tons	$ 8,750,000
Coke, 100,000 tons	660,000
Cement and building materials	2,500,000
Natural gas	1,875,000
Total	$13,775,000

Venice, Italy, has appropriated $20,000 to investigate the advisability of building a highway tunnel of 11,800 feet between that city and the islands of Giudecca, San Giorgio and Lida. If this investigating body reports that the plan is practicable, such construction will mean the passing of the picturesque gondola system of transportation. If the project is carried out the tunnel will be the longest highway tunnel in the world.

PROGRESS ON THE MOUNT ROYAL TUNNEL.

DURING the recent Annual Meeting in Montreal of the Canadian Society of Civil Engineers, the Mount Royal Tunnel and Terminal Company fittingly recognized the large assembly of Canadian engineers in (1) an invitation to visit and proceed through the tunnel—an opportunity which was largely taken advantage of by the members; and (2) the circulation of a 50-page booklet descriptive of the project and the methods adopted for the carrying of it to a speedy and successful conclusion. This pamphlet contains in concise form a great deal of value in the way of information on the subject of tunneling, and we strongly feel like recommending our readers interested in the same to write Mr. S. P. Brown, Chief Engineer, Mount Royal Tunnel and Terminal Co., Montreal, for copies for themselves.

The major portion of the reading matter, and many of the illustrations have been published in past issues of *The Canadian Engineer*, but the notes on the progress of excavation work, extracted below, have not previously appeared. Before beginning this, however, our readers are referred to the following articles for more complete information respecting the planning and carrying out of this project:—

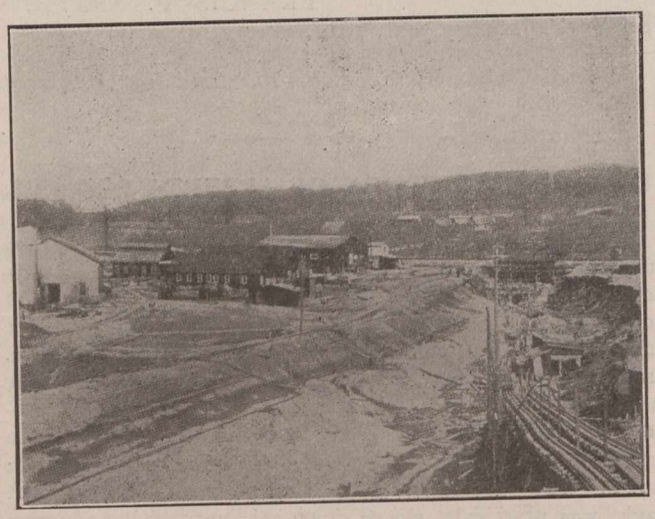

Fig. 1.—General View at the West Portal, Showing Plant and Tunnel Entrance as Seen at Present.

(1) A general description of the scheme, giving proposed location of tunnel and terminals; description of compressor plant, shops, and adopted methods of excavation, was published in *The Canadian Engineer* for January 16th, 1913.

(2) Additional data and numerous photographs, describing in detail the mechanical arrangement of plant and outlining the lines upon which drilling operations were conducted, was contained in *The Canadian Engineer* for February 6th, 1913.

(3) An article on the precise survey and measurement work, prelminary to the commencement of actual boring, by Mr. J. L. Busfield, assistant engineer, Department of Surveys and Alignment, appeared in *The Canadian Engineer* for February 27th, 1913.

(4) In our June 12, 1913, issue, announcement was made of the record in drilling which had been established during the month of May.

(5) July 10th, 1913, issue contained a description of the cross-section which had been adopted for the tunnel, and the factors attending the choice.

(6) The system of electrification decided upon was described in *The Canadian Engineer* for October 9th, 1913.

(7) A description of the electric locomotives to be used, together with equipment for control and operation, appeared in our issue of December 4th, 1913.

(8) An article by Mr. Busfield, on the underground survey work which was responsible for such a successful meeting of the headings, was published in *The Canadian Engineer* for January 22nd, 1914.

Geological Conditions of the Tunnel.—According to publication referred to above, Mount Royal, about 700 feet high, is the result of a volcanic intrusion of igneous rock forced upward through the original bed of Trenton limestone. Whether it was ever an active volcano is doubtful, as there is little evidence of lava, although it may have been scoured away by glacial, or other action, at the same time that the higher portions of the mountain were similarly eroded. There have evidently been several stages of eruption or intrusion, as both the limestone and main igneous body of so-called Essexite are broken and cut by a multitude of dikes and sheets of quite different character and evidently later origin. The trenton limestone, at a considerable depth, is found to be hard and crystalline, and is an excellent rock for tunneling. This rock, when in close proximity to a large igneous body, is sometimes highly impregnated with epidote, quartz, garnet, and other minerals.

At the city end, going west from Dorchester Street, the heading for the first 2,000 feet is in a soft black limestone, somewhat blocky and in places partially disintegrated, with occasional stretches of earth roof. The earth, above the limestone, consists of sandy clay, boulder clay, occasional layers of hard pan, fine sand and large bodies of blue leda clay. This being under the city proper, forms the most difficult ground and conditions to be encountered, and a roof shield will be used.

As the rock cover increases the rock becomes harder and more dikes of extremely hard igneous rock are encountered. By the time 3,000 feet of heading had been driven, from Dorchester Street, the heading (except for the dikes) was in good, sound Trenton limestone, becoming more crystalline. It was in this that the record progress was made.

The greatest difficulty encountered in drilling and excavating is due to the irregularity of the structure. Some of the limestone is so impregnated with various contact minerals that it is extremely hard to drill and some breccia is so broken and uneven that in places one hole would be lost out of three started. The worst trouble, however, occurred when large dykes were encountered which necessitated entirely changing the temper of the steel used; for instance, in the heading going east from the West Portal a dyke of porphyritic Camptonite, an extremely hard rock, four feet thick, continued in the face for 400 feet. Here two tempers of steel were required in the heading all the time. This greatly retarded the progress and materially increased the cost of excavation.

Another very difficult rock is a marmorized limestone that was found in one of the headings. This marble is impregnated with quartz and a natural cementing material that makes it hard to drill and causes the muck to set up so rapidly that it is very difficult to shovel into the cars.

In general, the Trenton limestone is an excellent tunneling rock although the roof is sometimes inclined to scale badly and where this ground is cut by dykes the tunnel walls are apt to be insecure. When this limestone

is badly distorted by neighboring igneous intrusions it is apt to be filled with internal strains which cause it to crack and fall making it rather treacherous and requiring heavy timbering and masonry lining.

