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# Canadian Engineer

A WEEKLY JOURNAL

For CIVIL, MECHANICAL, ELECTRICAL and STRUCTURAL ENGINEERS and CONTRACTORS

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**Sudbury, Ont.**—Golden Rose Mining Company, $500,000; J. H. Clary, G. E. Buchanan, G. Burroughs.

**Montreal.**—Chrome and Asbestos Mines, $199,000; W. A. Magor, C. L. Higgins, P. A. Boivin. Lafontaine Construction Company, $50,000; M. R. Forget, D. Masson, P. Desforges. Compagnie des Rechauds Injecteurs Guimont, $275,000; W. Guimont, G. Guimont, O. Guimont.

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# The Canadian Engineer

WEEKLY

ESTABLISHED 1893

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## The Canadian Engineer

ESTABLISHED 1893.

**Issued Weekly in the interests of the**

CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

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## RESEARCH WORK.

With the publication of the prize lists and scholarships of our Canadian Universities one is impressed with the lack of opportunity for research work by Canadians, in Canadian laboratories, in connection with subjects peculiar to the industries, the health and life of Canada.

The practical value of research work is being impressed upon the public. Edison, Bell, Marconi and Parsons spent years in quiet, and the results secured are interesting the public more and more in the training and the methods necessary to the attaining of practical solutions and demonstrations.

We recognize the work of the captains of industry and the great inventors, but too often we do not look back of this to the greater influence, the work done by the scientific investigators. These men, strictly scientific, are engaged in the greater work. They open up the way. Their forceful intellects reveal the secrets previously hidden from men. The scientist, the laboratory research man blazes the way for the inventor and the engineer.

Nature never reveals her secrets willingly. Her suitors must be patient, imaginative, constant. She responds only to those who love her for herself alone. Some lucky man may chance to stumble to the heart of things by a quick road—but not often. His is the unusual way.

When someone is working out an abstract problem, we often hear the questions: What is the use? What is the value of it all? We forget that it is impossible to know to what application knowledge may be put until it is acquired. After it has been secured it is a working tool with a value.

Engineering and applied science have made great developments, but we do not often realize that the discoveries made, the scientific laws framed, the basic principles formulated, were nearly all made by men without any practical application in view. The immediate practical application of the laws and discoveries in physics, chemistry, mathematics and astronomy were not thought of by those who made them.

The selection of men for research work is not an easy task. The peculiar qualities which make men successful in this work are only possessed by a few. These qualities are not recognized by every man. Yet we have the field and the men. It is unfortunate that we are without the available means and equipment for this very necessary work.

The field for this work is large. We have done very little scientific work in sanitation, in water testing, in ore reduction, in the problems of railway operation and electric development.

The State spends large sums for the exploring of new territory, the mapping of mineralized districts, in charting and gauging. Why not invest money in exploring and investigating in the laboratory?

## CREOSOTING PLANT.

The increasing difficulty and cost of securing crossties for Canadian railways is inducing the management of one of the large roads to consider the advisability of installing a creosoting plant for the treatment of ties.

Experiments have been made with steel and concrete to take the place of wood for ties, but these tests have not proven satisfactory. The greater cost, the additional expense in maintaining the heavier roadbed make it appear necessary for the railroads to continue using the wood tie which has been in use for this purpose.

On certain of the American roads the ties used for many years past have been treated, and the fact that these roads are continuing the work and extending it to new lines indicates that they are convinced that the policy is a good one. The life of the ordinary tie is reckoned at seven years. After treatment jack pine and tamarac ties will last for fourteen years, spruce ties for sixteen years, and oak ties for eighteen years.

It is stated that the first experiments in this work on the Canadian Pacific will be made this summer, and that treatment will be given to about one hundred thousand ties.

## A VANCOUVER BRANCH OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.

The Western members of the Canadian Society of Civil Engineers are to be congratulated on the success attending the efforts to organize a branch in Vancouver, B.C.

The Canadian Society is a national organization. The profession of engineering is not in any sense provincial. With Society rooms in six Canadian cities, the membership will soon learn to make these rooms their headquarters, a wider circle of acquaintance will be formed, the Society and its advantages will be more fully realized. Edmonton, Regina and Halifax next!

## EDITORIAL NOTES.

The council of Windsor, Ont., granted a $10,000 sidewalk contract on the condition that if any United States firm was found interested the contract would become void. This is surely Canada for the Canadians.

* * * *

Ventilated, fumigated, disinfected, and cuspidor-equipped station-rooms, waiting-rooms and passenger coaches. What luxury for Canadian railway travellers!

* * * *

The American Waterworks Association will meet in Milwaukee, Wis., in June, 1909. A splendid programme has been arranged, and the Milwaukee meeting will equal in attendance and interest any previous meeting. Special effort is being made to have the members in the east travel west by a special train, which will leave Toronto on June 6th at 2 p.m., and gather members at Hamilton, Buffalo and London. Mr. Alex. Milne, of St. Catharines, Ont., will be pleased to hear from Canadians anxious to travel with the party.

## SOCIETY NOTES.

**Canadian Society of Civil Engineers, Ottawa.**—On Wednesday evening, May 12th, Mr. J. B. McRae, consulting engineer, of Ottawa, addressed the Ottawa branch of the Canadian Society of Civil Engineers, on "The Development of Water Powers." Mr. McRae showed slides of the designs and photographs of the works from the Ragged Rapids dam and also from the Chaudiere. Mr. C. R. Coutlee, chairman of the local branch, presided. Among those present were: Mr. Geo. A. Mountain, president of the Canadian Society of Civil Engineers; Messrs. Lumsden, White, St. Laurent, McPherson, Steckel, Spence, Lieut.-Col. Anderson, Collingwood, Schreiber, Dion, Johnson, Kerry, Perley, Pinhey, and Coddy.

## RAILWAY TAXATION IN UNITED STATES.

During the year ending June 30th, 1907, over $80,000,000 was collected in railway taxation in the several States of the Union. This was at the rate of $367 per mile. The highest rate of taxation was levied in New Jersey, $2,047 per mile. Massachusetts came next with $1,525; District of Columbia third at $1,480, and the lowest rate was in the Indian Territory, $26 per mile.

The rate per mile was $18 greater than the year before, and $93 per mile greater than in 1902.

The detailed statement of taxation per mile for the various States in 1907 is as follows:—

| | | | |
|---|---|---|---|
| New Jersey | $2,047 | Colorado | $287 |
| Massachusetts | 1,525 | Montana | 271 |
| Dist. of Columbia | 1,480 | Tennessee | 267 |
| Connecticut | 1,339 | North Dakota | 265 |
| Rhode Island | 1,100 | Nevada | 265 |
| New York | 686 | Iowa | 234 |
| Maryland | 620 | Idaho | 233 |
| Ohio | 569 | Oregon | 228 |
| Pennsylvania | 510 | Arkansas | 224 |
| Indiana | 481 | Alabama | 218 |
| Illinois | 472 | Louisana | 218 |
| Nebraska | 429 | Mississippi | 214 |
| Minnesota | 429 | Missouri | 206 |
| Washington | 415 | Oklahoma | 194 |
| Wisconsin | 414 | North Carolina | 177 |
| West Virginia | 413 | Florida | 176 |
| Michigan | 398 | South Carolina | 176 |
| Delaware | 391 | Vermont | 172 |
| California | 390 | Georgia | 166 |
| Virginia | 376 | Texas | 153 |
| Kentucky | 366 | Arizona | 142 |
| New Hampshire | 358 | Wyoming | 141 |
| Utah | 320 | Nex. Mexico | 139 |
| Kansas | 296 | South Dakota | 101 |
| Maine | 292 | Indian Territory | 26 |

## ELECTRIC TRAMWAYS IN JAPAN.

Electric tramways in Japan are making steady progress. According to statistics of the Board of Railways at the end of February, the number of companies chartered has reached a total of 61; and all of them are now laying rails or making preparations to commence running. Of the above, the number of companies which have already opened service is 20.

# RAILWAY EARNINGS AND STOCK QUOTATIONS

| NAME OF COMPANY | Mileage Operated | Capital in Thousands | Par Value | EARNINGS Week of May 14 | | STOCK QUOTATIONS TORONTO | | | | MONTREAL | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1909 | 1908 | Price May 14 '08 | Price May 6 '09 | Price May 13 '09 | Sales Week End'd May 13 | Price May 13 '08 | Price May 6 '09 | Price May 13 '09 | Sales Week End'd M'y 13 |
| Canadian Pacific Railway | 8,920.6 | $150,000 | $100 | 1,373,000 | 1,209,000 | 160½ | 180 | 179¾ | 488 | 160 | 159⅝ | 180¼ | 2455 |
| Canadian Northern Railway | 2,986.9 | | | 175,800 | 150,200 | | | | | | | | |
| *Grand Trunk Railway | 3,536 | 226,000 | 100 | 742,672 | 708,979 | | *1st. pref. 106, 3rd pref. 52⅞, ordinary 21¾ | | | | | | |
| T. & N. O. | 334 | (Gov. Road) | | 24,261 | 14,070 | | | | | | | | |
| Montreal Street Railway | 138.3 | 18,000 | 100 | 72,230 | 68,167 | | | | | 185 | 182½ | 211 | 209 |
| Toronto Street Railway | 114 | 8,000 | 100 | 70,460 | 65,909 | 99 | 124 | 124 | | 98¾ | 98½ | 124 | 123¾ |
| Winnipeg Electric | 70 | 6,000 | 100 | | | 153 | 170 | 175 | 1007 | | 167¾ | 177 | 176 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | 210 | 209¾ | 332 | 352 |
| | | | | | | | | | | 123¾ | 123 | 218 | |

* G.T.R. stock is not listed on Canadian Exchanges These prices are quoted on the London Stock Exchange.

## THE PROTECTION OF GRADE CROSSINGS.

**By a British Signal Engineer.**

The recent agitation in Canada on this subject and discussion in the Canadian House of Commons have attracted no little attention in Great Britain, not only amongst railway men but also the general public.

The writer has had considerable experience of the situation in the United States, and while he has no practical knowledge of the local conditions in Canada, yet his acquaintance with American railroads is sufficient for him to appreciate the position and to know how far British practices are a remedy for the evil in Canada and, also, how far they fall short or are impracticable or undesirable..

Then, too, there is the question of the proper protection of railway grade crossings, which although not so serious a question in Canada as in the United States—due to there being fewer independent companies in the Dominion—is a matter of no little importance and one that has yet to be dealt with.

In the belief then that it would be of some little assistance to the railway companies of Canada and the provincial and local authorities the writer has put together the following particulars as to what is the British practice as to (a) the protection of highway grade crossings and (b) of railway grade crossings, also the remedies that he suggests be adopted to meet these evils in Canada.

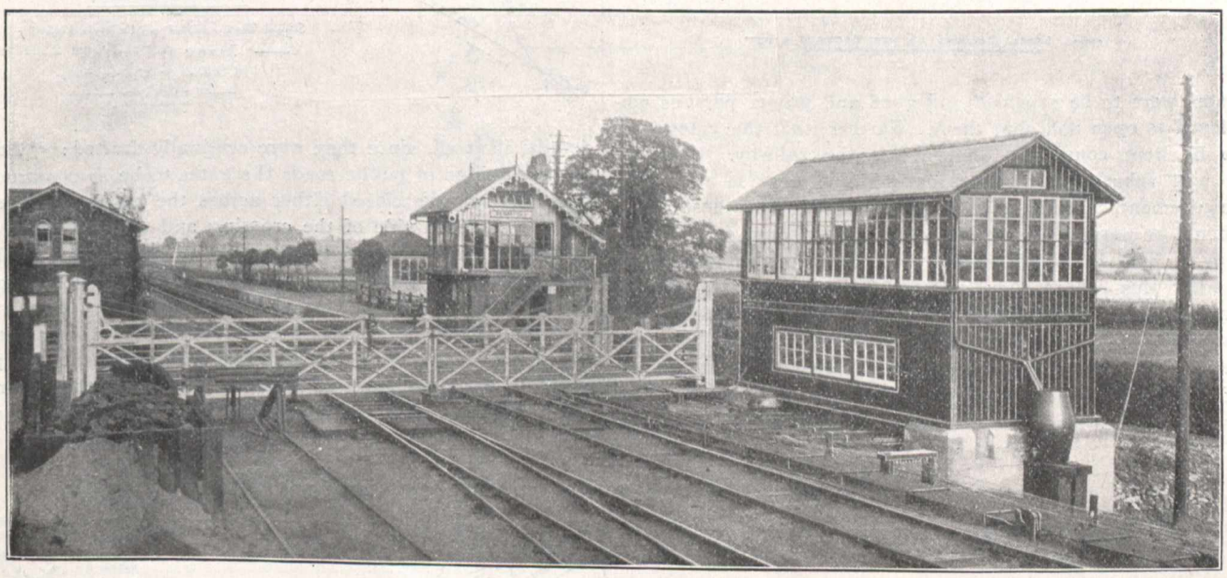


**Illustration of Level Crossing Gates, Northern Railroad.**

As will be readily understood the situation in England is, and always has been, different to that on the other side of the Atlantic. British railways were built to join the towns together and to deal with already existing trade, and there was not therefore the need as in the United States and Canada for rushing the tracks through regardless of what the subsequent circumstances might be of giving the railroads a right to cross the highways.

From their inception British railroads have travelled along their own right-of-way, which as a consequence has been fenced off, and this, together with the respect for private property, has prevented the trespass evil as known on the American continent from germinating. As long ago as 1840 an Act of Parliament was passed dealing with the question of trespassing on railways. The law on the subject of trespassing on railways was further strengthened in 1868 and again in 1871 and is strictly acted up to. With what result may be judged when it is stated that during the year 1907 there were 278 people killed and 115 injured while trespassing on the line, and there were 169 cases of suicide and eighteen of attempted suicide. These figures compare with 5,612 persons killed and 5,512 injured while trespassing on the railways of the United States during the year ending June 1907, and it is not to be surprised at to find the State Railroad Commission of Indiana saying in their bulletin for October-December 1907, "it is only fair and just to the carriers that they should be allowed to use their property exclusively for railroad purposes. It is especially unfair to the enginemen, who, on limited trains, are under the severest pressure to perform their manifold work, that they should be disturbed by persons on the track who often appear unconcerned and heedless of the signals and desperate dangers to which they subject themselves. It is the purpose of this Commission to recommend in its next report to the Governor, practical measures to abate this fatal nuisance, perhaps a recommendation to have enacted laws controlling on English railways, which require signs at crossings warning travellers to turn neither to the right or left on the railways, and bulletins in the passenger depots naming offenders and the fines and punishments imposed for trespassing on the tracks."

Returning for a moment to the question of fences on British railways it may be remarked that in 1842 an Act was passed compelling railway companies to provide "good and sufficient fences," and amongst the particulars to be sent to the Board of Trade of new lines to be inspected before being opened for passenger traffic is to be a "description of fences adopted for the line, giving in the case of post and rail fencing the height of the top rail and the distance between posts, and in the case of wire fencing, the height, number of wires, distance between supports and means of straining."

So much for fencing and the trespassing evil.

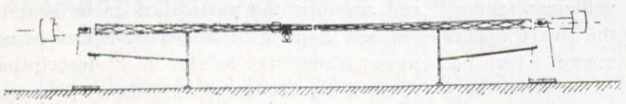
Now for the practice as to highway grade crossings, and here the writer would anticipate and first deal with trolley car or electric lines along highways crossing steam roads and vice versa, and so dispose of that part of this subject as a few words will suffice for that. There are not many such cases in Great Britain, and those that exist are cases where horse cars have been replaced by electrically propelled cars. Owing to the power possessed by the Board of Trade no such crossing—not even for horse cars—can be opened without parliamentary sanction and being submitted to the Board of Trade for inspection and approval, and no change in the method of operation can be made without the concurrence of the latter. This almost absolutely prohibits any new crossings as there is such a dead-set made against them and the Board of Trade approval of the changes made when a horse-car line is changed to an electric one is only obtained when every possible contingency has been provided for. In all such instances there is an interlocking tower provided on the railroad, and derails are laid in each line of the electric road on either side of the crossing, and as a rule current is cut off from the trolley wire unless the crossing is free for the trolley car to cross.

From the foregoing observations it will be clear that the question of how electric rails are protected against steam roads has never been placed on a definite footing in Great Britain as the instances of such are so few and are likely to be fewer.

We come now to a consideration of how ordinary highway grade crossings are protected in Great Britain. Fencing along the right-of-way being an essential, it follows that there have always been gates at the crossing to fence off the railway from the highway, and here British practice differs not only from Canadian and American practice but from that on the European continent. The difference lies in the fact that the gates open inwards towards the line, and when open for vehicular traffic fence off the railway so that nothing can stray on to the line. Cattle guards are not used on British railways.