Often, especially in the limestone, cavities are found filled with calcite crystals of both the dogtooth and nail-head pattern. Here, too, is found a good deal of saponite and pyrites in various forms. Considerable Dawsonite, Feldspar, metallic arsenic and gypsum have been found from time to time, but not in quantities to be commercially valuable.

Heading Excavation.—Time being of vital importance in the Mount Royal Tunnel, it was decided to adopt a bottom centre heading which could be driven ahead rapidly, without much regard for the character of the ground, and from which the full-sized excavation could be developed at as many places simultaneously as desired. The headings are driven 8 to 10 feet high by 12 to 14 feet wide (over 50% larger than the headings of the principal Alpine tunnels) for the sake of ultimate economy.

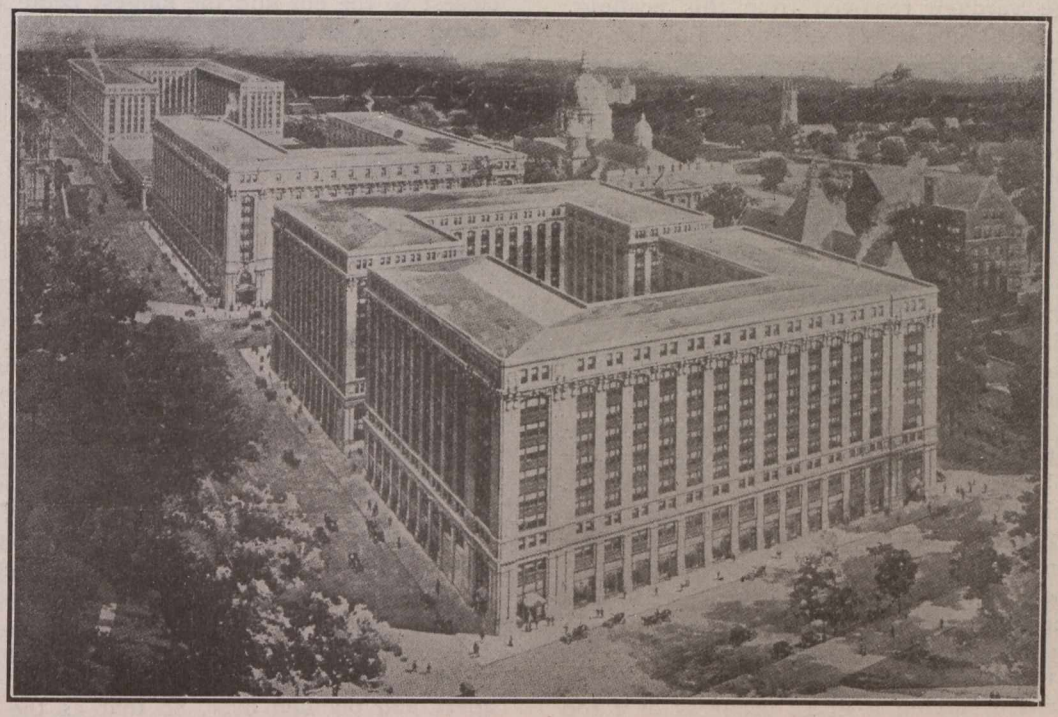

Fig. 2.—Proposed Buildings for the C.N.R. Passenger Terminal, Montreal.

While this somewhat reduces the rate of progress, it very much decreases the cost of further excavation and construction; permitting reasonably broad-gauge double track through the break-ups, where the full size tunnel section, 22 feet high by 30 feet wide, is developed.

In the headings three principal methods have been used. In the method where the rock was not so hard as to require an excessively heavy drilling equipment, the drills are mounted on a horizontal bar and the equipment is handled in and out of the heading by hand. During this stage at the city end the heading cross-section was reduced to about 8 by 12 feet for the sake of rapidity in progress. Here no drill carriage was used, as much lighter drills were required, and a progress of 810 feet was made in the 31 working days following May 1st. This is the greatest linear progress ever made in a hard rock heading on this continent and has only been exceeded in Switzerland.

Four drills are used in each heading, supported on a horizontal bar. These drills are operated by compressed air at about 100 lbs. pressure per square inch. Each drill is fitted with special connection so that water may be forced through the piston and drill steel, which are hollow, into the bottom of the hole being drilled, thus keeping it cool and clean.

It is also interesting because both the linear feet of drilling (about 650 feet per 24 hours) and cubic yards of excavation (93 cubic yards per day) exceed anything ever accomplished in the European tunnels.

As the headings got into the hard igneous rock heavier drills were required, so that the total drilling equipment, including drills, saddles, arms and bar, weighed several tons. To carry this mass two types of drill carriages were devised. Each carries the drill bar on a long cantilever arm having a reach of over 20 feet beyond the carriage and is so arranged that the drills never have to be dismounted from the bar nor disconnected from the hose-manifold which is fastened to this cantilever arm. Thus the only connections to be made, when moving out or setting up, are the main air and water hose to the pipe lines entering the heading, and the only labor is that of jacking the horizontal drill-bar tightly into position after it has been brought in and placed by the drill carriage.

All drill carriage track is riveted to steel plates so that the track may be cleared rapidly to within about 25 feet of the face after each shot, merely throwing the muck right and left. In the case of the muck-handling drill carriage the track is laid on one side of the heading while the other has its track down the centre. These machines save wear and tear on both men and machines, and make a surprising difference in the efficiency of both. With these machines the drills are in the heading ready to be jacked into place by the time the drillers have the loose rock barred down from the sides and roof and the muck thrown back sufficiently from the face to enable the bar to be set. Thus the time spent in setting up and taking down is much reduced. It is also notable that less muckers are required with this system than before the drill carriages were installed.

One drill carriage is so designed that the cantilever arm is given its motion, longitudinally, transversely and vertically by motor-driven attachments. This machine remains in the heading after the drills are placed and has a belt conveyer running through it longitudinally about 18 inches above the track, which elevates and dumps the muck into cars in the rear. This was used in one of the headings, as shown in Fig. 3.

The effect of installing the muck-handling drill carriage is shown to a remarkable degree by the difference in progress obtained without any increase in force. For the six months prior to its installation the average progress in this heading was 350 feet per month. For the six months after the installation of the drill carriage the average progress has been 485 feet per month. This is an increase of 38%. Furthermore, it must be remembered that before the drill carriage was installed the heading was in limestone, for the greater part, while the drill carriage has been working almost exclusively in Essexite. The best month, May, 1913, was 510 feet in 27 working days. This heading is 10 feet high by 12.5 feet wide.

The average yardage removed from this heading, including the 4 break-ups now working, is about 500 cubic yards, place measurement, per day. The linear progress in these break-ups is about twice that of the heading.

The other drill carriage used has no motor attachment and is removed from the heading after the drills are placed, leaving the cantilever arm attached to the drill bar and supported on a gallows frame which leaves the heading open for mucking, as shown in Fig. 4. In this case the cantilever arm is advanced by the locomotive which pushes the drill carriage into the heading. The lateral and vertical movement are obtained by jacks and by hand. The progress with this carriage is almost identical with that of the other.

The average progress over the entire job since the headings were started in the tunnel has been 420 feet per month in each heading. This makes no allowance for delays or lost time. It must also be remembered that for six months on the city end the blasting was restricted between the hours of 11 p.m. and 7 a.m. to avoid public annoyance. The average progress, where blasting has been unrestricted, has been 430 feet per month in each heading. From the time the first heading was started in the tunnel until the final meeting almost exactly fifteen months have elapsed, giving a gross progress of 1,100 feet per month.

The general heading procedure is as follows:—

After a round of blasts has been completed the loose rock is barred down from the roof and sides and the muck (i.e., the broken rock) is thrown back from the face sufficiently to permit the horizontal bar and drills to be set up. These are erected, connected with the air and water lines and drilling commenced. From 18 to 24 holes, 5 to 8 feet deep, are drilled in the heading. In the meantime the muckers have cleared the tracks, and are shovelling the muck into the cars, or onto the conveying belt where the muck-handling drill carriage is used. Smooth steel plates, called slick sheets, are laid in the bottom of the heading before each blast, for the muck to fall on, so that the muckers shovel off a smooth surface.

Where no drill carriage was used three muckers threw the muck back from the face to the slick sheets and four shovelled it into the cars. These four men, on each shift of 8 hours, handled all the muck made in that shift. Thus, during the record month, each man handled from 12 to 15 cubic yards of muck per shift, which, considering that about two hours of each shift were lost in blasting, was a most unusual performance.

All blasts are fired electrically from the lighting circuit; the blasting switch and leads being carried on the opposite side of the heading from other electric wires. Where time fuses are not used the rounds are usually fired in four shots; 1st, the cut holes, which form the opening wedge; 2nd, the relieving holes, immediately surrounding the cut; 3rd, the line holes, which break the heading to its full width; 4th, the dry holes, which break the heading to its full height. Sometimes the line holes and dry holes are fired together when the ground is breaking well.

When time fuses are used the cut is fired in the usual way with ordinary exploders so that if, as is very often the case, the cut does not break to the bottom at the first shot it can be fired a second time.

After the cut has been fired the rest of the heading is loaded with time fuses, cut at two-inch intervals, running in length from two inches up. Two of each length of fuse are used around the cut, the shortest fuses being closest to the cut and the longest being the two bottom corner holes so that the muck will be thrown back from the face by the last explosion. These fuses are ignited by electric igniters exactly similar in construction and resistance to the regular electric exploders. Thus all fuses are ignited simultaneously and regular exploders may be discharged at the same time if desired. This method saves time in blasting and leaves the men much fresher than if they had to go back into the smoke again and again. As all the fuses are very short the danger from cut-off holes is practically eliminated; in fact there has been no trouble from this source whatever thus far. This method is also used in all the break-ups.

In the heading a round of shots is fired from 3 to 6 times a day (24 hours). During the record month, with three exceptions, six shots were fired every day.

Break-up Excavation.—The break-ups (see Fig. 5), where the upper part of the tunnel section is excavated to its full width and height, are opened at intervals of 500 to 800 feet along the centre bottom heading. As many of these may be opened as are necessary to keep up with the heading progress, the advance in each break-up being about half that in the heading.

In making the break-up excavation heavy jumbo timbers are framed into the heading, about two feet apart and planked over, so that as the rock is blasted down from above, it can be run through the jumbo timbers into the muck cars in the heading beneath.

The break-ups are advanced by carrying an entry, about 15 feet ahead of the wing wall excavation, the same width of the heading and to the full height of the roof. A horizontal bar is used with 4 drills as in the heading. Immediately after shooting the bar is set up above the muck and the upper half of the entry is drilled. Then the bar is removed to the other end of break-up, and while the upper half of that entry is being drilled the muck is removed from the first entry. Thus when the upper half of the second entry is drilled the bar may be set up again in the first entry and the lower half drilled. By the time this drilling is finished the muck is removed from the second entry and the lower half of that may be drilled. In the meantime two columns with a single drill on each are set up in the wings and these drilled so that all the drilling is finished at the same time.

In the limestone two drilling shifts will break all the ground that three mucking shifts can handle economically. As the blasting is always breaking to two faces the drilling is comparatively light and very little powder

is required; the powder actually amounting to less than one-quarter that required in heading work. The blasting in the break-ups is done with time fuses which are ignited electrically. Thus it will be seen that the break-up excavation requires but little labor and explosive, being both rapid and economical. With four break-ups and one heading working at the back of the mountain the average excavation was about 500 cubic yards of place measurement daily, all of which goes out through the west heading to the main crusher plant.

A very important advantage of this method of tunnel driving is that where bad ground is encountered no material delay is experienced. The bottom heading progresses on through the bad material, which is treated carefully at leisure later on. This saves much time in the ultimate completing, and much money and risk in the construction. Some bad ground in break-ups where heavy internal stresses developed in the roof, require considerable timbering. This will be all concreted in with a reinforced single arch before the steam shovel reaches it, so that neither time nor money will have been lost.

In connection with the physical risk involved by this method it is interesting to note that within 15 months since the tunnel headings were started and with nearly a mile and a half of break-ups completed there has been only one fatal tunnel accident.

Bench Excavation.—The side benches, below the level of the jumbo timbers, are taken out, after the break-up excavation has been completed, by a steam shovel operated by compressed air. By this method the benches may be drilled and blasted well in advance and by a special loading device the usual delay in spotting cars is avoided, and no time will be lost by the shovel, making this excavation very cheap and rapid.

At places where a steam shovel cannot be used because of timbering, special construction, or shield work, the benches will be handled by hand and a belt conveyer loading into the tunnel cars.

Shield Work.—At the city end where very soft heavy ground is encountered under most unfavorable conditions, a steel roof shield has been adopted. This avoids settlement of overlying material, reduces the drainage of the surrounding ground, and eliminates the very heavy and expensive timberwork that would otherwise be necessary.