In 1839 an Act of Parliament was passed which ordered that where railways crossed public roads good and sufficient

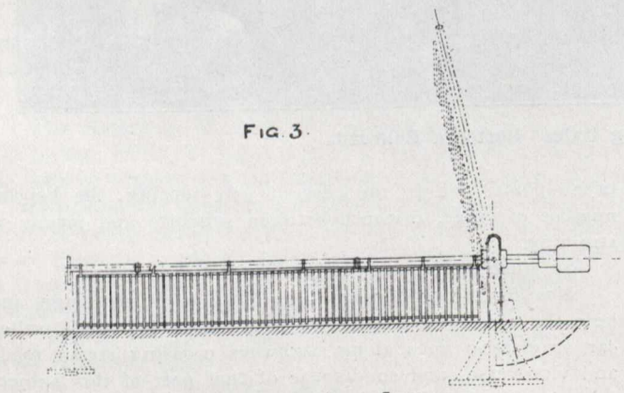
FIG. 2.



— LEVEL CROSSING LATTICE BARRIERS —

gates were to be provided and good and proper persons employed to open and shut them. Further, that the gates were to be kept constantly shut across the railway. However, it was subsequently found desirable to reverse the latter requirement, and in 1842 it was ordered that these gates should be normally across the roadway and open for the railway. The Board of Trade were, however, empowered to modify this where they saw fit. Cottages were usually erected near the crossing so that the gatekeeper was always available, day or night. The gatekeeper would be some servant who had been injured in the service or very often one of the track-men lived in the house rent free on condition that his wife attended to the gates during the day, whilst he

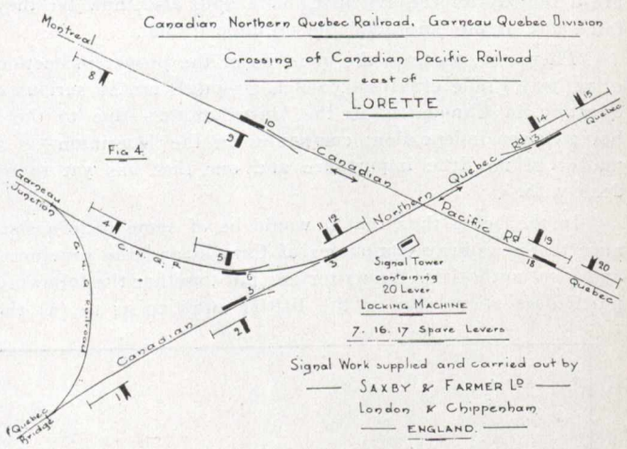
FIG. 3.



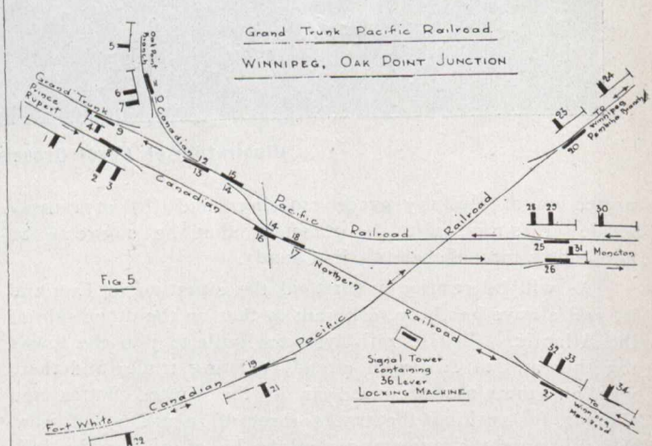
— TUBULAR BARRIER WITH HANGING FRINGE. —

was engaged in his ordinary duties. No signals were originally provided, all the security afforded was generally a large red target on the gate with a red lamp at night. In Rayner Wilson's "Mechanical Railway Signalling" there is an extract from a report made by a Board of Trade inspector on a proposed new railway where it was intended to have twenty-eight highway crossings in 47 miles. He had recently been over a similar railway where there were nineteen or twenty crossings in twenty-eight miles, and says "the trains on the Northern and Eastern Railway never slacken their speed when passing these points unless the gates should be shut across the railway which are sufficiently conspicuous by day and rendered so by a red lamp at night which is a signal to stop. This railway has been opened, though not to the whole of its present extent for about two years and a half, and no accident has ever occurred at any of the numerous level crossings. The example of this line is therefore sufficient proof that level crossings on a railway are perfectly safe, if steady gatekeepers be employed at all those of turnpikes or other public roads and the management of the Birmingham Railway (now the London and North-Western) is so perfect and all the enginemen, policemen (now called signalmen) and others in their employment so competent and correct in the performance of their duty that I see no danger whatever in allowing them to have so many level crossings as they please in the proposed line."

The Board of Trade requirements as to highway crossings are as follows—they have only been altered in minor




details, if at all, since they were originally drafted: "At all level crossings of public roads the gates to be so constructed that they may be closed either across the railway or across the road at each side of the crossing and a lodge, or in the case of a station, a gatekeeper's box to be provided, unless the gates are worked from a signal box. The gates must not be capable of being opened at the same time for the road and the railway and must be so hung as not to admit of being opened outwards towards the road. Stops to be provided to keep the gates in position across the road or railway. Wooden gates are considered preferable to iron gates




and single gates on each side to double gates. Red discs or targets must be fixed on the gates with lamps for night use or semaphore signals in one or both directions interlocked with the gates may be required. At all level crossings of public roads or footpaths a footbridge or subway may be required."

Notwithstanding the preference for single gates on each side it is generally customary to provide four gates—two on each side, and, as a rule, these are connected to a wheel or lever in an adjacent signal-box whereby the towerman can open and close the gates without leaving the signal-box, and the lever or wheel is interlocked with the levers working the running signals.

In 1863 an arrangement was designed whereby all four gates could be worked simultaneously so that the opening

of one gate opened the others. The well-known firm of Saxby & Farmer of London and Chippenham, England, who were the pioneers of railway signalling and stilll retain the premier position, and who as long ago as 1856 introduced the first interlocking of points and signals, have always been noted for their work in this direction, and the accompanying illustration (Fig. 1) shows a set of such simultaneously acting gates fixed on the Great Northern Railway (of England). It will be noticed that the gates are opened for vehicular traffic and that they entirely fence off the railway from the road. There are two signal-towers seen. The larger of these is a new one built to replace the other, which would then be taken away.

Precautions are also taken to guard against children and dogs creeping through the gates, and the Board of Trade requirements say, "At public road level crossings in or near populous places the lower portions of the gates to be either close-barred or covered with wire-netting."

For foot passengers smaller wicket gates are provided. and where there is a signal tower these are controlled by levers in the machine so that the towerman can fasten them

Occasionally the Board of Trade insert in their annual reports details of the accidents at crossings. This was done with the figures for 1904. In that year there were 67 persons killed, and choosing the first 19 at random we find the cause is assigned in 11 of the cases, of which seven are given as. "Was of weak intellect," "drunk," "stone deaf," "drunk," "a suspicion of suicide," "old and deaf," "very foggy at the time."

After this recital it will be seen that the casualties at highway grade crossings on British railways are very few and sink into insignificance when compared with those in North America. As no new crossings are now allowed, and existing ones are gradually being eliminated the number of accidents is likely to gradually grow less. Such elimination is welcomed by the railways as well as by the public. There is not only the natural feelings of regret that arise when an accident occurs, but a kind of stigma, often undeserved, rests on the railway, but furthermore, such crossings lead to delay to trains as in order to avoid complaints from the public the gates are not closed until the last possible moment. Then in addition, there is the cost of the gatekeepers' wages and

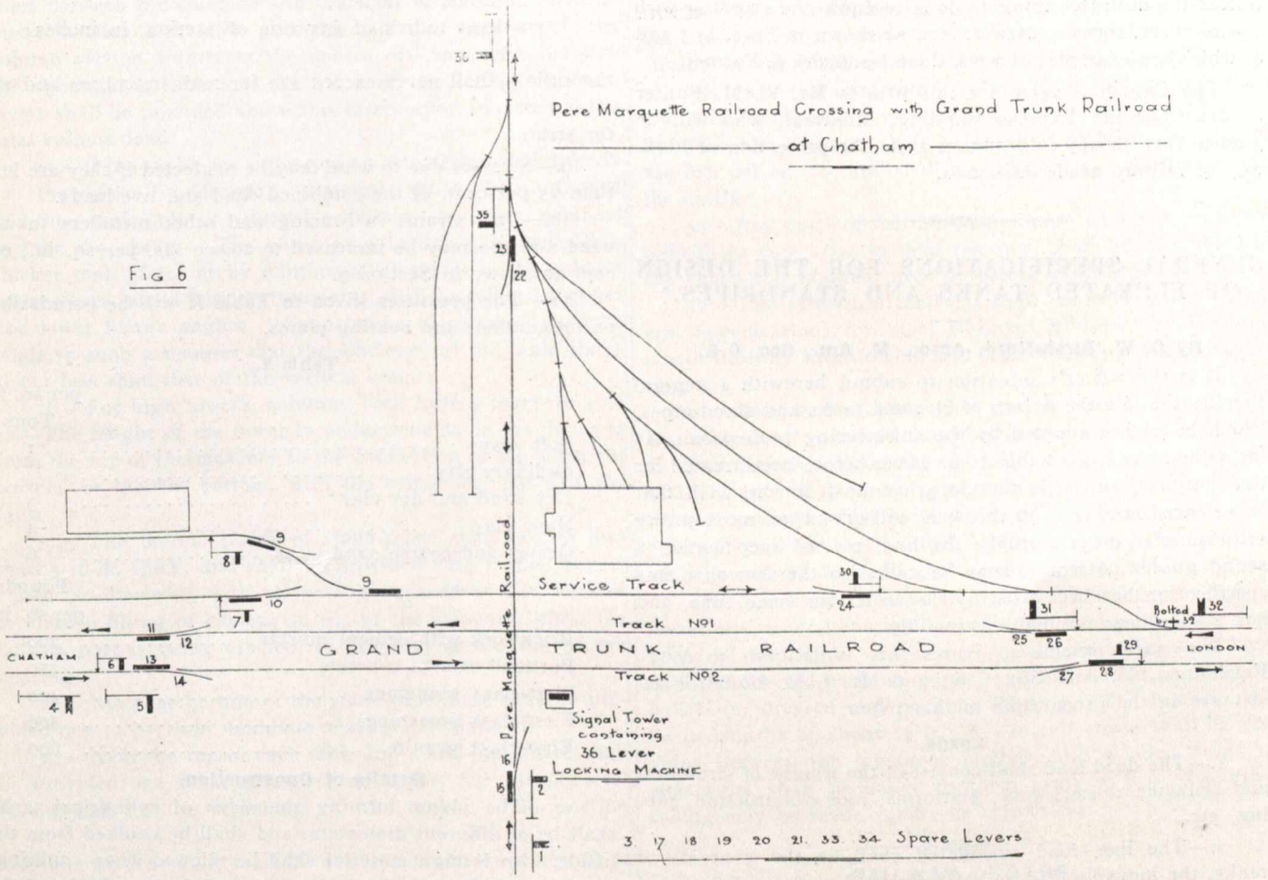



Fig 6

when a train is approaching and prevent foot passengers going through. This has saved many lives.

The last figures available as to casualties at level crossings are those in the annual report of the Board of Trade for the year 1907. It says that fifty persons were killed and thirty injured at level crossings, few of which are in proximity to railway stations. Of these nineteen were killed and sixteen injured at public road crossings, twelve were killed and nine injured at occupation crossings, and nineteen were killed and five injured at footpath crossings.

Three classes are here named, and of these it is only necessary for railway companies to protect the public road crossings. The occupation crossings are accommodation ones to give access from one part of an estate or a farm to another when the railway divides it. Fottpath crossings are those that are purely for foot passengers. In both these latter classes all who use the crossings do so at their own risk. The company, however, as an act of grace, sometimes provide electric crossing alarm bells.

signal tower, interlocking machine, signals, gates, etc., etc. Therefore any abolition is welcomed.

Naturally the railways will not incur the expense of building bridges if the cost, in the whole or in part, will be borne by the municipal authorities. Such work is therefore done by agreement as to the proportions to be paid, but before the work is done parliamentary powers must be obtained by the railway company, as they may not spend money without. There are many crossings existing in districts that are now populous and which are not abolished owing to the refusal of the local authorities to meet the reasonable demands of the railway company that the expense should be shared. Here be it remarked that the Board of Trade—which represents the Government—cannot force a railway company to build a bridge. Should, however, a new line be opened the Board of Trade may refuse its sanction if any deviation be made from the deposited plans, e.g., a crossing provided that was not shown on the plan.

Before leaving the subject it may be remarked that although not used in Great Britain, Messrs. Saxby & Farmer

make other types of gates than those already illustrated. There is the bascule type, as used in North America and illustrated by Fig. 2, and the barrier type as shown in Fig. 3.

Coming now to the grade crossings of two railways. These are very rare in Great Britain now, and there are only about twenty in existence. They are protected from one another entirely by fixed signals and the block system. Sometimes the manual control is used such as Saxby & Farmer's (Hodgson) system whereby the acceptance of a train from north or south prevents one being accepted from the east or west and vice versa. Where this is not in use reliance is placed on the signalman acting up to their instructions. Derails are never used—at least not in a facing direction—if the line is used for passenger traffic, and collisions or possible collisions are avoided by one of the trains being kept back. The adjoining signal-towers are placed as near to the crossing signal-tower as the volume of traffic demands. They are sufficiently near to avoid delay and yet far enough to remove the risk of danger.

In Canada it may be assumed that the amount of traffic would not justify such an expense, and as derails are permitted the desirable thing to do is to equip the crossing with signal-tower, signals, derails, etc., as shown in Figs. 4, 5 and 6, which are examples of work done by Saxby & Farmer.

The Canadian agent for this firm is Mr. W. M. Punter of 611 Canadian Express Building, Montreal, who will be glad to furnish any information as to the protection of highway or railway grade crossings.

## GENERAL SPECIFICATIONS FOR THE DESIGN OF ELEVATED TANKS AND STANDPIPES.*

**By C. W. Birch-Nord, Assoc. M. Am., Soc. C.E.**

It is the writer's intention to submit herewith a general specification for the design of elevated tanks and stand-pipes, which he wishes adopted by the engineering profession. As far as he knows this subject has never before been treated for this purpose, and it is therefore his most sincere wish that experienced engineers in this field will offer their most severe criticisms, in order to make the final revised specification a sound guide. Attention may be called to the fact that this specification has been used by the writer for some time, and has always been applied successfully.

The writer wishes to express his obligations to A. F. Reichmann, M. Am. Soc. C.E., and Mr. J. H. Hoff, for assistance in the preparation of this paper.

### Loads.

1.—The dead load shall consist of the weight of structural and ornamental steel-work, platforms, roof construction, piping, etc.

2.—The live load considered shall be the contents of tanks, the movable load on platforms and roofs, and the wind pressure.

3.—The weight of water shall be assumed to be 63 lbs. per cu. ft., and that of crude oil 56 lbs. per cu. ft., 1 cu. ft. of fluid being equal to 7.48 gallons.

4.—The live loads on platforms and roofs shall be taken at 30 lbs. per sq. ft., or a 200-lbs. concentrated load applied at any point.

5.—The wind pressure shall be assumed at 30 lbs. per sq. ft., acting in any direction. The surfaces of cylindrical tanks exposed to the wind shall be calculated at two-thirds of the diameter multiplied by the height.

6.—The movable live load on platforms and roofs shall not be considered as acting together with the wind pressure.

### Unit Strains.

7.—All parts of the structure shall be proportioned so that the sum of the dead and live loads shall not cause the strains to exceed those given in Table I.

*Read before the American Society of Civil Engineers.

**Table 1.**

| | Pounds per sq. in. |
|---|---|
| Tension in tank plates (net area) | 12,000 |
| Tension in other parts of structure (net area) | 16,000 |
| Compression (reduced) | 16,000 |
| Shear on rivets and pins | 12,000 |
| Shear on bolts and field rivets | 9,000 |
| Shear in plates (gross section) | 10,000 |
| Bearing pressure on rivets and pins | 24,000 |
| Bearing pressure on field rivets | 18,000 |
| Fiber strain in pins | 24,000 |

8.—For compression members, the permissible unit strain of 16,000 lbs. shall be reduced by the formula:

$$p = 16{,}000 - 70 - \frac{l}{r}$$

where p = permissible working strain in compression, in pounds per square inch;

l = length of member from centre to centre of connections, in inches;

r = least radius of gyration of section, in inches;

the ratio $\frac{l}{r}$ shall never exceed 120 for main members and 180 for struts.

9.—Stresses due to wind may be neglected if they are less than 25 per cent. of the combined dead and live loads.

10.—Unit strains in bracing and other members taking wind stresses may be increased to 20,000 lbs. per sq. in., except as shown in Section 9.

11.—The pressures given in Table II will be permissible on foundations and bearing plates.

**Table 2.**

| | per sq. ft. Tons |
|---|---|
| Soft clay | 1 |
| Ordinary clay | 2 |
| Dry sand and dry clay | 3 |
| Hard clay | 4 |
| Gravel and coarse sand | 6 |

| | Pounds per sq. in. |
|---|---|
| Brickwork with cement mortar | 200 |
| Portland cement concrete | 350 |
| First-class sandstone | 400 |
| First-class limestone | 500 |
| First-class granite | 600 |

### Details of Construction.

12.—The plates forming the sides of cylindrical tanks shall be of different diameters, and shall be caulked from the inside. No foreign material shall be allowed when caulking.