This shield consists of a cutting edge, shaped to conform to the outline of the tunnel roof cross-section, which forms the front of a steel envelope extending over the platforms on which the men work and back far enough to lap over the last "ring" or section of tunnel lining erected. Steel poling boards, semi-attached to the shield will be used, especially in the boulder clay, thus producing a cutting edge that may be advanced in sections where desired.

The shield is supported on steel columns forming the centre wall and on side walls which rest on the solid rock. It is forced ahead by hydraulic jacks, under a pressure of about 5,000 pds. per sq. in. These jacks push against the tunnel lining as it is erected.

The procedure is as follows:—

After a shove, i.e., a move of the shield, 27 in. ahead, a ring of concrete blocks, 27 in. wide, along the axis of the tunnel, by 24 in. thick and about 5 ft. long circumferentially, are set up in place by means of a hydraulic erector. When this tier of blocks is in place, the jacks are put in motion, jamming the new blocks hard against the last tier erected and forcing the shield slowly ahead, as fast as the ground is excavated in front of it. The excavated material, like that in the break-ups, is dropped directly into cars in the heading below. As soon as this shield has made a shove of 27 in. the process is repeated.

Where boulders are encountered the shield will be retarded and the steel poling boards advanced along the rest of the shield face for the 27-in. shove, when the boulder will have been removed in part or wholly.

Where special rectangular sections are built, a steel structure will be erected and steel sheeting used over and around it. This steel sheeting will be advanced by jacks, the structural steel and enclosing concrete being placed under the sheeting as it advances.

By this method the roof is never exposed; the men are never endangered by falling material, and if water is encountered the face can be protected by poling and breast boards with small pneumatic guns, or jacks, so that very little water or ground can escape.

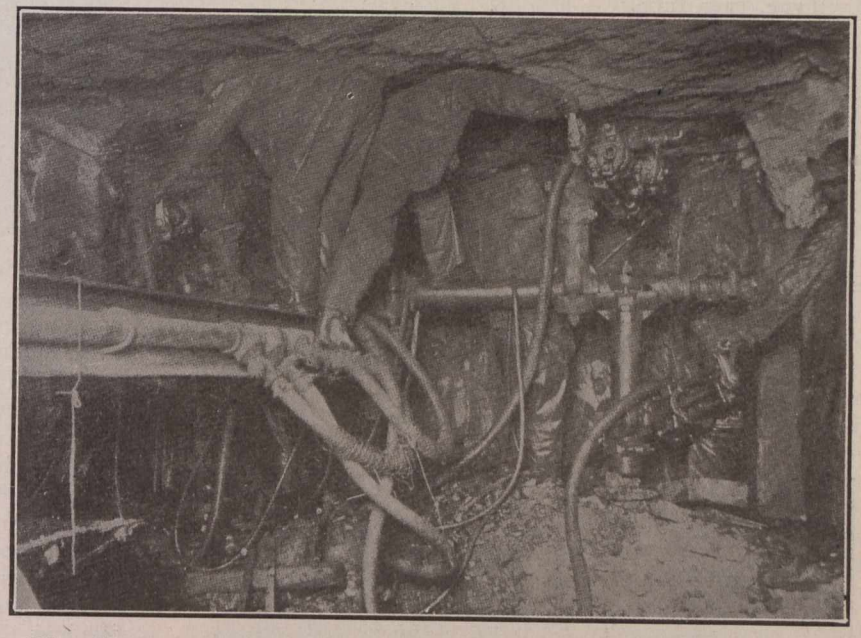

Fig. 3.—Heading Excavation Using Muck Handling Drill Carriage.

The blocks used are very massive and so designed that each block locks firmly into the two adjoining ones of the preceding ring, by oval shaped tenons. They are thus self-supporting and require no forms such as are usually necessary for concrete work. Since they are moulded many weeks in advance, before being brought into the tunnel, when they are erected under the shield they are sufficiently hard to withstand the thrusts of the jacks without injury. The blocks are also so designed that the extrados of the arch is continuous. but the joints in the intrados are about 1¼ inches wide. These joints are held to shape primarily by 3 part wedges or separators and later filled with mortar by means of a cement gun and grouting.

Crusher Plant.—All the rock excavated in the tunnel is being crushed for road materal and concrete stone. All that is not used by the company or railway is sold for local consumption about Montreal. The main crusher plant at the west portal consists of two No. 7 Kennedy gyratory crushers with Stephens-Adamson elevators, con-

veyers and screens. The capacity is about 1,600 cubic yards per day. The tunnel muck is hoisted in cars up an incline to tipples. After dumping, the empties are returned to the tunnel level, through a gravity switchboard. The muck passes through the crushers and is elevated to a revolving screen which separates the stone into the various sizes and distributes it by chutes into bins. It can then be run directly into trucks or cars on tracks connected with both the C.P.R. and G.T.R. The overflow is carried on belt conveyers to various stock piles for the different sizes of stone. From these piles the stone is loaded by means of a locomotive crane and clam-shell bucket.

At the city end the tunnell rock is sold as it comes from the tunnel and crushed by an outside company.

The following synopsis gives in a few words the main features of the tunnel itself:—

Length, 3 1/10 miles.
Heading in station site, ⅓ mile.
Grade, 0.6% down towards the city.
Section, 23.5 feet high by 31 feet wide, standard excavation.
Type, twin tube.
Depth, 600 feet below summit.
Geology, Trenton limestone and Essexite with igneous dykes.
Method, bottom centre heading and break-ups.
Progress, best single heading 810 feet in 31 working days, averaging 420 feet per month in each heading.
Gross average, 1,100 feet per month.
An estimate of quantities of material is as follows:—
Excavation, 20,000 cubic yards of earth; 405,000 cubic yards of rock.
Concrete, 50,000 cubic yards.
Steel and iron, 4,400,000 lbs.
Shafts, Maplewood, 240 feet deep; Dorchester, 55 feet deep.
Present pay roll, 1,000 employees.