In oil-tank work, both the inside and the outside of the tank shall be beveled for caulking.

13.—Joints for horizontal seams and for radial seams in the spherical bottoms of tanks shall preferably be lap joints.

14.—For vertical seams lap joints shall be used for ¼, 5-16, and ⅜-in. plates; double butt joints for 7-16, ½, 9-16, ¾, and 13-16-in. plates; and triple butt joints for ⅞, 15-16, and 1-in. plates.

15.—Rivets, ⅝-in. in diameter, shall be used for ¼ and 15-16-in. plates; rivets, ¾-in. in diameter for ⅜ to ⅝-in. plates, inclusive; and rivets, ⅞-in. in diameter, for 11-16 to 1-in. plates, inclusive.

16.—Plates more than ⅝-in. thick shall be sub-punched and reamed.

17—The minimum thickness of the plates for the cylindrical part shall be ¼-in. The thickness of the plates in spherical bottoms shall never be less than that of the lower ring in the cylindrical part of the tank.

18.—The facilities at the plant where the material is to be fabricated will be investigated before the material is ordered.

19.—All plates shall be punched before being bevel-sheared for caulking.

20.—Radial sections of spherical bottoms shall be made in duplicates of the number of columns supporting the tank, and shall be reinforced at the lower parts, where holes are made for piping.

21.—When the centre of the spherical bottom is above the point of connection with the cylindrical part of the tank, there shall be provided a girder at said point of connection to take the horizontal thrust. The horizontal girder may be made in connection with the balcony. This also applies where the tank is supported by inclined columns.

22.—The balcony around the tanks shall be 3 ft. wide, with a ¼-in. floor-plate, and shall have a suitable railing, 3 ft. 6 in. high.

23.—The upper parts of spherical bottom plates shall always be connected on the inside of the cylindrical section of the tank.

24.—In order to avoid eccentric loading on the tower columns, and local stresses in spherical bottoms, the connections between the columns and the sides of the tank shall be made in such a manner that the centre of gravity of the column section intersects the centre of connection between the spherical bottom and the sides of the tank. Enough rivets shall be provided above this intersection to transmit the total column load.

25.—If the tanks are supported on columns riveted directly to the sides, additional material must be provided in the tank plates riveted directly to the columns to take the shear. The shear may be taken by providing thicker tank plates or by reinforcement plates at the column connections, while bending moments shall be taken by upper and lower flange angles. Connections to columns shall be made in such a manner that the efficiency of the tank plates is not less than that of the vertical seams.

26.—For high towers, columns shall have a batter of 1 to 12. The height of the tower is understood to be the distance from the top of the masonry to the connection of the spherical bottom, or the flat bottom, with the cylindrical parts of the tank.

27.—The bottom plates of stand-pipes shall be not less than 5-16-in. thick, and shall be provided with tapped hopes, 1¼-in. in diameter, with screw-plugs spaced at 4-ft. centres to allow a filling of cement on top of the masonry, while the bottom part is being erected, in order to secure the proper bearing.

28.—Near the bottom of the stand-pipe there shall be provided one 12 by 18-in. manhole of elliptical shape.

29.—Near the top of each tank and stand-pipe there shall be provided one Z-bar acting as a support for the painters' trolley and for the stiffening of the tank. The section modulus of the same shall be not less than $\frac{D^2}{250}$, where D is equal to the diameter of the tank, in feet. If the upper part of the tank is held by the roof construction, this may be reduced.

30.—On large tanks, circular stiffening angles shall be provided in order to prevent the tank plates from buckling during windstorms. The distance between the angles shall be located by the following formula:—

$$d = Vt \frac{900}{D}$$

where, d = approximate distance between angles, in feet;
t = thickness of tank plates, in inches;
D = diameter of tank, in feet.

31.—The top of the tank will generally be covered with a conical roof of thin plates; and the pitch shall be 1 to 6. For tanks up to 22 ft. in diameter, the roof plates will be assumed to be self-supporting. If the diameter of the tank exceeds 22 ft., angle rafters shall be used to support the roof plates.

Plates of the following thickness will be assumed as self-supporting for various diameters:—

3-32-in. plate, up to a diameter of 18 ft. ⅛-in. plate, up to a diameter of 20 ft. 3-16-in. plate, up to a diameter of 22 ft.

Rivets in the roof plates shall be from ¼ to 5-16-in. in diameter, and shall be driven cold. These rivets need not be headed with a button set.

32.—A trap-door, 2 ft. square, shall be provided in the roof plate. Near the top of the higher tanks a platform with a railing shall be provided, for the safety of the men operating the trap-door.

33.—An ornamental finial shall be provided at the top of the roof.

34.—A ladder, 1 ft. 3 in. wide, shall be provided from a point about 8 ft. above the foundation to the top of the tank, and also one on the inside of the tank. Each ladder shall be made of two 2½ by ⅜-in. bars with ¾-in. rungs. On large, high tanks, 30 ft. or more in diameter, a walk shall be provided from the column nearest the ladder to the expansion joint on the inlet pipe.

35.—In designing tanks, 6 in. additional height shall be allowed for over-run.

36.—The bracing in the towers shall be adjustable.

37.—The size of the anchor-bolts shall be determined by the uplift when the tank or stand-pipe is empty. The unit strains in the anchor-bolts shall not exceed 15,000 lbs. per sq. in., and the minimum section shall be limited to a diameter of 1¼ in.

38.—The concrete shall be assumed to have a weight of 140 lbs. per cu. ft., and shall be sufficient in quantity to take the uplift.

39.—Any parts of the tank, stand-pipe, or tower, in which difficulties may arise in field riveting, shall be assembled in the shop, and marked properly before shipment.

40.—The structural material shall conform to the "General Specifications for Steel Railroad Bridges" by the American Railway Engineering and Maintenance of Way Association.

41.—The workmanship shall be in accordance with the Manufacturers' Standard Specifications of February 6th, 1903.

42.—Before leaving the shop all work shall be painted with one coat of approved paint, excepting the laps in contact on the tankwork. All parts which will be inaccessible after erection shall be well painted. After erection, the structure shall be covered with one coat of the same paint.

43.—Three-ply frost-proof casing shall be provided, if necessary, around the inlet pipe. This casing shall be composed of two layers of 1 by 2½-in. lumber, and each layer shall be covered with tar paper, and one outside layer of ⅞ by 2½-in. dressed and matched flooring. The lumber shall be in lengths of about 12 ft. A 1-in. air space shall be provided between the layers of lumber, and wooden rings or separators shall be nailed to them every 3 ft. The frost casing may be made square or cylindrical.

## RAILWAY ORDERS.

(Continued from Page 685.)

6929—April 28—Amending Order No. 5102, 29th July, 1908, by substituting the figures "167" for the figures "237" in the 6th line of the recital of the Order, and substituting for the case and file numbers "1233" and "4564," respectively, where they occur in the last line of the recital and in the last line of the first paragraph of the operative part.

6930—May 4—Ordering the G.T.P. Railway to vacate its right-of-way where the same affects the land of Charles Smith, Johnson Douglass and Henry Thomson Champion, in the City of Winnipeg, Man.

6931—May 4—Requiring proposed application to the Board for the approval of an amalgamation agreement between the C.N.R. and the Alberta Midland Railway Company to be published in the Canada Gazette, and in one newspaper in Toronto, Edmonton, Calgary and Lethbridge.

6932—May 4—Authorizing the C.N.O. Railway and C.P.R. to each construct certain portion of the road allowance near Parry Sound, Ontario, as specified in Order No. 6365, of January 27th, 1909.

6933—May 3—Granting leave to the Town of Buckingham, P.Q., to construct and maintain, at its own expense, the highway known as First Avenue across the tracks of the C.P.R. at Buckingham, P.Q.

6934—May 4—Requiring proposed application to the Board for the approval of the amalgamation agreement between the C.N.R. and the Saskatchewan-Northwestern Railway Company to be published in the Canada Gazette, one newspaper in Toronto, Regina, Moose Jaw, and Saskatoon.

6935—May 4.—Authorizing the Welland Co. Lime Works Company, Ltd., of Port Colborne, Ont., to lay gas pipe under the tracks of the G.T.R. Company at Port Colborne, between lots 29 and 30, First Concession, Township of Wainfleet, County Welland, Ont.

6936—May 3.—Granting leave to the Bell Telephone Company to erect, place and maintain its aerial wires across the tracks of the G.T.R. Company at private property one half mile north of Canal, Hamilton Beach, Ont.

6937—May 4.—Approving by-law of the Spokane and British Columbia Railway, authorizing O. E. Fisher, G.F. & P.A., to prepare and issue all tariffs of tolls to be charged for all traffic carried by that company.

6938—May 5.—Approving Standard Passenger Tariff C.R.C. No. 6 of the Spokane and British Columbia Railway between all stations in British Columbia subject to the condition that the tariff be published in at least two consecutive weekly issues of the "Canada Gazette."

6939—May 5.—Dismissing application of Edward S. Brennan of the City of Hamilton, Ont., for Order directing the G.T.R. to refund the sum of $73.89, alleged to have been overcharged on a shipment of seventeen cars of lumber from Wiarton to Hamilton, Ont., in July 1908.

6940—May 3.—Directing that watchman which was to be provided by Order No. 6340 of February 22nd, 1909, include a night as well as a day watchman at crossing of the G.T.R. at Main Street, Welland, Ont.

6941—May 4.—Approving and sanctioning location of the C.N.O. Railway Company's Ottawa-French River division through the townships of Fitzgerald, Deacon, Lister, Boyd and Pentland, District of Nipissing, Ont.

6492—May 4.—Approving plan of proposed new iron bridge, to replace the present wooden bridge carrying John Street, Stratford, Ont., across the right-of-way and tracks of the G.T.R. at M.P. 116.75, on the 20th district.

6943—May 4.—Extending for one month the time within which the Chatham, Wallaceburg and Lake Erie Railway shall equip with air brakes its cars.

6944—April 28.—Directing the C.N.R. to make crossings already constructed over its line of railway, in the district 18-B-3, Sask., and also in Townships 36.5 and 35.5, in said district in accordance with regulations.

6945—May 4.—Granting leave to the C.P.R. to construct its tracks across Con. St., in the village of Havelock, Ont., and construct highway crossing, in accordance with highway crossing regulations.

6946—May 4.—Authorizing the C.P.R. to construct three bridges on its line of railway; No. 38.48 North Bay Sec. Lake Superior Div.; No. 96.4, Portal Sec., Western Div.; and No. 46.9, Megantic Sec. Eastern Div.

6947—April 26.—Directing the C.P.R. to arrange with its connections for the publication of new tariffs from California shipping points to Regina on shipments of fruit.

6948—September 15, 1908.—Ordering that the M.C.R.R., G.T.P. Railway, and G.T.R. be added as parties to the application of Jos. Lemon and others of Winnipeg, Man., for Order directing the revision of the provisions of the Canadian Classification re bill of lading or live stock special contract, fixing freight rates on horses, high priced or otherwise, on the basis of declared valuation, and restricting the liability of the carrier with respect thereto.

6949—May 5.—Dismissing complaint of the residents of the Township of Sydenham and the town of Owen Sound, Ont., complaining of the dangerous condition of highway where it crosses the line of the C.P.R. at Murray's Cut, near Owen Sound, Ont., and applying for Order directing construction of bridge over the railway at point in question.

6950—May 6.—Granting leave to the C.N.O. Railway to construct its line of railway across eight highways in the Township of Thorah, County of Ontario, Province of Ontario.

6951—May 7.—Authorizing the New Brunswick Railway Company (C.P.R.) to open for carriage of traffic that portion of its grade revision between mileages 0.3 and 0.47, near Aroostock Junction and between mileages 19.1 and 20.2, near Grand Falls, N.B.

6952—May 7.—Authorizing the C.P.R. to open for the carriage of traffic that portion of its main line at mileage 33.4 at the opening of the Grand River, N.B.

6953—May 6.—Approving and sanctioning location of the G.T.P. Railway from mileage 30.11 to mileage 43.56, District of No. Alta., Province of Alberta.

6954—May 6.—Approving and sanctioning location of the Grand Valley Railway Company, mileage 0 to 9.868, Ontario.

6955—May 6.—Dismissing application of Thomas Crockett, of Riviere du Loup, P.Q., for Order directing the I.C.R. and its connecting companies to comply with provisions of clauses of previous Orders of the Board, in respect to the carriage of cedar railway ties, with particular reference to shipments from Riviere du Loup Station on the I.C.R. to Bennington, Vermont, a station on the Rutland R.R.

6956—May 4.—Order the C.P.R to construct a permanent subway at a point 200 feet west of Winnipeg Station, Municipality of Schreiber, Ont., the same to be completed before January 1st, 1910.

6957—May 6.—Authorizing the Ottawa Gas Company to lay gas pipe under the G.T.R. track at Main Street (Ottawa East), Ottawa, Ont.

6958—May 6.—Granting leave to the London Township Telephone Company of Vannock, Ont., to erect, place and maintain its aerial wires across the track of the G.T.R. Company at public road crossing at Hyde Park Station, Ont.

6959—May 4.—Granting leave to W. J. Anderson, of Beeton, Ont., to erect, place, and maintain aerial telephone wires across the track of the G.T.R. Company at the 7th line of Township of Tecumseh, Ont.

6960 and 6961—May 5.—Granting leave to the Norfolk Gas Company to erect, place, and maintain water and gas pipe under the track of the G.T.R. Company at a point about 1,410 feet east of Port Dover, Ont.

6962—May 5.—Authorizing the C.N.O. Railway to construct bridge to replace the wooden structures near St. Norbert Station, P.Q.

6963—May 4.—Rescinding Order of the Board dated May 3rd, 1905, in so far as it approves the location of the Calgary and Edmonton Railway through lots 57, 58, 59 and 63, as shown on plan, profile and book of reference, Alberta.

6964—April 7.—Approving and sanctioning deviation of the C.P.R. Company's branch line of railway on the south side of the Lachine Canal, in the town of St. Paul, P.Q.

6965—May 7—Ordering that every railway subject to the legislative authority of the Parliament of Canada, be, and is directed and required to keep all its passenger stations, waiting-rooms, and closets clean and well ventilated; to keep all its cars in which passengers may travel, including the closets and smoking compartments of such cars clean, ventilated, and in cold weather properly heated; and have one employee on each passenger train, whose duty it shall be to see that every such car in the train is kept clean, ventilated,

and when necessary, properly heated. To place cuspidors or receptacles suitable for the purpose in passenger stations and passenger cars where smoking is permitted; and to have such cuspidors emptied and washed clean whenever necessary, but at least once in every forty-eight hours.

6966—May 7—Authorizing the Pere Marquette Railroad to construct, maintain, and operate branch line of railway for the accommodation of the Imperial Oil Company, Limited, extending from a point of the P.M.R.R. on the northerly side of St. Andrew Street, Sarnia, Ont., thence southerly across St. Andrew Street along the westerly side of King Street across south-east corner of Lot 14, R. 2 Francis Survey, the property of the St. Clair Tunnel Company to connect with another branch line of the Pere Marquette Railway.

6967—May 6—Authorizing the Municipal Council of the Municipality of Johnson to construct a crossing over the Soo Branch of the C.P.R. near M. P. 148, where the highway is laid out to cross the railway between Lots 4 and 5, Concession 6, Township Johnson, Ont.

6968—April 27—Ordering the G.T.R. Company to protect with gates the crossing at Weston Road, West Toronto, Ont.

6969—May 6—Directing the G.T.R. and C.P.R. to honor, from the International Boundary, and respect of their lines in Canada, any through tickets and through baggage checking arrangements issued and provided by initial United States Railways from points in the United States to non-competitive points on the Canadian Northern Ontario Railway.

6970—May 7—Directing the G.T.R. Company to refund to Long Lumber Company $3.88, the amount of stop-over charge collected by the Railway Company at Sarnia, Ont., on a shipment of shingles.

6971—May 8—Authorizing the C.P.R. to construct its railway across the highway in the Township of Bentinck, County of Grey, Ontario, at mileage 25.49.

6972—May 6—Approving special contract or "Release" of the G.T.R. respecting the carriage of silver and other valuable ores, and authorizing the use of the said form upon its line of railway until further notice.

6973 to 6976 Inclusive—May 7—Granting leave to the British Columbia Telephone Company to cross the C.P.R. at four points in the Province of British Columbia.

6977—May 7—Granting leave to the village of Port Dover, Ont., to lay and maintain a sewer pipe under the track of the G.T.R. where the same crosses Chapman Street, Port Dover, Ont.

6978—May 4—Dismissing application of the Q. M. & S. Railway for authority to extend its terminals at St. Lambert, P.Q., so as to form a connection between the Q. M. & S. R., and the G.T.R., Rouses Point Division.