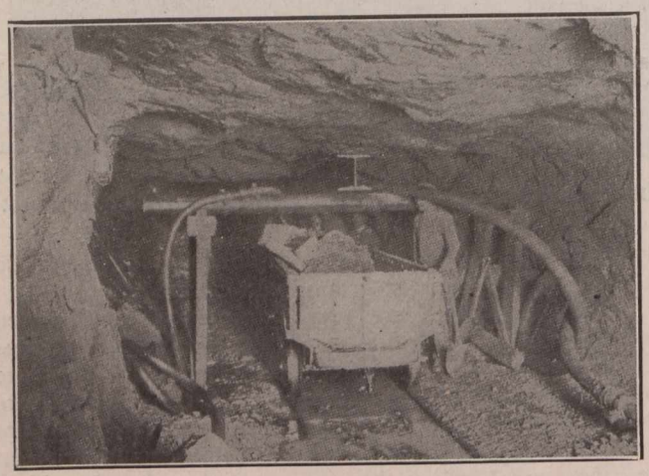

Fig. 4.—Heading Excavation, Rear End of Cantilever Beam of Drill Carriage Without Conveyer.

Present daily consumption of 60% dynamite, 2,000 pounds.

Present daily rate of solid excavation, 900 cubic yards.

Concerning the terminal site, exclusive of buildings, the figures given below are announced in the report:—

Length, 1,200 feet.
Width, 350 feet.
Depth, 50 feet maximum.
Total tracks, 13.

Excavation, 540,000 cubic yards earth; 95,000 cubic yards rock.

Concrete, 100,000 cubic yards retaining walls, track, slabs and platforms,

Reinforcing steel, 3,500,000 lbs.
Structural steel, 8,000,000 lbs.

The Mount Royal Heights station, as designed, gives the following estimate:—

Length, 500 feet.
Depth, 35 feet maximum.
Excavation, 24,000 cubic yards earth; 7,000 cubic yards rock; concrete, 7,000 cubic yards.

Fig. 5.—Break-up Excavation, Showing Bottom Heading With Jumbo Timbers.

Personnel.—The engineering and construction organization is under the direction of Mr. S. P. Brown, B.Sc., Managing Engineer for Mackenzie, Mann & Co., Limited, and Chief Engineer of the Mount Royal Tunnel and Terminal Company, Limited. In the Department of Design, Mr. W. C. Lancaster, E.E., M.E., is electrical and mechanical engineer; and Mr. H. D. Robinson, B.Sc., is engineer of structural design. The Department of Surveys and Alignment is in charge of Mr. Howell T. Fisher, Tunnel Engineer. Assisting him are Mr. J. L. Busfield, B.Sc., on the eastern division, and Mr. R. S. Bassett, B.Sc., on the western division. Mr. J. C. K. Stuart is first assistant engineer, Department of Construction, while Ed. Duffy and Richard Byers are superintendents of the eastern and western divisions respectively.

FINAL WORK ON GATUN DAM.

The two wings of Gatun Dam have been practically finished, the crests being raised three feet above final level, in order to allow for settlement. The remaining work on the dam proper will be in grading the top after the settling. Spoil from the borrow pit beyond the west end of the dam is now being placed at the west end of the east wing, next to the spillway, to cover the draft tubes leading to the hydro-electric station, and to connect the dam by suitable slopes with the side wall of the spillway discharge-channel. The total amount of material placed in the dam to December 1st, 1913, according to the Canal Record for December 24th, was 22,052,666 cubic yards.

Over 1,400 water meters were installed by the city of Regina during 1913.

AMENDMENT TO THE SASKATCHEWAN PUBLIC HEALTH ACT OF INTEREST TO MUNICIPAL AND CONSULTING ENGINEERS IN THE PROVINCE.

AN amendment was passed at the recent session of the Saskatchewan Legislative Assembly, which will prove of interest and advantage to municipalities in that province contemplating the establishment or extension of public health works, and to the engineers acting for such municipalities. The Public Health Act of Saskatchewan is frequently referred to as providing the most advanced legislation in the Dominion with regard to waterworks, sewerage and sewage disposal control.

Previous to the passing of the amendment referred to, the Act required that complete plans and specifications of all waterworks, sewerage or sewage disposal systems or extensions, should be submitted to the Commissioner of Public Health, and his certificate of approval obtained, before any by-law for the purpose of raising money for such works could be submitted to the votes of the electors; and further, that no debentures would be valid if issued under any by-law passed in contravention to the foregoing requirement.

The Commissioner has received the hearty co-operation of the various municipalities in the administration of the Act, but he has noted that in some cases, particularly in the smaller towns, the preparation and submission of complete plans and specifications, previous to the passing of the by-law was a matter which called for re-consideration, because of the following circumstances.

(1) A municipal council taking up office in January required some six weeks in which to formulate the constructional programme for the year. The engineer, on receiving his instructions, proceeded with the preparation of plans and specifications which occupied at least two months. These plans and specifications were submitted to the Commissioner of Public Health during the month of April, and assuming that they were satisfactory to the Commissioner, the by-law could not be voted upon until it had been advertised for three successive weeks. Thus, the electors did not vote until about June 1st, and the necessary procedure following the passing of the by-law, usually delayed the letting of the contracts until the constructional season was far advanced.

(2) Consulting engineers engaged by municipalities had of necessity to incur considerable expenditure in rushing the preparation of detailed plans and specifications, for which remuneration was not forthcoming in many cases until debentures were sold.

(3) There was a possibility of the by-law being opposed by a majority of the ratepayers, in which case, the preparation of the details of the scheme meant unnecessary expense to the municipality.

The difficulties raised will be met by the new amendment, wherein it is required that a report, general plans and such information as may be required to allow of a general understanding of the proposed system or extension may be submitted, and a provisional certificate issued by the Commissioner, which will be sufficient for the purposes of the by-law.

No debentures will, however, be valid until the complete plans and specifications of the system have been submitted and approved.

Regulations will shortly be issued from the Bureau of Health, stating definitely what form the various plans and data necessary for the provisional and final certificates shall take.

SEPARATING WATER FROM CREOSOTE OIL.

By Thomas White,
Assistant Manager of American Creosote Works.

IT is an established fact that it is practically impossible to obtain creosote oil entirely free of water owing to the origin of the oil. After the purchase of almost water-free oil it requires eternal vigilance to keep it so. Some methods of effecting a separation of the water were described by Mr. Thos. White, at the annual convention in New Orleans, of the American Wood Preservers' Association. From his paper the following is reproduced.

Among the conditions which bring about this intrusion of water are difficulties to be expected from the nature of the treating business. Among these are to be mentioned leaks in the steam coils of the storage and treating tanks and cylinders caused by the acids of the oil or the timber, steam condensation and moisture from the timber in the cylinders, or if the plant uses underground tanks seepage of ground water into these through open seams or pin holes. While some water from rainfall becomes mixed with the oil if in open tanks, this can be siphoned off directly from the top. This free water is really an asset in that it affords positive fire and light ning protection.

In these varous ways water is slowly accumulated in the oil. This water is readily gotten rid of by the use of the steam coils in the tanks which are brought into every-day use, but if kept cold in a reserve storage tank which is only drawn on at wide intervals we may expect some difficulty from it. In this cold condition the contents will stratify in the tank into three main horizontal zones, each of varying depth, depending upon the gravity of the oil. The top zone will be free water floating over the middle one, which is an emulsion, while the bottom zone will contain the least amount of water, which we incorrectly say is in chemical combination with the oil. The water in this bottom zone is usually such a small portion, within our lawful allowance, that it will hardly be troublesome This zone is the most accessible in the tank, and very likely will be first used. It is the water in the middle zone which is most difficult to eliminate. Heating the contents to boiling point in an open tank with steam coils will create an upward circulation, which will continue after the steam has been shut off and until the liquid thoroughly cools. Since the water is lighest it will rise to the top, where it can be readily drawn off. If the tank is provided with an agitator it will greatly facilitate the operation, causing quicker evaporation and stratification.

The other method of water extraction, which is the best but not always justifiable at the creosoting plant, is the still method. Ordinarily, the use of the still for this purpose at the treating plant is so seldom required, coupled with its comparatively higher cost of installation and maintenance, make it rather prohibitive there. Although the still may be used to refractionate the oil to make either a lighter or heavier one, at the same time the open tank, with its necessary steam coils, is always reserve storage capacity.

Of the two styles of stills, namely, the horizontal and the vertical, the latter is thought by the writer to

be the more preferable for water removal, although the horizontal still seems to be used almost universally throughout the United States for tar distillation. Even from the point of construction and maintenance the vertical one is most favorable in that it would not require a separately built smokestack and when burned out at the bottom could be replaced easily. It should induce better evaporation in that there would be a more direct and quicker circulation of the gases. While the heating surface appears less this may be increased by the use of vertical fire flues, which would also serve as smokestacks. There would also be less tendency to foam, which means that the operation could be rushed more with less danger of the oil boiling out of the still.

The open-tank method described above should evaporate at least 1 per cent. of water per day while the liquid is kept heated above 180° F., not to mention the free water which would separate and rise to the top. The still method would probably evaporate about 1 per cent. of water per hour. The still would require extra fuel and attention, whereas the open-tank coils would tax the main boiler and its fireman very little more.

Of course, there are numerous other methods of water extraction, such as the centrifugal and vacuum processes, some of which might be preferred in individual cases.

THE WORKING OF GYPSUM.

Mr. L. C. Snider has published some good information in Bulletin 11 of the Oklahoma Geological Survey, concerning the calcining of gypsum.

Its principal commercial value arises from the fact that at the moderate temperature of 130° C., three-fourths of its water of crystallization is expelled, yielding plaster of paris. Water begins to come off below 100° C., but very slowly up to 130°. At 163° C. more water is expelled, and if a temperature of 221° is not exceeded, the resulting plaster is still serviceable, but if calcined above that temperature, the plaster becomes increasingly slow to set with the addition of water. At 343° C. gypsum is completely dehydrated, and the "dead burned" plaster loses all hydraulic properties, becoming $CaSO_4$, or anhydrite.

In practice, two dissimilar methods are employed for calcining gypsum. The older method uses kettles holding up to 25 tons. The gypsum is first pulverized by passing successively through jaw crushers, gyratory crushers, and buhr mills, and is then charged slowly into the kettles, which are heated from outside and are provided with interior stirring devices. In about 1 hr. after filling, the mass reaches a temperature of 230° F. and begins to "boil" by raped expulsion of water. When it reaches 350° F., the plaster is discharged into a cooling pit, and is afterwards screened, the coarser grains being reground.

The more modern Cummer continuous process utilizes a rotary kiln through which furnace gases and hot air are drawn by fan. In this method, the gypsum is crushed only to nut size before being fed automatically and continuously into the kiln. It passes through the kiln in about 10 min. and is discharged at a temperature of nearly 500° F., which, however, is not sufficient to "dead burn" the gypsum, owing to the presence of moisture which is not fully expelled during the short stay in the kiln. The hot gypsum is then stored in brick bins, where the mass acquires a uniform temperature just sufficient to produce plaster paris of the right quality. The calcined lumps are then pulverized and sifted. The advantages of the latter method are (1) that less than half so much fuel is required per ton of output, owing to the continuity of the heating, and (2) less power is required to pulverize calcined than raw gypsum.

COAST TO COAST.

St. Mary's Ont.—A new C.P.R. station at St. Mary's has been opened recently for public use.

St. Thomas, Ont.—Water has been pumped into the new water tower at St. Thomas, and no fault has been found in the construction.

Edmonton, Alta.—Estimates amounting to $1,325,161 as expenditure for maintenance and operation of the city utilities department are being considered by the Edmonton City Council.

Port Nelson, Ont.—The last mail received from Port Nelson, which arrived at Ottawa, contained the information that the tower of the wireless station being constructed there to connect with Le Pas, had attained the height of 150 feet on December 15th. It is estimated that, by this time, it is complete.

Guelph, Ont.—The annual report of the road superintendent submitted last week at the county council showed the amount expended under the Highway Improvement Act last year to be $61,283.95. Of this sum, $25,968.97 was expended upon bridges, and $35,314.98, upon culverts and general road construction .

Ottawa, Ont.—The annual report of the N.T.R. Commission for the financial year ending March 31, 1913, showed the total expenditure for construction as $13,729,461; or, the total expenditure from March, 1904, to March, 1913, as $130,247,152. The total grading done by March, 1913, was 1,739 miles. The total miles of track laid was 1,720 miles on the main line and 384 miles on sidings and double track, making a maximum total of 2,125 miles.

Winnipeg, Man.—The surplus on the operation of Government telephones for the year ending November 20, is shown by the report of the Hon. Hugh Armstrong, provincial treasurer, to be $30,264.64. The total revenue for the year is quoted as $1,707,149.74; net earnings, $437,239.84; and interest charges, $406,975.20. The report also details large expenditure on new construction during the year, as well as a general increase in the salaries of employees throughout the system.

Verdun, Que.—Some months ago, Verdun embarked upon a project to prevent just such an emergency as occurred recently in Montreal—i.e., it reorganized its water service, the result being that within a few weeks, it will have in operation a new pumping plant capable of supplying to the town 4,000,000 gallons daily, this in addition to two reserve pumps, which at present supply 3,000,000 gallons daily, making a total of 7,000,000 gallons; while the total consumption of the town at present is only 1,000,000. The new pump is supplied by a separate intake, the two already in existence supplying the two reserve pumps, and will provide, when it is completed, three distinct and complete sources of water supply. In addition, the water will be filtered.