6979—May 10—Amending Order of the Railway Committee of the Privy Council, dated May 13th, A.D. 1898, so as to provide that the C.P.R. may fill in portion of the trestle bridge from the north end of the island to the main shore, near Simcoe, in the city of Peterborough, Ont.

6980—May 10—Authorizing the G.T.R. Company to construct branch line to and into the premises of the Consumers' Gas Company, Toronto, Ont.

6981—May 10—Authorizing the C.P.R. to construct four bridges, two on its Ontario Division, one on Eastern Division, and one on Pacific Division.

6982—May 10—Granting leave to A. Michaud to lay water pipe under the tracks of the Temiscouata Railway, at St. Francis de Madawaska, P.Q.

6983—May 10—Certifying that a mistake was made in representing Chas. Oligny as sole owner of Lot Cad astral No. 645-J; he being curator for Albert Oligny and Arthur Oligny, and others, and that same has been changed.

6984—May 7—Rescinding Order of the Board No. 6913, dated April 28th, 1909, dismissing application of the Municipal Corporation of the town of Canboro, Ont., for Order directing the Canadian Southern Railway to construct a suitable highway crossing over its line of railway to connect highway land out by the applicants.

6985—May 6—Rescinding Order No. 5643, dated November 3rd, 1908, directing the G.T.R. to provide a suitable flagstation at Fern Glen, or Walls Crossing, one half mile west of Scotia Junction, Ont.

6986 to 6989 Inclusive—May 10—Granting leave to the Bell Telephone Company to cross with its wires the tracks of the G.T.R. at Sundridge, Ont., and Drayton, Ont., respectively; and to cross the Michigan Central Railway at Petrolea, Ont.

6990—May 10—Granting leave to the Zorra Telephone Association, Limited, Embro, Ont., to erect, place, and maintain its wires across the track of the Tillsonburg, Lake Erie and Pacific Railway Company, between the 3rd and 4th Concessions of West Zorra, Ont.

6991—May 10—Granting leave to the Bolton Telephone Company to erect, place, and maintain its wires across the track of the C.P.R. on Lot 13, between Concessions 4 and 5, Township of Albion, County of Peel, Ontario.

6992—May 10—Authorizing the C.P.R. to construct bridge No. 68.31, on the Chapleau Section of its line.

6993—May 10—Authorizing the C.P.R. to construct bridge at mileage 63.55 of the White River Section of its line.

6994—May 10—Authorizing the Crow's Nest Pass Coal Company, Limited, to construct bridge structure over the main line of the C.P.R. at the town of Michel, B.C.

6996—April 29—Ordering that commencing not later than June 1st, next, the rates to be charged from Montreal by the C.P.R. to its stations in New Brunswick, on western grain for domestic consumption, arriving at Montreal by vessel, be made by adding five cents per one hundred pounds to the "arbitrary" rates from Montreal to the New Brunswick points.

6997—May 11—Authorizing the O. & N. Y. Railway to construct a draw span and pivot pier on the Cornwall Canal Bridge.

6998—May 4—Extending time for the installation of fire extinguishers in cars of railways under the jurisdiction of the Board to six months from May 4th, for cars undergoing repairs, and eighteen months from the 3rd of November, 1908, for cars at present in use.

6999—May 10—Dismissing complaint of John Kerr, Franklin, Man., against the rate charged by the C.P.R. of 13c. per 100 lbs. in carload lots, on vegetables from Franklin to Winnipeg, Man.

7000—May 4—Authorizing the G.T.R. Company to use and operate jointly and on equal terms with the C.P.R. branch line to and into the premises of the Sunbeam Incandescent Light Company, on the west side of Mowat Avenue, Toronto, Ont.

7001—May 11—Approving character of work provided for in report in connection with the proposed drain to be constructed across the Erie & Huron Railway, (P.M.R.R.), in the Township of Harwich, County of Kent, Province of Ontario.

7002—May 11—Granting leave to the city of Hull, P.Q., to construct and maintain an highway across the track of the Ottawa, Northern & Western Railway at a point opposite the present northerly extremity of Chaudiere Street, Hull, P.Q.

7003—May 12—Approving and sanctioning amended location of the line of railway of the United Gold Fields of British Columbia from Frank to Grassy Mountain, B.C.

7004—May 12—Granting leave to the C.P.R. to construct its railway across the highway between Lots 25 and 26, Concession 9, Township of Vaughan, County York, Ont., mileage 16.93 on its main line, and at mileage 17.40.

## ENGINEERING SOCIETIES.

**CANADIAN SOCIETY OF CIVIL ENGINEERS.**—413 Dorchester Street West, Montreal. President, Geo. A. Mountain; Secretary, Prof. C. H. McLeod.

QUEBEC BRANCH—
Chairman, L. A. Vallee; Secretary, Hugh O'Donnell, P.O. Box 115, Quebec. Meetings held twice a month at Room 40, City Hall.

TORONTO BRANCH—
96 King Street West, Toronto. Chairman, J. G. G. Kerry; Secretary, E. A. James, 62 Church Street, Toronto.

MANITOBA BRANCH—
Chairman, H. N. Ruttan; Secretary, E. Brydone Jack. Meets first and third Fridays of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—
Chairman, Geo. H. Webster; Secretary, H. K. Dutcher, 40-41 Flack Block, Vancouver. Meets in Engineering Department, University College.

OTTAWA BRANCH—
Chairman, C. R. Coutlee, Box, 560, Ottawa.

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. Percy Barnes, Edmonton; Secretary, H. M. Widdington, Strathcona, Alberta.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS (TORONTO BRANCH).—W. H. Eisenbeis, Secretary, 1207 Traders Bank Building.

AMERICAN MINING CONGRESS.—President, J. H. Richards; Secretary, James F. Callbreath, Jr., Denver, Colorado.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.—President, John P. Canty, Boston & Maine Railway, Fitchburg, Mass; Secretary, T. F. Patterson, Boston & Maine Railway, Concord, N.H.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.—President, Wm. McNab, Principal Assistant Engineer, G.T.R., Montreal, Que.; Secretary, E. H. Fritch, 962-3 Monadnock Block, Chicago, Ill.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—Secretary, C. W. Hunt, 220 West 57th Street, New York, N.Y. First and third Wednesday, except July and August, at New York.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—29 West 39th Street, New York. President, Jesse M. Smith; Secretary, Calvin W. Rice.

ARCHITECTURAL INSTITUTE OF CANADA.—President, A. F. Dunlop, R.C.A., Montreal, Que.; Secretary, Alcide Chaussé, P.O. Box 259, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, E. Grandbois, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Vice-President, C. F. Pulfer, London, Ont.; Secretary-Treasurer, Alfred E. Uren, 62 Church Street, Toronto.

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, J. F. Demers, M.D., Levis, Que.; Secretary, F. Page Wilson, Toronto.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, W. G. Miller, Toronto; Secretary, H. Mortimer-Lamb, Montreal.

CANADIAN RAILWAY CLUB.—President, H. H. Vaughan; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto; Secretary, F. W. H. Jacombe, Ottawa.

CANADIAN STREET RAILWAY ASSOCIATION.—President, J. E. Hutcheson, Ottawa; Secretary, Acton Burrows, 157 Bay Street, Toronto.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto. President, C. A. Jeffers, Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July, August.

DOMINION FORESTRY ASSOCIATION.—President, Thomas Southworth, Toronto; Secretary, R. H. Campbell, Ottawa.

DOMINION LAND SURVEYORS.—Ottawa, Ont. Secretary, T. Nash.

EDMONTON ENGINEERING SOCIETY.—President, Dr. Martin Murphy; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alta.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. Prtsident, A. B. Barry; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INTERNAL COMBUSTION ENGINEERS' ASSOCIATION.—Homer R. Linn, President; Walter A. Sittig, Secretary, 61 Ward Street, Chicago, Ill.

MANITOBA LAND SURVEYORS.—President, Geo. McPhillips; Secretary-Treasurer, C. C. Chataway, Winnipeg, Man.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. H. Winfield; Secrttary, S. Fenn, Bedford Row, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, W. H. Pugsley, Richmond Hill, Ont.; secretary, J. E. Farewell, Whitby, Ont.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, Louis Bolton; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

WESTERN CANADA RAILWAY CLUB.—President, Grant Hall; Secretary, W. H. Rosevear, 199 Chestnut Street, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

WESTERN SOCIETY OF ENGINEERS.—1735 Monadnock Block, Chicago, Ill. Andrew Allen, President; J. H. Warder, Secretary.

## COMING MEETINGS.

**American Society of Civil Engineers.**—Annual convention, Mount, Washington Hotel, Bretton Woods, N.H., July 6 to 9. Secretary, Chas. W. Hunt, 220 West 57th Street, New York.

**American Railway Association.**—May 19. Annual meeting at New York City. Secretary, W. F. Allen, 24 Park Place, New York City.

**American Waterworks Association.**—June 8-12. Annual convention at Milwaukee, Wis. Secretary, John M. Diven, 14 George Street, Charleston, S. C.

**American Railway Master Mechanics' Association.**—June 16-18. Annual convention at Atlantic City, N.J. Secretary, Jos. W. Taylor, 390 Old Colony Building, Chicago, Ill.

**American Railway Bridge and Building Association.**—October 19-21. Nineteenth annual convention at Jacksonville, Florida. Secretary, S. F. Patterson, Boston & Maine Railway, Concord, N.H.

**International Railway General Foremen's Association.**—June 1 to 5, 1909, at Chicago. E. C. Cook, Royal Insurance, Chicago, Ill.

**Master Car Builders' Association.**—June 21 to 23, 1909, at Atlantic City, N.J. J. W. Taylor, Old Colony Building, Chicago, Ill.

**National Electric Light Association.**—June 1 to 4. Thirty-second convention, Atlantic City, N.J. Secretary, John F. Gilchrist, 29 West 39th Street, New York.

**National Fire Protection Association.**—May 25 to 27. Annual meeting at New York City. Secretary, W. H. Merrill, 382 Ohio Street, Chicago, Ill.

THE

# Sanitary Review

SEWERAGE, SEWAGE DISPOSAL, WATER SUPPLY AND WATER PURIFICATION

## ALBERTA AND SEWAGE DISPOSAL.

We have it on good authority that the Provincial Government of Alberta are about to adopt a standard of purity for sewage discharges into rivers and streams which are, or may be in the future, used as drinking supply sources.

The proposed standard is a biological one, demanding a high percentage of bacteria removal, viz., 95 per cent.

We do not know of any country or district where an equally high standard of purity has been asked for—certainly in Great Britain and Europe such has not as yet been dreamed of. A non-putrescible effluent is all that has generally been asked for. The question has not been one of producing from sewage a drinking water, but only an effluent incapable by putrefaction of giving off any smell or producing any nuisance, either to the stream or its banks.

Conditions in Alberta appear, however, to be somewhat different from those in Great Britain. In the latter country, with the exception of the city of London, most of the towns and cities are supplied with water, not from the rivers, but by surface collection in the upper reaches of the water sheds. Alberta, on the other hand, appears to depend on its rivers (comparatively small in volume) as the source of water supply. It is, therefore, necessary that these sources be maintained as pure as possible.

In Europe and the States, where river waters are used for domestic purposes, owing to neglect in the past, it is now necessary to spend large sums of money in filtering the river water before delivering it. Alberta evidently wishes to avoid this condition of things. The Government, then, are about, on the advice of their engineer, to insist on a standard of purity.

While we feel that the Government is adopting a wise and far-seeing policy in guarding the purity of its streams, we certainly think that if they attempt in every case to demand a fixed standard of 95 per cent. removal of bacteria from sewage, they will be asking in some cases too much, and in others too little.

A fixed standard of purity is not only an injustice in some communities, but it is also an absurdity. Any standard of purity must have reference to the character and volume of the stream into which it discharges. A rapid flowing stream is capable of oxidizing and purifying sewage effluents much more rapidly than a sluggish stream. The relative volume of the stream as compared with the amount of sewage effluent discharge determines the eventual purity of the stream, apart from any fixed standard of purity of sewage effluent.

To take an example from the Lawrence Filters and reduction of bacteria, a crude sewage is given containing 4,758,000 bacteria per c.c. A percentage reduction was obtained from Filter No. 1 of 99.39 per cent., which shows the number of bacteria remaining in the effluent to be 28,800 c.c With a 95 per cent. reduction standard the bacteria remaining in the effluent would amount to 237,900 per c.c.

Now, in either case it must be obvious that to render any water safe into which either of the above effluents is discharged must depend upon the amount of dilution effected.

In cases where it is a question of sewage effluents entering small volumes of water used for drinking purposes, we do not see that any method can be relied upon apart from sterilization.

It may be well to quote in the above connection Professor Dunbar, of the State Institute of Hygiene, Hamburg (page 34, Principles of Sewage Treatment): "A complete separation or destruction of pathogenic germs is not possible with any one of the methods of purification which have been successfully adopted on a practical scale. Hence, in cases where pathogenic germs must necessarily be removed from sewage, special measures must be adopted. No process of filtration is known which will effect the object in question. Methods depending upon heat or chemicals can alone be considered.

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In our next issue we intend to publish the valuable paper recently given by Mr. H. C. H. Shenton on "Practical Sterilization of Water and Sewage Effluents," read at the Institution of Municipal Engineers, England, last week.

## SEWAGE DISPOSAL.

### REMOVAL OF SUSPENDED MATTERS.

### CHAPTER III.

#### Sludge Disposal.

We have seen that it is possible, by reducing the velocity of sewage flow, to deposit by means of properly constructed tanks from 60 to 70 per cent. of the solids in suspension. Unfortunately this deposited matter, known as sludge, consists for the most part of water. Fresh sludge usually contains about 90 per cent. of moisture, while sludge which is allowed to remain in the tank and undergo septic putrefaction contains about 80 per cent. of moisture. The dry residue in the latter case amounts to 20 per cent., as against 10 per cent. in fresh sludge. Each cubic yard of septic sludge contains, generally, as much solid matter as two cubic yards of fresh sludge.

The disposal of sludge, because of this high percentage of moisture, is one of the most difficult problems in dealing with sewage, this is especially the case in large cities.

One million gallons of average domestic sewage contains approximately 31 cwt. of dry sludge, i.e., sludge, containing no moisture, of this amount about one ton or 65 per cent. can be deposited by sedimentation. One ton of dry sludge together with 90 per cent. of moisture represents ten tons of wet sludge for every 1,000,000 gallons of ordinary sewage treated. Of course this amount will vary slightly with different sewages.

Every community may, therefore, be said to have to face the question (if sedimentation be a part of the scheme of sewage disposal), what has to be done with this ten tons of wet sludge representing each 1,000,000 gallons of sewage treated?

Before discussing the question of disposal of sludge, it is well to decide how often it is necessary to remove it from the sedimentation tanks.

As previously stated, no tank either septic or otherwise should be allowed to fill with sludge above the level of the depth of the shallow or outlet end. The depth below this level, including the pump, well, may be considered as space in which the sludge may gather without detriment to the flowing liquid.

With septic tanks no exact period can be laid down as to time for sludge removal. It will be found that after a certain amount of deposit is effected, that the sludge will settle by gravity and weight of the supernatent liquor into a more solid form, and that the depth of sludge will increase very slowly. The time for removing septic sludge can only be judged by an analysis of the tank liquor, and when such analysis shows the percentage of suspended matter is greater in the tank liquor than the amount deposited, then the tank should certainly be cleaned out. This means that whenever the tank liquor shows a greater percentage than 50 per cent. of suspended matter, it is time to remove the sludge from the tank.

With continuous flow sedimentation tanks, however, the object is to maintain the deposit of the suspended matter at the maximum, so as to present to the filters constant liquor as far as suspended matter is concerned.

The Royal Commission in their report recommend that such tanks be cleaned out once a week. Assuming a discharge of 1,000,000 gallons per day, depositing ten tons of wet sludge per day; and a tank built capable of dealing with 1½ hours discharge, with a velocity flow of ½-inch per second, the dimensions would be as follows: 75'.0"×6'.0×2'.4" deep at shallow end.

Allowing a depth of 6 feet at inlet end below line of shallow depth the sludge not being allowed to rise above the level of shallow end, a sludge capacity of 1,350 cubic feet would be provided. This would mean that the sludge should be removed every four days, as by that time it would have filled the sludge space allowed for its accumulation.

A tank built as described presents the ideal proportions, and the bases for all continuous flow sedimentation tanks, but is only of practical value where attendance can be relied on; as there is no automatic method as yet devised, allowing of the removal of the sludge when it obtains the maximum level permitable.

The time period for the removal of sludge can be extended by the deepening of the tank below the level of the shallow end, viz., by increasing the sludge capacity of the tank without interfering with the continuous flow of the liquor. This extension of time is understood to be limited by the moment when septic action starts in the retained sludge. Hence the Royal Commission Report, "that continuous flow sedimentation tanks be cleaned out once a week."

We may, therefore, take it without further argument that a town discharging 1,000,000 gallons of average domestic sewage per day has to face the problem of removing from sedimentation tanks 70 tons of wet sludge each week, these 70 tons containing 63 tons of water and 7 tons of dry residue.

The sludge may be removed from the tanks by various methods. In every case tanks should at least be in duplicate, so that one may be kept in work while the sludge is removed from the other.

Assuming that a tank has filled with sludge to the level of the shallow depth at outlet end, and the levels will so allow, the usual and the best method is to draw off the liquid by means of a floating valve, until the level of the sludge is reached, and then by opening a valve fixed at the bottom of the tank or sludge well, the sludge by its own specific gravity flows out of the tank.

When the process of sludge removal by gravity cannot be effected, it must be raised out of the tank, either by hand by means of a chain pump, or artificial power.

For large tanks, special apparatus is designed for directing and collecting the sludge to the outlet valve—Fidler's sludge collector may be noted in this connection.

### Disposal on Land.

Many exaggerated opinions are held as to the value of sewage sludge as a manure. The fact that 90 per cent. is moisture detracts considerably from its fertilising qualities. The extraction of the moisture is an expensive process and it has been shown in practice than the manurial qualities even of the dried sludge do not pay for any process of sludge pressing.

Sewage sludge only contains relatively small quantities of nitrogenous compounds and sulphates, there may be sufficient grease, as from wool factory wastes to repay the expenses of extraction, but by far the greater part of the dry sludge is made up of mineral matters, together with cellulose.

A dry, porous and light character of land will benefit by a mixture of sludge, and there are occasions when farmers will continue to take as much of it as they can obtain. In the wet state, however, it is difficult to handle or convey any distance. A general method of sludge disposal is by burial in land, when sufficient land can be obtained for the purpose of a suitable character. It is usual to cut V-shaped trenches about two feet wide at the top and about one foot deep. The wet sludge is allowed to run from, or is pumped into the trenches, which are filled and covered in with the top soil. The area thus treated is allowed to remain until dry, after which it is ploughed and either used for cropping or again for sludge.

The Royal Commission on Sewage Disposal advise that with good or medium soil four acres are sufficient to deal with the sludge per annum of 1,000,000 gallons of sewage discharge per day.

The operation should be carried on as rapidly as possible and during dry weather, when practically no nuisance is experienced.

(To Be Continued.)

## CURRENT NOTES.

### Montreal Water Supply.

It looks very much like action being at last taken by the Corporation of Montreal with a view to water purification.

Dr. H. St. George has presented a comprehensive report upon the whole question, he has, as the result of analyses of various samples, been able to show conclusively that Montreal's water supply is not really fit for drinking purposes.

The people of Montreal have, however, known this for years; as proof, they are willing to pay an immense sum of money every year in order to obtain laurentian spring water by the bottles, rather than drink the city supply. The people, in fact, (those who can afford it), pay for two water supplies,one served through pipes without any guarantee of purity, the other hawked in bottles with a guarantee of purity.

Dr. St. George's report is referred to the Water Committee for consideration, and will be further reported to the counci'. The report evidently recommends a system of filtration. With the evidence before us, "slow sand filtration," although expensive in the first instance, certainly appears to have accomplished much as far as river waters is concerned; on the other hand, coagulation combined with improved forms of mechanical filtration have also given fairly good results, and we find in Great Britain a decided tendency towards their adoption. On the other hand, the question of sterilising water by means of ozone and other agents, is receiving considerable attention at present.

We certainly consider that the advice of Dr. Lachapelle (President of the Quebec Provincial Board of Health), should not be lost sight of in any panic of eagerness to do something. He recommends (as reported) that experiments should be made along with full enquiry into the best method of purifying the St. Lawrence River Water.

The Paris Municipality have decided to sterlize 10,000,000 gallons per day by the "Otto" ozone process. Such a process does not take the place of either preliminary sedimentation or a certain amount of filtration, but it is claimed that it enables an economy to be effected, seeing that it is possible to pass the water through filters at twice the ordinary rates,

and ensure a final supply absolutely free from intestinal bacteria.

We trust that Montreal will arrive at a final and efficient solution to what must be considered the most important feature in its civic programme.

**Toronto Water Supply Question.**

In our issue of April 30th last, we stated with reference to the proposal to treat Lake Ontario water by slow sand filtration, that "there was no data (experimental or otherwise), as a basis for this proposal."

We note that since the issue of this statement, the question is re-opened in several quarters.

Dr. Sheard, through the medium of the daily press, has some remarks to make on the subject. We quote as follows:—

"It is not a political question—it is a sanitary one."

"There is practically no difference in the purity of the water since the tunnel was built."

"The Board of Control has been notified every day of the condition of the water as shown by the analysis."

"During the first twelve days of May there were six days in which b. coli were found in the water."

"There was a very large vote for the city by-law, and the press supported it." No one would be so foolish as to doubt the doctor's analyses, all that he says we feel and know is perfectly true.

No one is more capable of judging the matter from a sanitary point of view than the Medical Officer of Health.

This Review is not political, and has no political interests, it is an engineering journal, and merely makes an engineering statement with reference to **"data."**

It is a well-known fact that certain classes of water are more readily affected by slow sand filtration, than others, depending on the character and amount of suspended matter in the water, which forms the bacteria filter scum.

We may be wrong in stating that no data exists with reference to similar water to Lake Ontario. If we are wrong we will be too willing to confess to our error and put the matter right.

We do not think we are wrong, we understand that both Mr. Watson and Mr. Rudolph Herring have had no experience with slow sand filtration with this particular character of water. We know that in both the States and Britain, and also in Europe, the experience has been wholly gained in treating river waters.

We think that if Dr. Sheard has any data on this point, he will perform a duty to the public and to engineering enquiry in general, if he makes it public.

**Owen Sound Water Supply.**

Mr. Robertson's Report—Secretary of Fire Underwriters' Association advises re the proposed extension to water supply.

Toronto, Ont., May 7th, 1909.

F. W. Harrison, Esq., Mayor, Owen Sound.

Dear Sir,—Referring to our recent correspondence respecting the by-laws it is proposed to submit to the ratepayers of Owen Sound, for the raising of money to improve the water supply and pressure, I have now received our engineer's report upon the situation and have had the opportunity of submitting the matter to the committee of our association that deals with these questions. I have now pleasure in advising that if all the proposed improvements are carried out, viz.:—

1. The construction of a new reservoir in two sections of 2,500,000 gallons each at an elevation of 216 feet above the street level at the City Hall.

2. This reservoir to be supplied at the rate of 1,000,000 gallons per day from the Sydenham River above Inglis Falls.

3. To lay from this course of supply a new main, 18 inches and 12 inches diameter, along Poulett Street to Division Street, and thence along Union Street to the new reservoir.

4. This new main to be connected with the present main on Poulett Street by a valve opposite the fire hall, the arrangement to be such that when this valve is opened the pressure from the new reservoir will extend over both the new and the old systems.

5. A sufficient number of hydrants to be placed on the new main.

6. The present reservoir to be kept full by means of a special communication with the new one.

This association is prepared to make a reduction of 10 per cent. in all the mercantile ratings in your town. In this connection I would point out that it was only in February last that Owen Sound was re-rated, and at that time favorable consideration was given on account of the good record of the town and the key-rate, therefore, placed at a lower figure than would ordinarily have been the case for the protection furnished.

Yours truly,

John A. Robertson,

Secretary, Canadian Fire Underwriters' Association.

**London (Ontario) Water Supply.**

Chairman of Board of Health waited on the Water Commissioners.

"We want to draw your attention to the condition of the ponds at Springbank," he said. "Our reports show that colon bacilli is in the water. I do not think this comes from the springs, but I think the public should be excluded from the grounds. I would recommend also that the lower driveway be closed to the public."

**Will Protect Supply.**

"We certainly want to do everything to protect the supply from contamination," said Commissioner Darch. "Is that amount of colon bacilli very high compared with other cities?" asked Engineer Moore.

"No, not particularly," said Dr. Niven.

"I have nothing definite to propose," he continued, "but would suggest that we go down together and look over the ground."

This was agreed to.

An interesting feature to be noted in the above is the question put by the engineer as to the amount of colon bacilli. The presence of colon bacilli in a drinking water is a proof of the presence of sewage contamination. This particular bacilli is peculiar to the intestines of animals, and is given off in intestinal discharges. It should never be present in drinking waters no matter what the amount.—Ed. Sanitary Review.

**Town of Verdun (Water Filtration).**

Verdun has the distinction of installing the first filtration plant on the island of Montreal. For the past ten years the water required for domestic purposes has been supplied by the Montreal Water & Power Company, but after the 1st of next June the town will supply its own water. Samples of water shown Saturday were of crystal clearness, and much satisfaction was expressed on the energy of the town authorities.

The filtration of the raw water is performed by means of two large tanks, eight feet in diameter and some twenty feet long. Five feet of fine sand is placed in each tank, through which the water filters. A small quantity of alum, consisting of one grain to each gallon of water, uniting with the lime therein, has the effect of thickening all the impurities in solution which, adhering to the sand, catches the bacteria, and in that way purifies the water. These tanks are really long barrel-like pipes attached to the water main, coming from the pumps, and after the water passes through them it goes on into the regular water pipes, to be distributed where desired. The water is not exposed to the air after it once enters the pump.

The apparatus installed will filter 1,000,000 gallons of water in twenty-four hours, which is considerably more than is consumed in Verdun at the present time. Each of the filters may be cleaned by a simple operation as often as liked. The sediment collected and other impurities are run off into the sewer and a fresh supply of sand is put in.

Two Worthington triple expansion pumps of one million gallons each, with boilers and filtering tanks, have been supplied by the firm of John McDougall & Company. Mr. C. Lester, engineer, has charge of the work.

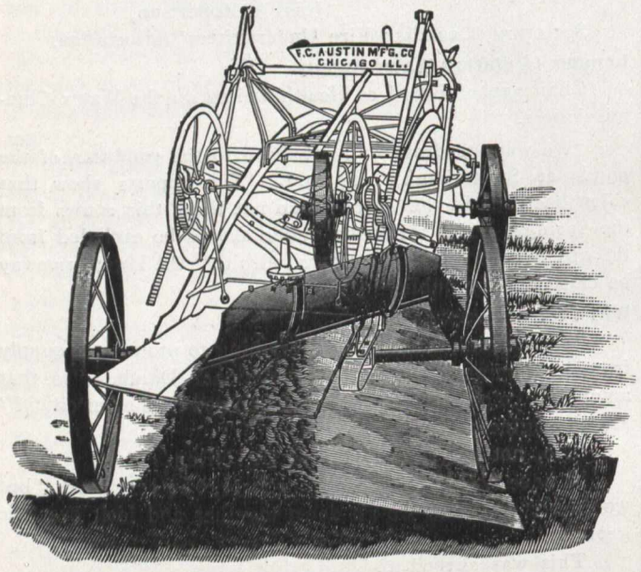
(Continued on Page 691).

## ROAD MACHINERY.*

A. Rankin, Collins Bay.

The public roads in Ontario up to a few years ago were in the same condition as the roads in England about the year 1810, and the method of building and repairing was the same, but with the advent of road-building machinery the method of constructing roads underwent a change.

The roads of the present time have been divided into two systems, (1) the gravel road and the macadam. These roads are so named because of the materials used in their construction. The gravel roadway may simply be regarded as a sub-




**Reversible Road Machine.**

stitute for the macadam, due to the decreased cost of construction and maintenance.

The macadam roadway is built of broken stone thoroughly rolled into place. The consolidation is done by machinery and should never be left to traffic.

Macadam roads are sub-divided into the two classes—

(1) The macadam roadway.

(2) The Telford road.

These two classes refer to the foundations. The Telford foundation is one formed with coarse stone for under-pinning and simply acts as a support.

In the County of Frontenac the roads in the past have been more or less gravelled or covered with broken stone so that the plan to be adopted will take this into account. Instead of the trench construction, as has been adopted in many places—the surface of road will be broken up by a scarifier after all the mud has been removed, and levelled and re-rolled, and then the road surface immediately laid on top of this, and properly graded and consolidated.

The scarifier is perhaps a new departure in the building of rural roads in Ontario. About the only one used in the smaller cities of this Province to-day is the one employed in Kingston. The one used there consists of a heavy framework, weighing approximately 2¼ tons, mounted on a pair of wheels. On each end are attached four heavy steel teeth. These latter can be adjusted and regulated to any depth of cut by means of a small wheel and worm at either end of the frame.

The advantage of the scarifier is that it is operated by its own weight and does not depend on manual labor. The machine is operated by attaching it to a road roller, or better to a traction engine. It has given good satisfaction; the cost of operating per square yard of road surface broken up, being comparatively small, 1 cent per square yard.

Where a scarifier cannot be obtained, picks placed in the rear wheels of a road roller, may be used. This will operate on the hardest of roads. The picks punch holes in the roadway and on being pulled out, the slightly lateral motion of the pick point, due to the rotary motion of the wheel, loosens the material. This method is open to the objection that the roller tends to consolidate somewhat the already loosened material.

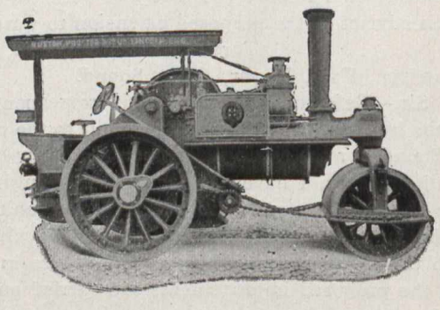
The rooter plough, which is practically a steel point attached to a strong heavy framework of iron or steel, is also greatly used. It may be drawn by a traction engine or by two or three teams of horses. Usually on hard roads, three men are required to keep the point in the surface, but after the first few cuts are made the roadway may be rapidly broken up.

Where none of these methods are available, a hand-pick may be used, but this method is very slow and expensive, and should not be used if it can possibly be avoided. Machinery should be made to take the place of all manual labor, where feasible, both for loosening the old material, shaping the roadway and spreading and consolidating the new materials.

After the roadway has been broken up, it should be properly trimmed and levelled. This is done by means of a scraping-grader consisting of a large knife-edge mounted on four wheels. The blade is controlled by gearing, so that it may dip at any angle and make any angle with the direction of travel. By this means any desired cut may be made, and any desired disposition of the materials accomplished, and any shape given to the surface. The grader is usually operated by four horses, or better still by a traction engine.

After the surface has been trimmed, it should be rolled, and the road metal added. The metal is obtained from a crusher plant, where it is crushed and screened into the various sizes required for road-work. The stone may be broken either by hand or by machinery—the former method, while it gives better stone, is not adopted because of its excessive cost. A crusher plant should then be provided, which consists of (1) a crusher; (2) an elevator; (3) screens; (4) power to operate these; (5) bins for the storing of the screened and sorted stone.

The crusher itself may be one of two varieties, (1) the jaw. This crusher is operated by means of toggle joints, or cams, acting on the jaws which vary the distance between them. The stone is in this manner crushed. The distance apart of the jaws is regulated by means of a wedge, and governs the size of the output. (2) The gyratory crusher, operated by means of a casting acting eccentrically about a vertical shaft. Its advantage over the jaw crusher is that no time is lost in the drawing back of jaws for the next blow, crushing being continuous. Its disadvantage is that smaller stone must be fed to the hopper. Crushing plants are either portable or stationary. The gyratory crusher is only used in



**Steam Road Roller and Scarifier.**

stationary plants as it is too heavy to move. The jaw crusher is adaptable to portable plants.

From below the crusher the stone should be carried by an elevator to the screen. The elevator usually consists of a series of buckets attached to an endless chain, and is operated from the crusher directly.

The screen is usually cylindrical in form and is slightly inclined, so that the rotary motion tends to move the stone forward. The holes in the screen are usually of three sizes, and the size of these holes governs the size of the output. Usually three sizes of holes are employed; those passing one-

*Read before the Ontario Good Roads Association.

half inch stone, those passing one and one-quarter, lastly those passing two and a half inch stone. The smaller size holes are usually at the upper end, and the crusher product entering at the upper end has the various sizes screened out in succession. Thus the stone is divided in four classes, (1) the one-half inch size; (2) the one and a quarter inch size; (3) the two and a half inch size; (4) what is known as tailings, or the stone which is too coarse to pass through the holes in the screen. This may be re-run through the crusher by means of a belt conveyor, or used in foundation work. The various sizes of stone are dropped into bins which have trap doors or sliding gates, by which the stone may be loaded into wagons.

The wagons employed may be the ordinary farm wagon, or a special wagon constructed for this class of work. The latter is of hopper type, and with sloping bottom. The stone is dumped by opening the bottom and drawing the wagon ahead and spreading the stone evenly over the road. If this latter operation is not possible, it is dumped into piles and distributed by hand.

In placing the stone care should be taken to keep the stone graded, and each size placed by itself in the roadway. The usual manner is to place the two and a half inch stone, then the one and a quarter, and finally the screenings to act as a binder. Each layer should be spread and levelled by a grading machine. Some of these grading machines are simply fashioned like a cultivator, only the teeth are replaced by a broad, flat blade.