Fort William, Ont.—A busy season in ship repair and construction is reported at the harbor of Fort William, and also at the Port Arthur drydocks. At Fort William, the tugs "Sarnia" and "Home Rule," owned by the Thunder Bay Contracting Company, are undergoing extensive alterations and repairs; and the eight dredges which have been working in the harbor during the past season for navigation, are being overhauled in preparation for next season's work. At Port Arthur, the work on the large steel freighter under construction is progressing favorably and it is expected that the vessel will be launched about the end of March. Also new motors have been installed in the C.P.R. steamers "Alberta" and "Athabasca"; new pistons are being installed in the engines; the wiring system of the boats is being entirely renewed; new anchors have replaced the old-fashioned ones; and alter-

ations to the cabins have been commenced. Repairs have also been completed to the "Plummer," "Dwyer" and the tug "James Whalen."

Regina, Sask.—Considerable interest is manifested in Regina in the natural gas proposition made by the Coste-McAuley Syndicate, which has been favored by the city council. According to the terms of this agreement, the city will secure natural gas at the rate of 20 cents per cubic foot, which will mean that power can be supplied to industrial concerns at a nominal figure without incurring any loss to the city. The power problem has been recognized by the city for some years past as a difficult one; and, although Regina's rates were lower than those of practically every city in the west, it was recognized that the advantage to industrial concerns was to a certain extent off-set by the high rate for power. With natural gas at this price, it is claimed that power rates for such as milling enterprises, etc., would be reduced to a minimum; and all of Regina's business men are very optimistic with regard to the probability of greater industrial development. The gas will be secured within 100 miles of Regina, and piped to the city.

Montreal, Que.—This city is now advertising for tenders for the fourth unit of work in connection with the filtration plant under construction. This last portion requires an approximate expenditure of $150,000, which will bring the total cost of the plant to about $1,350,000. The construction of the filtration plant was divided into four portions—namely, the supply and installation of the machinery; the construction of final filters, including gravel and sand beds; the construction of pre-filters and filtered water reservoir, and the construction of buildings. The first three contracts are not quite completed, much delay having been experienced in the laying of the foundations, which were damaged by frost in the course of last winter and had to be repaired. The British Electric Plant Company, of Alloa, Scotland, for the sum of $40,250, is supplying and installing the pumping machinery, which consists of 14 centrifugal pumps directly connected to the electric motors, 4 of which are of a capacity of 17,500 gallons per minute, 2 of 11,600, 2 of 5,800, 2 of 1,300, 2 of 330 and 2 of 150 gallons. The rotary blower to be connected to an electric motor has a capacity of 5,000 cubic feet of air against 5 pounds per square inch pressure. The contract also provides for the supply of 2 hand-operated cranes of a capacity of 6 tons. Mr. Norman M. McLeod is executing the contract for the second division of the work at a cost of $673,000, and also for the third division at a cost of $485,000. This third contract calls for 16 reinforced concrete pre-filters of the mechanical type of 3¼ million gallons each per 24 hours; and for a reservoir with a capacity of 6¼ million gallons.

Victoria, B.C.—Arrangements are being made for an early start this year on the water rights investigation work being carried on in Greater Vancouver and in the lower Fraser Valley. That portion of the work of particular interest to Greater Vancouver is the measurement of the flow in Lynn, Seymour, and Capilano Creeks and their tributaries; and calculations as to water storage possibilities on these streams and investigation into the watershed situation with a view to ascertaining what damage might be done to the water supply by the removal of the timber on alienated land. Much of this work has been under the direction of Surveyor W. C. Smith; and he will continue his field investigations during the coming season. The work in the entire district mentioned is under the control of E. A. Jamieson, one of the assistant engineers of the provincial water rights department. The work on the north shore will be under the immediate supervision of William Young, comptroller of the provincial water rights branch. The investigations of the water rights department will have the effect of putting Vancouver's claim in Seymour Creek on a more definite basis. It has been reckoned that there are 3,000 miners' inches of water in the creek, of which 1,700 are controlled by the city of Vancouver, including those acquired from Point Grey and Burnaby for conveying water to those municipalities. The volume of water has never been known with any certainty, and doubt has been expressed that there are 3,000 miners' inches in the dry season. Moreover, the surveys of the Seymour Creek watershed by the department of water rights will have direct bearing on the scheme for conserving the water supply being put forward by Vancouver. On the report of this department, and of the forestry branch which has been investigating the timber in the watershed, will depend whether or not the city will buy the timber rights and crown grants above Seymour Falls for a reservoir.

Vancouver, B.C.—It seems a certain thing that by early March the eastern portion of the new C.P.R. station at Vancouver will be occupied. When the office staff and regular facilities have been transferred to this new structure, the work of razing the old depot will be undertaken, and upon its site will be constructed the Granville viaduct, which is another of the terminal units planned by this railway system. The new station will measure across the tracks from east to west, 480 feet, or practically two blocks long. It is being constructed of red brick, terra cotta, and granite and limestone trimmings. Along the Cordova street side there will be ten great Corinthian free-standing columns and ten engaged columns, constructed of limestone. The great entrance will open out directly on Cordova Street. From this entrance straight through the general waiting-room will be the main entrance and exit to all trains. There also will be an entrance off Granville Street and one on the track side for third-class passengers from the wharves and trains. In all, there will be six entrances. There will be two floors below the street level on the track side. Baggage and express departments will occupy most of the room in these. Here also will be the mail room, telephone exchange, service department, pump and boiler-rooms, also two large electrical transformers for lighting the building and running the elevators. The lower mezzanine floor is to be occupied by the kitchen; the central portion of the main floor by the general waiting-room, which will be 150 ft. long and 60 ft. wide, with massive pillars at the sides and a ceiling heavily beamed and panelled, 40 feet above the floor. In this room the lunch counter will be installed. A large lobby will open from the main waiting-room for first and second-class passenger business, while the third-class waiting-room and ticket office will be on the upper mezzanine floor. On the main will be located also the general freight department, general passenger agents, baggage agents, claims agents, as well as the offices of the Canadian-Australian steamship service, commissary, etc. Finally, the attic floor will be occupied by the general staff and all offices, such as private bureaux, the draughting-room for the engineering department, the railway telegraph and the like.

PERSONAL.

CHAS. H. KEEFER, C.E., Ottawa, was elected to the Board of Directors of the American Society of Civil Engineers, at its annual meeting in January.

W. G. CHACE, Chief Engineer of the Greater Winnipeg Water District will address a meeting of the University of Manitoba Engineering Society, on February 9th.

S. G. PORTER, M.Am.Soc.C.E., addressed the Calgary branch of the Canadian Society of Civil Engineers at a meeting on January 23rd, on "The Engineer and his Relation to Society."

P. B. McGINNIS, until recently connected with the Canada Cement Company, in their Winnipeg office, has been

transferred to Medicine Hat to take charge of the construction work of the company's plant, No. 14, there.

A. N. PITCHER, who has been constructing engineer during the development period of the Canadian Coal and Coke Company in Alberta, has been appointed chief engineer. The head offices of the company are at present in Montreal, but they will be moved to the collieries near Lethbridge.

FRANCIS P. SMITH, M.Am.Soc.C.E., chemical and consulting paving engineer, New York City, on January 29th delivered before the graduate students in Highway Engineering at Columbia University, an illustrated lecture on "Plant, Highway and Laboratory Inspection of Bituminous Materials."

GEO. JANIN, City Engineer of Montreal, has been seriously ill for several weeks and shows little improvement. The Board of Control has relieved him of all responsible duties for a month. During the repair of the conduit break a month ago, Mr. Janin remained continuously in charge, and his physicians now attribute his present illness to overexposure.

ARTHUR H. BLANCHARD, M.Am.Soc.C.E., Professor in Charge of the graduate course in Highway Engineering at Columbia University, on January 26, 1914, delivered illustrated lectures at the University of Illinois on the subjects:—"Bituminous Surfaces and Bituminous Pavements" and "Modern Developments in Highway Engineering in Europe."

DOUGLAS C. LIVINGSTON, B.Sc., a graduate in mining of McGill University, and for some years prominently connected with mining operations on Vancouver Island, has been appointed head of the mining engineering department of the University of Idaho. For the past three years he has been associate professor of mining. He succeeds Prof. R. S. McCaffery, who lately resigned to join the faculty of the University of Wisconsin.

H. N. RUTTAN, City Engineer of Winnipeg, addressed the University of Manitoba Engineering Society recently on "Advice to Young Engineers." Col. Ruttan dwelt first on the necessity for carefulness, accuracy and attention to detail, realizing from the first the sense of responsibility in all matters. He impressed the importance of loyalty, particularly to the chief of the staff. No engineering achievement is a one-man proposition, it requires the united efforts of the whole staff to bring it to a successful conclusion. The exercise of the faculties of observation to the fullest extent in connection with any project is necessary, and notes on all matters in relation to it are of great importance. The young engineer should not be content but should qualify for higher responsibilities. He must be well informed on all public matters of engineering interest, and be able to clearly present his views.

Recent appointments to positions in the Topographical Surveys Branch, Department of the Interior, Ottawa, include those of L. T. Venney, Brockville, Ont.; W. K. Thompson, Toronto; Alan Fraser, Toronto; L. S. Cockburn, Toronto; C. M. O'Neill, Erindale, Ont.; A. L. Morgan, Kingston; W. E. Lumb, Fort Stewart, Ont.; W. W. Doxsee, Peterborough, Ont.; H. J. Dunlap, Ottawa; and Jas. Hall, Edinburgh, Scotland. The first five mentioned are graduates in engineering of the University of Toronto.

OBITUARY.

THOS. M. McLEOD, C.E., of the firm of McLeod and Merrill, Toronto, and a graduate of McGill University, died recently of appendicitis. Mr. McLeod was a native of Georgetown, P.E.I. He had been connected with many extensive engineering contracts in Canada and the United States.

MANITOBA LAND SURVEYORS.

The thirty-fourth annual meeting of the Association of Manitoba Land Surveyors was held in the Industrial Bureau Buildings, Winnipeg, on January 21 and 22. After a very interesting address from the retiring president, J. L. Doupe, chief surveyor of the Canadian Pacific Railway Company, the following papers were read and discussed:—

"Early Surveys and Land Administration in Manitoba," by William Pearce, of Calgary.

"How to Treat the Closing Error," by C. C. Chataway, of Winnipeg.

"Accuracy in Field Work," by A. C. Garner, chief surveyor of the land titles office, Regina.

"Special Surveys," by G. B. McColl, of Winnipeg.

"Right of Way Surveys," by F. A. Wilkin, Winnipeg, right-of-way surveyor for the Canadian Pacific Railway Company.

"Street Plans and their Control," by H. F. McDonald, of Winnipeg.

"Some Useful Diagrams in Computing Earthworks," by H. L. Vercoe, Winnipeg.

The following officers were elected for 1914:—C. C. Chataway, president; R. J. Jephson, vice-president; W. B. Young, secretary-treasurer; and G. A. Bayne, H. F. McDonald, R. C. McPhillips and R. H. Avent, as members of the executive council; and H. G. Beresford and H. A. Bayne, as auditors.

"THE ELECTRIFICATION OF STEAM RAILWAYS."

This was the subject of an illustrated address by Mr. N. W. Storer, of the Westinghouse Electric and Manufacturing Company, Pittsburg, delivered to the Toronto section of the American Institute of Electrical Engineers on January 30th.

LECTURE ON STEEL TUBE MANUFACTURE.

The University of Toronto Engineering Society will hold a special meeting in Convocation Hall this evening (February 5th), at 8 p.m., which will be addressed by Mr. F. N. Speller, B.A.Sc., a graduate in engineering of the University of Toronto. Mr. Speller is Metallurgical Engineer for the National Tube Company, Pittsburg, Pa., and will give a lecture on the manufacture of steel pipes and tubes. His talk will be illustrated by motion pictures showing the methods of manufacture. The Canadian Railway and Engineering Club will attend the meeting in a body.

COMING MEETINGS.

WESTERN ONTARIO CLAY PRODUCTS ASSOCIATION.—Convention to be held in Chatham, Ont., February 4 and 5, 1914.

AMERICAN CONCRETE INSTITUTE.—Tenth Annual Convention to be held in Chicago, February 16th to 20th, 1914. Secretary, E. E. Krauss, Harrison Building, Philadelphia, Pa.

NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.—Meeting will be held in Chicago, Ill., February 12th to 14th, 1914. Secretary, J. P. Beck, 72 W. Adams Street, Chicago, Ill.

AMERICAN WATER WORKS ASSOCIATION.—Thirty-fourth Annual Meeting to be held in Philadelphia, Pa., May 11-15, 1914. Secretary, J. M. Deven, 47 Slate Street, Troy, N.Y.