Each layer should be properly consolidated before another is added. The consolidation is done by means of a horse-roller or steam-roller. It should never be left to traffic. The horse-roller consists simply of a heavy steel cylinder from 4 to 5 feet in length, and weighing from three to six tons. It is operated by horses. This method is objectionable in that the roller is not heavy enough to accomplish the consolidation, and the horses' hoofs break up the road almost as fast as it can be rolled.

The steam-roller consists of a boiler and engine mounted on four wheels, or rather rolls. Those in front are about three feet in width and fastened close together, and two in the rear about eighteen inches in width and not tracking with the front ones. The rear wheels act as the driver and can be thrown in or out of gear by means of a friction clutch. By this means the roller may be temporarily thrown out of action, and used to drive the crushing machinery. This is not economical, as it is not good policy to use the roller for this purpose, but it should be kept at work consolidating the roads. The steam road-roller is made from ten to twenty tons in weight, twelve to fifteen tons being the roller usually employed for road work. The fifteen-ton roller may have to be used in gravelling or clayey soils, or with hard rock. With soft stone a ten-ton roller may be sufficient, otherwise the metal will be crushed. The pressure attained by the rear wheels varies from four hundred and fifty to six hundred pounds per square inch. A fast moving roller does not give proper consolidation, neither does one that is too slow. A roller travelling from two and a half to three miles per hour gives the best results.

Each layer should be properly consolidated before another one is added, and should be continued until the stone ceases creeping. The rolling should be done gradually from the gutters to the crown. This avoids crushing the material out to the sides, and the consequent flattening of the crown.

Some advocate the free application of water during the rolling, but on clay bottom this causes too much clay to squeeze up below the lower stones. With frost in the spring, this will heave, and the traffic cutting through the surface has no support, and consequently the road becomes badly cut up. A little water is advisable to flush the binder between the coarser particles, otherwise the rain and the wind will remove the binder from the surface of the roadway.

The method of applying the water is usually by means of a watering cart, with a sprinkler attached to the rear. Care should be taken to see that the water is evenly distributed, and in not too large quantities.

The unit costs of labor and materials in the County of Frontenac are estimated as follows for the road improvement for 1909:

1. Removing the mud per square yard, ½c. to 20c.
2. Scarifying, grading and re-rolling, per sq. yd., 4½c.
3. Stone in place on the road per cubic yard, 78½c.
4. Rolling of road surface per square yard, 3c.
5. Sprinkling of road surface per square yard, 2c.

Cost per mile, gravel 4 inches thick, 8 inches wide, scarified, graded, rolled and sprinkled, $700.00; or gravel 6 inches thick, 8 inches wide, $1,000.00. The thickness referred to is after being consolidated.

## WATER METERS.

J. J. Traill, B.A.Sc.

Water meters may be defined as instruments by which the quantity of water flowing in a pipe is measured and the amount passed is recorded automatically. The number of meters devised is legion, if one may draw definite conclusions from patent office records, the British patent office records showing that for one period of ten years there were granted 389 patents of water meters or parts thereof. No perfect meter has been devised as yet, but this is not otherwise than should be expected, for the variety of service to which they are put is so great that most meters are designed to serve well in a few classes of work, while they may be entirely useless in other classes.

The important desiderata of a perfect meter are as follows: It should accurately measure all flows, whether fine or full; should work at very slight pressure; should work at high pressure without shock or water-hammer; should be small in bulk and easy to set and repair; should not be liable

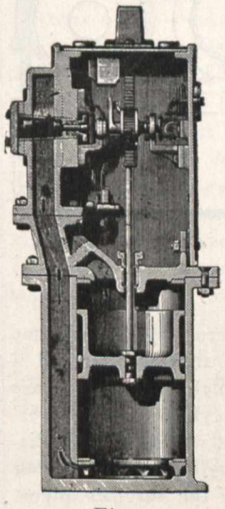


Fig. 1.

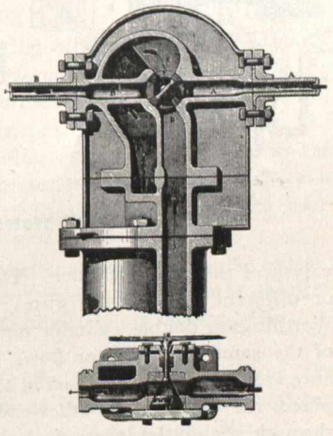


Fig. 2.

**Traill Water Meter.**

to "stick up" or stop, and when not registering when water is being passed through it should give some outward indication of the fact; and, finally, should be incapable of passing water backwards.

Meters are of two kinds, viz.:—Positive and Inferential. Each of these classes may be subdivided. Positive meters measure the actual volume of the water by the action of a piston working in a cylinder which is successively emptied and filled at the completion of each stroke. The cylinder being of known dimensions affords a measure of the quantity of water discharged in a given interval of time. Inferential meters measure the velocity of the flowing water, generally by recording the revolutions of a turbine or other water wheel or, in the case of the Venturi meter, the pressure on a gauge.

Nearly all positive meters are included in the following four classes:—Single cylinder reciprocating piston meters, double cylinder reciprocating piston meters, rotary piston meters (including the disc meters) and diaphragm meters.

The Kennedy meter shown in Figs. 1 and 2 is of the single cylinder reciprocating piston type. This meter will register the flow accurately even when so small a quantity as a drop at a time is being discharged. It is very bulky considering the quantity it will discharge, and is not, therefore, used to any extent as a domestic service meter. Its accuracy is such as to recommend it as a test meter and it is often used for this purpose, the meter to be tested being put in series with it, water run through and simultaneous readings taken on the two dials. The meter consists essentially of a cylinder and piston, a two-way cock, a tumbling weight to operate the cock and a dial on which the discharge is registered. Fig. 1, shows a section of the inlet and outlet pipes and the cock; Fig. 2, a side section of cylinder and piston inlet and outlet pipes and cock. The packing of the piston consists of a ring of very pure soft rubber, shown between the piston and walls of the cylinder. As the piston rises water flows into the bottom of the cylinder, filling it; the rack on the piston rod raises the weight by means of the pinion to which the latter is attached, until, when the end of the stroke is reached, the rack passes beyond the pinion, the weight falls, reversing the cock and the piston commences the return stroke. Any error which might occur through short stroking is made ineffective by having the counting gear record the distance travelled by the piston. With this meter there is danger of water-hammer if the piston speed becomes high.

Much more compact instruments are the double cylinder reciprocating piston meters. In these one piston actuates the

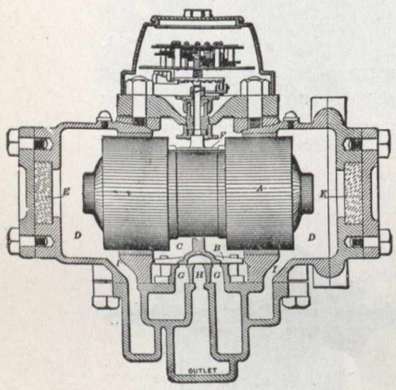



Fig. 3.

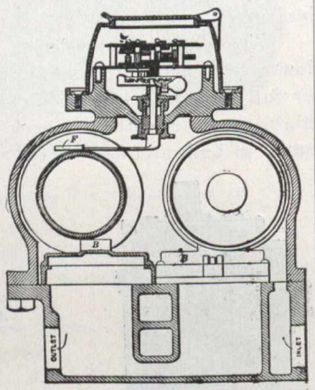



Fig. 4.

**Traill Water Meter.**

valves of the other cylinder. The cylinders may be the same or different in size. Figures 3 and 4 show sections of a Worthington double cylinder meter in which both pistons are of the same size. Water flows into the cylinder under pressure from the main, displacing the piston, which, in turn, displaces the water in the other end of the cylinder, this flowing through the outlet port of the valve to the services pipes. Thus the plunger in moving displaces a fixed volume of water, discharging it through the outlet. The arrangement is such that the stroke of the two plungers alternates, the valve actuated by one admitting water behind the other. The plungers come to rest when they reach the rubber buffers at t'e ends of the cylinders. One plunger imparts a reciprocating motion to the lever F, which operates the counter movement through a spindle and ratchet gear. With this meter, which is otherwise a very accurate and reliable instrument, there is a danger of over-registration at fine flows through a tendency to short stroke.

Rotary piston and disc meters, engravings of which are shown in Figures 5, 6 and 7, are the next in the scale of accuracy where considerable variation in the flow is to be expected. These meters are easily kept in order, there being no valves, and, with the exception of the counting gear and piston or disc, no moving parts. The piston or disc in these meters is usually made of hard vulcanite with a specific gravity, nearly unity, the advantage being a slight reduction in friction. The pistons are of various shapes, generally complicated, but the action of all meters of either class—rotary piston or disc—is essentially the same for the class.

In the rotary piston meters the action is as follows:—The centre of the piston has a circular motion, the lobes working in the small chambers of the cylinder, and these alternately cover and uncover the inlet and outlet ports of each chamber. The amount of water passed per revolution is equal to the dif-

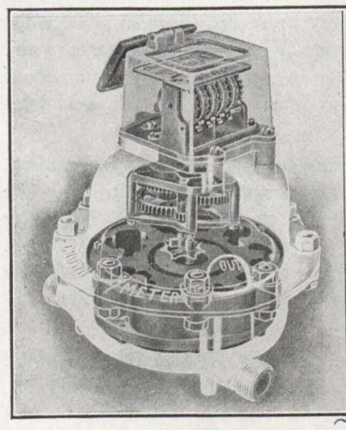



Fig. 5.

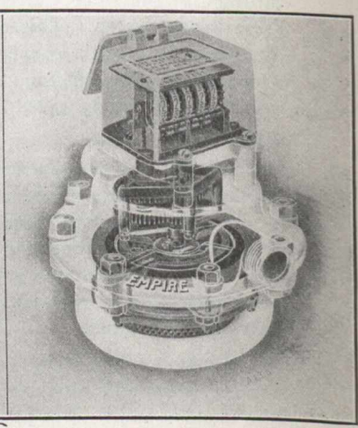



Fig. 6.

ference in volume of the cylinder and piston. In these meters provision is made for a small amount of water to pass when, through accident, the piston becomes "stuck up." This is necessary in domestic supply meters, as the meter should not cut off the supply completely, but if not registering should give some decided indication of the fact.

The meter illustrated in Figure 6 is, as it were, a transition from the rotary piston to the disc type. There is, as in the rotary piston meter, a piston, but the arrangement of inlet and outlet ports is exactly similar to that of the disc meter.

In the disc meter shown in Figure 7, a disc with the shape of a flat cone "wabbles" back and forward in such a way that one element of the cone is always in contact with the chamber in which the disc works, thus shutting off free flow from the inlet to the outlet ports. The volume of water passed per revolution is, of course, fixed by the size of the chamber.

Rotary piston and disc meters are in use to a very large extent in America for metering domestic supply. In one instance a city in one of the northern states placed an order for 15,000 disc meters at one time. Both classes are fairly accurate over quite a wide range of flow. The life of the rotary piston meter is longer than the life of the disc meter. It is possible also by a simple repair to take up the wear of

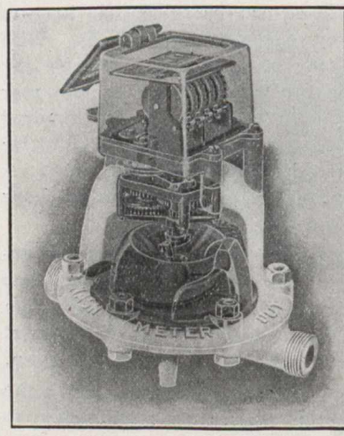



Fig. 7.

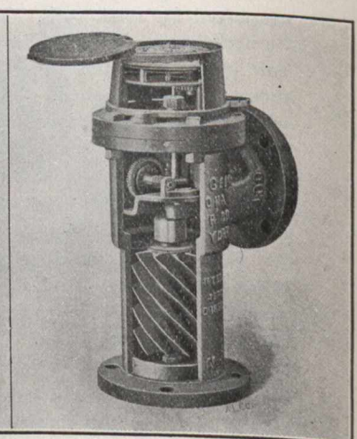


Fig. 8.

the piston for the former, but when the disc and disc chamber of the disc meter become worn the meter's usefulness is ended.

Diaphragm meters are not used to any great extent for water measurement. The meter consists of a pulsating diaphragm, in a vessel of known capacity, which is moved as

the side chambers are alternately filled and emptied. The common dry gas meter is essentially a diaphragm meter.

Coming to the second general class, Inferential meters, we have first of all rotary turbine meters, a good type of this meter is shown in Fig. 8. By a comparison of the supply pipe of this meter with that of any of the positive meters it is immediately evident what a great saving in size—and hence in cost—is obtained by using a meter of this kind. The saving is at the expense of accuracy of registration at fine flow, meters of that kind being accurate only for medium or full flows. The action of the meter is evident from the figure.

Rotary fan meters are similar in principle to the ordinary windmill.

The Venturi meter might also be classed as an Inferential meter. Briefly, the method of measurement of water by this meter is based on the fact, that when water flows through a pipe of which the section is gradually contracted and subsequently gradually increased, the pressure in the smallest section is much less than in the largest section on either side of the contraction. The discharge through the meter varies directly as the square root of the drop in pressure from the largest section up-stream to the throat. For use in pumping stations the meter is furnished with an autographic recorder,

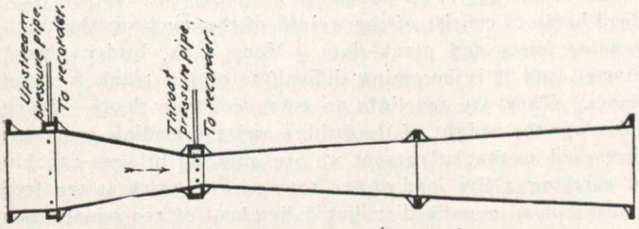



Fig. 9 Longitudinal section of Venturi Meter

which shows, by a diagram, the volume of flow. A diagram of the meter is shown in Fig. 9.

A very decided advantage of the Venturi meter is that the loss due to friction is small. The meter is very accurate, for large discharges, more accurate than any other meter.

For domestic supply the favorite meter in America is one of the positive types, usually the rotary piston or disc meter. The double cylinder reciprocating piston meter is also used frequently. European practice seems to favor the use of Inferential meters for this purpose. The explanation is probably found in the different number of persons per service in America and in Europe. In America the number of people using one service is probably about ten on the average. In some cities it is as low as five. In Europe the number is much larger. In Berlin, for instance, the latest figures available state that there are seventy people per service. With this condition the flow would be fairly continuous and a cheap compact meter which will give a reasonably correct measurement is therefore used. The average number of people per service is large in nearly all European cities.

For trade supply Inferential meters are almost universally used. It should be noted that Inferential meters may pass large quantities of water without registering, as, if they become "stuck up" they offer very little resistance to the flow.

For measurements of municipal supply the Venturi meter is used. The Pitometer, a rated pitot tube arranged to give a photographic record of flow, is coming into use for this purpose also.

## RAILROAD ORDERS.

(Continued from Page 687).

6905—April 30—Authorizing the City of St. John, N.B., to lay and thereafter maintain a cast iron water main across the tracks of the C.P.R. at Green Head Road, Parish of Lancaster, City and County of St. John, N.B.

6906—April 28—Directing the G.T.R. Company to construct a culvert under the tracks of the Buffalo & Lake Huron division of its line, where the same crosses the side road between Lots 23 and 24, Concession 1, Township of Wainfleet, Ont.

6907—April 28—Ordering the construction of a culvert under the tracks of the G.T.R. Company in the west half of Lot 20, Concession 5, in the Township of Eldon, Ontario.

6908—April 28—Dismissing application of the Plymouth Cordage Company, of Welland, Ont., for order directing the G.T.R. to refund the sum of $884.01, the amount of alleged excessive freight charges collected on shipments of sand and gravel from Niagara Falls, Ontario, to Welland, Ontario.

6909—April 27—Ordering the G.T.R. to at once erect and maintain, at Garnet, Ontario, a shelter to accommodate the traffic at that point.

6910—April 29—Authorizing the C.P.R. to reconstruct bridges on its line of railway, No. 89.9, Ruscom River, Windsor section, Ontario division, No. 23.56, North Bay section, Lake Superior division, and No. 116.4, Souris River, Souris section, central division.

6911—April 30—Authorizing the C.P.R. to construct, maintain, and operate branch line to and into the premises of the Imperial Oil Company at Saskatoon, Sask.

6912—April 28—Refusing application of the Don Valley Brick Works, of Toronto, Ontario, for Order directing the G.T.R. Company to make reparation on shipments of enamelled brick, made to Ottawa.

6913—April 28—Dismissing application of the municipal corporation of the Township of Canboro, County of Haldimand, Ontario, for Order directing the M.C R.R. to construct a suitable highway crossing over its line of railway, to connect the line of highway laid out by the corporation.

6914—April 27—Granting leave to municipal council of Ekfrid to cross the main and air line branches of the G.T.R. east of Glencoe, Ontario, with culverts.

6915—May 1—Authorizing the Shawinigan Water and Power Company to lay water main under St. Gabriel de Brandon branch, C.P.R., at Joliette, P.Q.

6916—April 28—Disapproving of plans filed by the Township of Raleigh, for authority to construct what is known as "Pike's Drainage Works" across the right-of-way of the G.T.R. in the Township of Raleigh, Province of Ontario.

6917 to 6921, inclusive—May 1—Granting leave to the Manitoba Government Telephones, to erect, place and maintain wires across the tracks of the Canadian Northern Railway at five points in the Province of Manitoba.

6922—April 27—Dismissing complaint of E. B. Sutton, of Bala Falls, Ont., alleging excessive freight rates charged by the C.P.R. on brick in carloads, from Milton, Ont., to Bala Falls, Ont.

6923—May 3—Authorizing the C.P.R. to open for the carriage of traffic that portion of its line of railway between mileage 63 and 64, on the Medicine Hat section, Alta.

6924—April 28—Dismissing application of the Byron Telephone Company for leave to install a telephone in the station of the G.T.R. at Komoka, Ont.

6925—May 3—Granting leave to the Caradoc-Ekfrid Telephone Company, Limited, to erect, place, and maintain its wires across the tracks of the M.C.R.R. in Ekfrid Township, Province of Ontario.

6926—April 30—Authorizing the C.P.R. to construct, maintain, and operate branch line across Manitoba and River Streets in Moose Jaw, Sask.

6927—May 3—Dismissing the application of the C.P.R. for Order amending Order of the Board No. 5102, dated the 29th July, 1908, authorizing the G.T.R. to cross the tracks of the Owen Sound section of the C.P.R. and Ontario and Quebec Railway Company near Toronto Junction, Ont.

6928—March 5—Ordering the C.P.R. to change the location of its rails, where its railway crosses Mill Street, Enderby, B.C., so that the top of the rails shall not rise above or sink below the level of the highway to the extent of not more than one inch.

## CONCRETE AND STEEL BRIDGES.*

**Chas. Talbot, County Engineer of Middlesex, Ont.**

Reinforced concrete bridges are becoming popular, because of their cheapness and durability. After the approaches to such structures have settled to position the bridge requires little or no further attention. To all appearance they are permanent structures in the truest sense, in that if properly constructed age increases their solidity and their strength.

Failures of concrete structures are reported frequently. Such unfortunate occurrences can be avoided if the municipality will employ competent men to design their bridges and draw their specifications, and after the plan and specifications are obtained will let the contract to a reliable firm, and employ an honest and experienced inspector to see that the plans and specifications are complied with.

Spans under fifty feet in length, built either in the form of a flat top or an arch, can be used with good results, and on an average will not cost more than bridges built of concrete abutments, steel superstructure and concrete floors. Arches of longer span than fifty feet will cost more than steel bridges, but have the advantage of greater permanency. Flat top bridges of reinforced concrete can be erected on any foundation that is suitable for a steel superstructure and concrete floor.

Last April, Middlesex County Council called for tenders for several bridges. Among them was one to be erected over Reynolds Creek in Dorchester Township. For this bridge they asked for tenders for a forty-foot reinforced concrete beam bridge, and also for tenders on a forty-five-foot steel bridge with concrete floor. The lowest tender for the concrete bridge complete was $1,300.00. The tender for the steel design, with concrete abutments and floor was $1,400.00. The steel bridge was erected.

These men decided in favor of the steel because they had experience with it, whereas the concrete was looked upon as an experiment. At the same time, however, they awarded contracts for two reinforced concrete bridges, which were erected and are giving entire satisfaction. Were they now making the decision I have no doubt they would build the concrete bridge.

The following schedule shows the prices Middlesex County paid for different spans of different design last year:

| No. of Spans. | Length of Span. | Clear Width of Roadway. | Height of Concrete Substructure | Material in Superstructure | Total Cost. |
|---|---|---|---|---|---|
| 1 | 10 feet | 16 feet | 9 feet | Concrete slab | $ 295 00 |
| 1 | 10 " | 16 " | 13 " | Arch | 430 00 |
| 1 | 15 " | 14 " | 9 " 6 in. | Concrete slab | 340 00 |
| 1 | 20 " | 16 " | 19 " | Reinforced beam bridge | 1,100 00 |
| 1 | 45 " | 14 " | 16 " | Steel | 1,400 00 |
| 1 | 56 " | 14 " | 19 " | " | 1,930 00 |
| 1 | 60 " | 14 " | 16 " | " | 1,960 00 |
| 1 | 66 " | 16 " | 21 " | " | 2,575 00 |
| 3 | 1-150 " 2-75 " | 16 " | 2 piers 49 feet 2 abutments 20 feet | " | 14,000 00 |
| 2 | 120 " | 14 " | 2 abutments 24 feet 1 pier 27 feet | " | 11,000 00 |
| 1 | 27 " | 14 " | 14 feet | Reinforced concrete beam bge. | 1,450 00 |
| 2 | 80 " | 14 " | 21 " | Steel | 2,384 00 |

The $1,400 bridge is between Middlesex and Elgin. Elgin paid half cost.

The average price paid for concrete abutments and pier, inclusive of excavation and filling is $5.40 per cubic yard. Concrete used in arches from the spring to the crown and in flat tops costs $8.00 per cubic yard, exclusive of the reinforcing.

Concrete floors cost 22c. per square foot surface. All contracts are advertised and let by tender. The lowest tender is usually accepted. Excavation and filling is let with the concrete work. While the shorter spans are being built of concrete the longer spans are almost entirely built with concrete abutments and piers, concrete floors and steel superstructures.

The County of Middlesex and the City of London built the Victoria Bridge, over the River Thames, in 1875. The bridge consists of two spans, each 120 feet, supported on two stone abutments and a stone pier. The iron superstructure cost $7,360. In 1876 the County built the Adelaide Street Bridge over the north branch of the River Thames, being two spans 120 feet each, the iron costing $3,300. Both bridges are in good condition and carry the heaviest traction engines, although they were originally designed for concentrated live loads of five tons on two axles at 10 feet centres. They were built under the supervision of competent engineers and were well designed and properly erected.

Previous to 1898 Middlesex County built steel bridges designed to carry live loads of five tons on two axles or equally distributed loads of 80 pounds per square foot floor surface, dead loads to consist of the weight of the steel together with wooden joists and plank floor. Many such bridges were erected and it is becoming difficult to obtain plank for the floors. They are too light to carry concrete floors. Since this date the weight of the bridge and the loading has been increased so that at present we are building bridges capable of carrying a live load of ten tons on two axles at ten feet centres or an equally distributed live load of 100 pounds per square foot for floor system and a dead load equal to the weight of the steel and a concrete floor six inches thick. Such a bridge designed and erected according to any standard specification in my estimation meets all the requirements of an ordinary highway bridge, as it is very seldom a load of even eight tons crosses a country bridge, and such a structure will carry an occasional load of 15 or 20 tons on two axles without over-straining any member or connection of the design.

No municipality should undertake the erection of a steel bridge without the services of a competent engineer. Such a person will see that the proposed structure is not uselessly strong and will prevent the erection of structures that are unsafe for public traffic.

*Read before the Ontario Good Roads Association.

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The number of meters in service April 30th, 1907, was 547, or about 1-13 of the services. The revenue from them is abou one-third of the total receipts not including fire protection. The total on April 30th, 1908, was 1,130.

## FACULTY OF APPLIED SCIENCE, TORONTO UNIVERSITY.

The results of the examinations of the faculty of applied science and engineering of the University of Toronto were announced May 14th. The following candidates have passed the examinations for professional degrees in engineering:—R. W. Thomson, '92, of Johannesburg, S.A., Degree of Mining Engineer (M.E.), and E. W. Oliver, '03, Assistant Chief Engineer Canadian Northern Ontario Railway, Toronto, the Degree of Civil Engineer (C.E.)

Of those who wrote on the first year examination 27 per cent. failed, in the second year 14 per cent. failed, and in the third year 4 per cent. Of those going up for the degree of B.A.Sc. all were successful.

### Bachelor of Applied Science.

The following candidates have passed the examinations for the degree of B.A.Sc., with honors. Arranged in alphabetical order:—W. L. Amos, H. Coyne, A. D. Dahl, F. C. Dyer, C. L. Gulley, D. J. Huether, J. N. M. Leslie, A. A. McRoberts, F. H. Moody, W. P. Murray, M. Pequegnat, J. T. Ransom, W. B. Redfern, R. R. Rose, R. B. Stewart, W. M. Stewart, J. L. Stiver, F. D. Wilson, A. R. Zimmer.

Pass—H. G. Akers, W. S. Brady, P. R. Brecken, J. A. Brown, P. H. Buchan, C. E. Bush, A. W. Campbell, H. R. Carscallen, F. H. Chestnut, W. C. Collett, R. Y. Cory, G. C. Cowper, J. V. Culbert, R. S. Davis, C. Edwards, A. H. Foster, A. Gillies, J. W. Hackner, K. Hall, C. T. Hamilton, M. C. Hendry, A. D. Huether, A. N. Hunter, W. Jackson, J. D. Keppy, F. C. Lamb, A. L. McLean, H. C. McMordie, R. J. Marshall, J. B. Minns, E. D. Monk, J. H. Morice, F. E. H. Mowbray, E. W. Murray, H. J. Peckover, F. E. Prochnow, E. M. Procter, C. F. Publow, A. R. Robertson, W. E. V. Shaw, H. F. Shearer, W. L. Stamford, R. H Starr, H. B. Stuart, G. F. Summers, V. C. Thomas, J. H. Thornley, R. M. Wedlake, W. J. White. C. R. Murdock must take supplemental examination in strength of materials and M. Pivnick in electricity before they are eligible for the degree.

### Diploma in Civil Engineering.

Honors—G. A. Bennett, W. J. Boulton, C. G. Cline, G. Hogarth, J. E. Jackson, C. C. Johnson, A. H. E. Keffer, R. W. E. Loucks, A. B. Manson, E. S. Martindale, F. V. Munro, A. N. Petrie, C. R. Redfern, N. C. Stewart, P. H. Stock, H. W. Tate, O. T. G. Williamson.

Pass—E. W. Brown (hydraul.), J. A. Buchanan, M. G. Cameron, J. G. Collinson, G. W. Coltham, F. A. Dallyn, E. M. Dann, H. C. Davis, I. H. Dawson, R. H. Douglas, M. O. Duff (hydraul. eng. chem.), F. S. Falconer, J. B. Ferguson, A. A. Glover, D. A. Graham (thermo.), J. E. Gray, G. E. D. Greene, W. H. Greene, W. W. Gunn, D. W. Harvey, C. O. Hay, G. C. Hoshal (ast. and geod.), A. E. Hunter, E. W. James, C. E. Johnston, W. J. Johnston, D. J. Kean (th. of const.), N. C. A. Lloyd (sur., ec. geol.), A. S. McArthur, F. H. McKechnie, V. McMillan, J. G. Mackinnon, W. A. MacLachlan, N. W. Macpherson, O. W. Martyn, E. A. Neville, C. A. O'Gorman (th. of const., el. chem.), A. W. Pae, R. B. Pigott, J. Quail, A. F. Ramsperger, A. U. Sanderson, C. A. Scott, F. V. Seibert (aegrotat standing), A. Sedgwick, B. H. Segre, D. S. Stayner, J. C. Street, R. G. Swan, A. D. Sword, C. C. Sutherland, G. A. Tipper, J. E. Underwood, C. P. VanNorman, J. Van Nostrand, A. Vatcher (th. of const.), C. M. Walker, E. E. Webb, C. E. Webb, R. G. Wilkinson (sur. th. of const.).

### Diploma in Mining Engineering.

Honors.—E. T. Austin, A. I. Davis.

Pass.—L. J. Duthie (pr. chem., 3rd pr. min.), R. R. Grant, C. A. Morris (pr. min.), G. M. Ponton (pr. min., th. const.), S. A. Wookey.

### Diploma in Mechanical and Electrical Engineering.

The following (i.e., the whole year) will be required to fulfil the conditions respecting practical work in machine design before becoming eligible for the diploma:—

Mech. section.—E. G. Arens, W. H. Barry (mag. and elec., 2nd elec.), E. R. Birchard, W. D. Black, J. Burns, W. E. Corman, C. N. Danks, W. H. Delahave (mech. of mach.), A. T. Ferguson, E. R. Frost (mech. of mach., mag. and elec.), C. Hughes, W. R. Key, C. B. Langmuir, W. G. McIntoch (mach. des.), G. MacLeod, N. H. Manning, L. S. Odell, J. J. Spence (th. of const., 2nd elec.), A. G. Trees, F. F. Wilson, L. R. Wilson.

Elec. section.—H. V. Armstrong, R. D. S. Beckstedt, A. M. Bitzer (ex. heat, mag. and elec.), D. C. Blizard, G. H. Bowen, C. E. Brown (electro chem.), R. A. Campbell, H. A. Cooch, T. H. Crosby, R. H. Cunningham, H. W. Davis, W. P. Derham, T. A. Fargey, T. E. Freeman, F. G. Hagerman, R. H. Hall (2nd elec.), C. J. Harper, J. Hemphill, A. E. Holmes, C. R. Holmes, H. Irwin, J. Isbister (alt. curr., elec. des.), F. P. Jackes, J. B. O. Kemp, A. W. Lamont, A. E. Lennox, D. D. McAlpine (elec. and mag., alt. curr.), C. R. McCollum (ex. heat), A. S. McCordick, P. J. McCuaig (electro. chem.), J. H. McKnight (electro. chem.), E. D. Macfarlane, M. A. Maclain (ex. heat), G. Morton (mach. des., mag. and elec.), V. J. O'Donnell (mag. and elec.), J. J. O'Hearn (mach. des., mag. and elec.), W. M. Philip (ex. elec., mech. of mach., vacation work), C. J. Porter, A. I. Proctor, L. T. Rutledge, R. A. Sara, A. Schlarbaum, C. E. Schwenger, M. W. Sparling, S. Stroud, E. A. Thompson, W. G. Turnbull (mag. and elec.), F. C. White, A. R. Whitelaw.

### Diploma in Analytical and Applied Chemistry.

Honors.—W. A. Dodds, J. A. McK., Williams. Pass.—W. G. Collinson (electro chem.), A. E. Gooderham (2nd geol.), F. K. Harris (crystallog.), H. N. Klotz (pr. chem., 2nd elec.), M. R. Shaw (pr. chem., 2nd elec.).

### Diploma in Chemical Engineering.

Pass.—A. R. Duff (mach. des., 2nd elec.). The prize for general proficiency in civil engineering in the third year is awarded to E. S. Martindale. Donor—T. Kennard Thomson, C.E.

Candidates whose names are followed by brackets must pass supplemental examination in the subjects indicated.

**Vancouver Branch, Canadian Society of Civil Engineers.**—At a meeting on Wednesday afternoon, May 5th, in the Board of Trade Rooms, by the local members, associate members and student members of the Canadian Society of Civil Engineers, it was decided to form a Vancouver branch of the society, and the following officers were elected: Geo. H. Webster, chairman, and H. K. Dutcher, sec.-treasurer. For a time the meetings will probably be held in the rooms of the engineering department of the University College, and later on permanent quarters will be secured in the city, where papers will be read and discussed and a library created suitable for the needs of the members.

## ORDER OF THE RAILWAY COMMISSIONERS OF CANADA.

**Copies of these orders may be secured from the Canadian Engineer for a small fee.**

6901—April 16—Ordering that the additional charge which railway companies subject to the jurisdiction of the Board may make for changing the destination of carload traffic while in transit shall not exceed $3 per car.

6902—April 26—Granting leave to the Manitoba Government Telephones to erect, place, and maintain wires across the G.T.P. Railway at P.C. between Sections 22 and 23-11- 4 W. Man.

6903—April 29—Granting leave to Alfred H. Watson of Creemore, Ont., to erect, place, and maintain wires across the tracks of the G.T.R. Company at the village of Creemore, County of Simcoe, Ont.

6904—April 30—Granting leave to the British Telephone Company to erect, place and maintain wires across the tracks of the Esquimalt & Nanaimo Railway Company (C.P.R.) at Beaver Creek, B.C.

(Continued on Page 685).

# A PAGE OF COSTS

## ACTUAL, ESTIMATED and CONTRACTED

### CONTRACT PRICES ON RAILWAYS IN NORTH ONTARIO.

The Haileybury Branch is a branch from the main line of the T. & N. O. Railway, leaving the main line at about mile 110. The branch is about two miles long. The work was commenced in the spring of 1908, and grading was completed by August. McQuigge and Hunt were the contractors, and the contract prices were as follows:—

| Description. | Unit of Measurement. | Rate. |
|---|---|---|
| Clearing | per acre | $45 00 |
| Grubbing | " | 150 00 |
| Close-cutting | " | 25 00 |
| Cross-logging | " | 750 00 |
| Solid rock excavations | per cu. yd. | 1 75 |
| Loose rock | " | 65 |
| All other material | " | 30 |
| Solid rock in wet foundations | " | 3 00 |
| Loose rock in wet foundations | " | 2 00 |
| All other material | " | 1 00 |
| Masonry, 1st class | " | 18 00 |
| Masonry, 2nd class | " | 15 00 |
| Masonry, dry | " | 5 00 |
| Concrete | " | 11 00 |
| Concrete culvert pipe, 36 in. diameter in place.. | per lin. ft. | 2 10 |
| Concrete culvert pipe, 30 in. diameter in place.. | " | 1 90 |
| Double strength vitrified culvert pipe, 24 in. diameter in place | " | 2 20 |
| Double strength vitrified culvert pipe, 18 in. diameter in place | " | 2 10 |
| Double strentgh vitrified culvert pipe, 12 in. diameter in place | " | 1 80 |
| Rip-rap, hand laid | per cu. yd. | 3 75 |
| Rip-rap, loose laid | " | 2 25 |
| Crib filling | " | 1 60 |
| Paving | " | 2 10 |
| Blind stone drains | " | 2 50 |
| Piling driven under cap | per lin. ft. | 32 |
| Piling delivered | " | 15 |
| Ties on right of way | per tie | 20 |
| Telegraph poles on right of way | per pole | 25 |
| Fence posts on right of way | per post | 08 |
| Permanent trestles, timber built in, including iron | per ft. B. M. | 05½ |
| Permanent trestle timber delivered | " | 04¼ |
| Temporary trestle, timber consisting of sills, caps, posts and stringers built in, including iron | per lin. ft. | 35 |
| Temporary trestle, timber, consisting of all classes of braces, built in, including iron.... | " | 25 |
| Culverts, timber built in, including iron..... | per ft. B. M. | 02½ |
| Culvert timber delivered | " | 01½ |
| Cribs, timber built in, including iron | " | 10 |
| Cribs, timber delivered | " | 06 |
| Fencing, including gates | per rod | 1 25 |

### COST OF CLEANING WATER MAINS.

On June 18th, 1907, the high service main of the city of Halifax, N.S., was cleaned. The Spruce Hill Lakes were almost overflowing, but the pipes were well coated. The 20-inch scraper made the run of 6,712 feet in 26½ minutes, and the 15-inch scraper passed through 29,628 feet of pipe in 1 hour and 38 minutes. It took 1 hour and 26 minutes to replace the reducer. The total time occupied in cleaning being 3 hours and 30 minutes, and costing for the 36,340 feet $12.91, or .035 cents per foot.

### ESTIMATING THE ENGINEERING EXPENSES.

It is usual to allow 10 per cent. for engineering expenses and contingencies when making up estimates. In the report of the T. and N. O. Railway the total amount spent during the year on three sections of construction work is given in some detail.

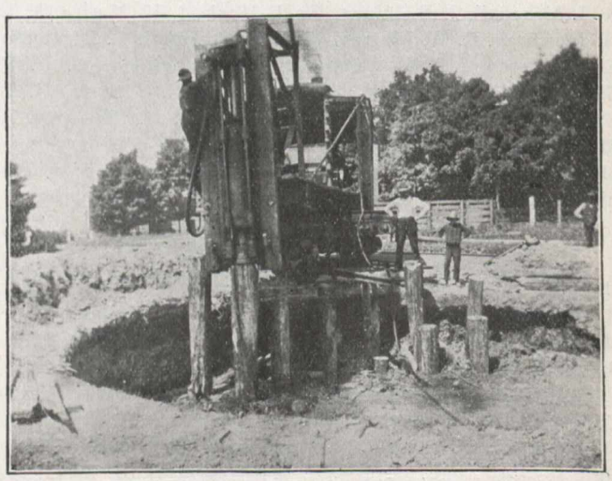
From North Bay to New Liskeard, $458,572.45 was spent; the engineering expenses were $23,000.94, or 5 1-10 per cent.

On the one hundred miles north from New Liskeard, $546,825.82 was spent, and the engineering expenses amounted to $10,459.57, or 1 9-10 per cent. of the total.

The forty miles extension to the G.T.P. Railway junction required $808,279.17 during 1908, and the engineering expenses were $33,633.71, or 4 1-10 per cent.

### COST OF PILING, STEAM DRIVEN.

In the summer of 1908, Galt and Smith, Consulting Engineers, Toronto, Ont., required a foundation for a water-tower which they were having erected at Palmerston, Ont. The area of the foundation was a little over 960 square feet, and it was required to carry 1,551 tons. The ground was not considered



compact enough to carry this load, so it was decided to sink 100 piles.

These pile were driven with a steam hammer of 6,000 pounds, having a drop of 3 feet and striking 58 blows per minute.

The total length of piling driven was 100 × 17 = 1,700 lineal feet, at a cost of $245 for driving, or 14.4 cents per foot. The piling cost delivered 15 cents per lineal foot.

## STATEMENT OF COST OF PUMPING WATER.*

| Date 1899 | Engine | | Pump | | Suction | | Discharge | | Period of Pumping (hours). | Fuel | Amount of Fuel (gallons or pounds). | Water Pumped (gallons) | Fuel per 1000 gal. of water (gals. or lbs) | Cost | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Make | Size | Make | Size | Vertical | Horizontal | Vertical | Horizontal | | | | | | Fuel per 1000 gal. of water pumped. | Labor per 1000 gal. of water pumped. | Total for 1000 gal. of water pumped. |
| May 5 | Otto | 6 H. P. | Curtis | 5"x15" | 10'-25' | | 39.8' | 2600' | 6 | Gasoline | 2.9 | 26,965 | .1075 | $ .01075 | $ .01196 | $ .02271 |
| Sept. 1 | " | 10 H. P. | " | 6"x18" | 13' | 200' | 63' | 1000' | 4 | " | 2.25 | 36,180 | .062 | .0062 | .00891 | .01511 |
| Sept. 4 | " | " | " | " | " | " | " | " | 3.5 | " | 2.714 | 31,320 | .0862 | .00862 | .01030 | .01892 |
| March | F.M. & Co. | 3 H. P. | Comb'n | | 10'x25' | | 35' | 300' | 131.6 | " | 55,375 | 532,500 | .104 | .0104 | .01088 | .02128 |
| March | Stewart | 6" x 10" | Stewart | 5"x10" | 20' | 200' | 56' | 1000' | 38 | Screenings Coal | 94.9 | 360,720 | 26,308 | .00775 | .0119 | .02966 |
| March | " | " | " | " | " | " | " | " | 40 | Lump Coal | 79.4 | 320,760 | 24,769 | .01114 | .0246 | .03574 |
| March | " | " | " | " | " | " | " | " | 43 | Screened coal | 84.25 | 342,900 | 24,569 | .00827 | .0231 | .03137 |

*Condensed from the report of a Committee appointed by the American Railway Bridge and Building Association.

## SEWAGE DISPOSAL AND PURIFICATION.*

By C. M. Arnold, City Engineer, Lethbridge, Alta.

Although much has been accomplished during the past twenty to twenty-five years, the subject of sewage purification still remains a very complex one. The greatest advance has taken place in England, though important results have been obtained elsewhere. The most valuable literature on the subject consists of the reports of the Royal Commission on Sewage Disposal from 1901 to the present time. Various commissions and committees have investigated the subject in England since 1857, and the latest reports of the Royal Commission referred to present the best and latest information on the subject.

Since the agitation for purification of sewage first started many different processes have been put forward as solutions of the problem; among these may be mentioned chemical treatment in various forms and land treatment.

The general conclusion of the earlier bodies was that land treatment was the only proper one. In many cases adequate areas of suitable land at reasonable cost were not obtainable, and this led to the investigation of newer methods, generally called "Bacteriological" or "Biological" processes.

The biological process, giving the sewage treatment first in septic tanks or plain sedimentation tanks, the effluent from which is carried to different forms of filters, among which are contact beds, percolating or sprinkling filters and intermittent sand filters. In some cases the effluent from the filters receives a final sedimentation before its discharge.

By these methods the Royal Commission Report states as their conclusion that it is practicable to purify sewage to any degree required, and that both by land treatment and by treatment of artificial filters the purification is effected by means of micro-organisms. In considering what system to adopt, two questions are apparent. First, what degree of purification; and second, how this degree of purification can be most economically obtained. The choice of a scheme depends on many local considerations.

The tank treatment is usually referred to as the preliminary treatment, and of the exact nature of the action which takes place in septic tanks and filter beds very little is known, but there is much to show that the oxidation of the organic matter is chiefly a biological process.

One of the main objects of the preliminary treatment is the removal, as far as possible, of suspended matters. This in most cases is effected by the tank treatment, although in some plants crude sewage has been satisfactorily purified in filters. In most cases this has been abandoned on account of their rapid choking. There are many cases in which crude sewage has been treated directly on land, but the results show that this is liable to give rise to nuisance by the accumulation of solids on the surface.

In the preliminary tank treatment the sewage is passed through screens to remove the suspended matters, such as sticks, cloths, paper, etc. This brings it into grit, or detritus, tanks, in which the heavier matters are deposited. From the grit tank the sewage goes forward into the septic tank, discharging two or three feet below the surface of the sewage within it. These septic tanks should be in duplicate, each one of which will contain twenty-four hours' sewage flow, and should be designed so that the liquid passes through at a low velocity, traversing the length of tank in from 12 to 24 hours. At intervals of 5 to 6 feet baffle boards are placed vertically across the line of flow to prevent any more disturbance to the tank contents than is necessary by the inflowing sewage. The top of the sewage becomes coated with a heavy scum, the formation of which is necessary to obtain the best results.

* Read at the Convention of the Union of Alberta Municipalities in Edmonton.

The septic tanks are usually built 100 feet long, 14 to 16 feet wide and 6 to 8 feet deep. The discharge leaves the end opposite the intake at a point well under the surface of the liquid, and is usually carried over a series of weirs or falls for the purpose of aerating the effluent as much as possible.

The septic tank acts as a sedimentation tank, a portion of the suspended matter forming sludge on the floor of same, which is cleaned out periodically, the periods ranging from a few months to two or three years. Many of the advantages originally claimed for the septic tank appear now to be unsustained by later experience. These claims were that the organic solid matter was wholly digested in the tank; that all pathogenic organisms were destroyed; that the effluent was more easily oxydized than the effluent from plain sedimentation tanks.

It is now established that hardly more than 25 per cent. of the organic solids are digested; that the effluent from septic tanks is bacteriologically almost as impure as when entering, and that the septic tank effluent is not more easily oxydized than liquids undergoing other preliminary treatment.

The Royal Commission's conclusion is, that in many cases the adoption of septic tank treatment as a preliminary process is efficient and economical. Most authorities state that the action in the septic tank is brought about by the agency of an aerobic bacteria, which work without the aid of light or air, and which are found in enormous numbers under the scum on the inside surfaces of the tank. It is generally taken that by this means complex organic matter is broken up into simpler forms, and more readily to be acted upon in the subsequent treatment.

Plain sedimentation tank treatment is used with success in many installations. The principal function of this is to deposit as far as possible the suspended matter, which is more frequently cleaned out than in septic tanks.

In some cases the liquid is allowed to have quiescent settlement for two to three hours, and in other cases the sewage is allowed to flow through the tanks slowly but continuously.

Sedimentation tanks must be cleaned out frequently, or the deposited sludge will ferment and become a nuisance. As a rule, the liquor issuing from the septic tank contains on the average 15 to 20 parts of suspended solids per 100.000, but from sedimentation tanks only from 3 to 6 parts per 100,000. The periods between dates of cleaning of septic tanks depend on local circumstances; for many reasons the sludge should remain for a year or more, though the period should not be too long, as the amount of suspended matter issuing greatly increases with time.

The evidence shows that the tanks should not be cleaned out completely, as, if some of the solid is left, fermentation is hastened when the tank is restarted. The sludge removed is usually buried in trenches in the ground, preferably in dry weather.

The actual mean rate of flow through the first set of tanks was given by Messrs. Watson & O'Shaughnessy to be 87 feet per minute, and from the second set of tanks 32 feet per minute. A greater rate of flow was considered detrimental to the septic action, while other evidence goes to show that if sewage be kept too long in the tank the subsequent oxydation in the filters is impaired. Most septic tanks are covered for certain reasons, but results in both open and closed tanks are practically the same.

The Royal Commission still considers chemical precipitation useful, as preliminary treatment in certain cases. In this way it is practicable to produce a tank liquor containing only from one to four parts of suspended matter per 100,000.

Among the chemicals used may be named lime, copperas, alumine ferric sulphate, and ferrozone.

The choice of preliminary tank treatment depends largely upon the kind of filters to be used for the oxydation of the tank liquor. If fine filters are to be used, the tank treatment should be such as to eliminate a large proportion of the suspended and collodial matter. In general, chemical precipitation is more suitable for strong sewages, and septic

tank treatment or sedimentation would be preferable for weak sewage.

**Purification by Artificial Filters.**

Sewage filters may be divided into two classes, Contact or Bacteria beds, and Percolating or Sprinkling Filters. Contact beds are tanks filled with filtering media in which the sewage is held up before being discharged. The bed after being emptied remains so for some time before receiving the next filling. In percolating filters the sewage is not held up, but is allowed to percolate through the filter. In contact beds it is found that two hours' contact and four hours' rest generally gives the best results, the beds being filled three times a day. Usually automatic gear is used for filling and emptying the contact beds, though sometimes it is preferable to use manual labor.

Purifying action in Contact beds depends upon the large colonies of bacteria called aerobic-bacteria, which act with the aid of oxygen.

The size of the filtering material in contact beds and percolating filters should depend upon the amount of the suspended matter in the liquid to be filtered. Fine or fair-sized material usually gives the best results, but if the sewage contains much suspended matter the filters are apt to become an inch diameter to 3-inch diameter, and greater in perco- clogged. Material in contact beds runs from one-quarter of lating filters, from ⅛-inch to 3-inch diameter and upwards.

To obtain efficient results from percolating filters it is necessary to deliver the liquid as uniformly over the whole area as possible. Various devices are in use to accomplish this, among which are rotary sprinkling arms, stationary pipes, fine material laid on the surface of the filter, and dripping-trays and troughs. Experiments are still being carried on to determine the most advantageous form of device to use. Many experimenters have obtained satisfactory results by treating crude sewage direct in filtering beds without preliminary treatment of any description; one essential for the success of this being plenty of fall. Though in most cases it is considered essential to remove as much of the suspended solids as possible before filter treatment.

Sand filters will treat from 400,000 to 2,500,000 gallons of well-clarified liquor per acre per day; contact filters, from 300,000 to 1,000,000 gallons of partially clarified sewage, and sprinkling filters from 600,000 to 2,000,000 gallons, depending on the form of preliminary treatment and the consequent amount of suspended matter contained in the liquid.

The approximate cost of each type may be taken as follows: Sand filters, from $15,000 to $25,000 per acre; contact filters, from $20,000 to $30,000 per acre, and sprinkling filters from $40,000 to $45,000 per acre. The sprinkling filter, though of greater cost, is a much more economical installation on account of lower operation charges, due to the very much greater rate at which they can be worked. Authorities differ as to the possibility of operating sprinkling filters or intermittent sand filters in extremely cold winter climates in winter, as some cases have been known in England and Massachusetts where sprinkling filters and dosing gears have been rendered inoperative during cold weather. Doubtless some forms of distributing apparatus may be worked without trouble from frost in cold climates. The surfaces of sand filters have in some places been ploughed, and thus kept from freezing during cold weather.

In many places in the United States experimental plants have been maintained through which much valuable information has been gathered. The investigations of the Massachusetts Board of Health at the Lawrence Experimental station during the last ten years have been very valuable. Their results tend to show that the best form of sewage treatment is first by septic tanks or plain sedimentation, followed by percolating filters, then sedimentation for a brief period, which latter treatment may be omitted where effluent non-putrescible, but containing considerable suspended matter is permissible.

One of the largest and most recent purification plants is located at Berlin-Wilmersdorf, Germany, which consists of sedimentation basins, through which the sewage passes successively, from the last of which it passes intermittently to the trickling filters. From these filters the sewage flows into another series of six sedimentation basins, from which it is discharged. In the future it may be further purified in sand filters. The sprinkling filters in this plant are principally built of coke, varying in size from 2-inch to 8-inch. These filters are operated with rotary sprinklers, which, according to evidence, operate successfully in cold weather. The tests of the effluent are reported to be very satisfactory.

The writer recently inspected the experimental sewage disposal works at Kew Beach, Toronto, consisting of three septic tanks and twelve contact beds, constructed from designs by the Cameron Septic Tank Company, and operated by their patent gear. The tanks are each 100 ft. x 14 ft. x 7 ft. 3 in., and have a total capacity of 183,000 gallons. The bacteria beds are each 50 ft. x 28 ft. and 4 ft. 6 in. deep, and filled 4 ft. deep with furnace slag from ¼ in. to 1½ in. in size. They are operated resting full two hours and emptied two hours alternately, and the results as shown in the effluent are so far satisfactory.

In Europe State control of sewage and water systems and sewage disposal systems is an accomplished fact, and many of the greater and lesser cities of Europe were forced to purify their sewage years ago. On the other hand, no large American city has purification works in operation to-day. Some cities of second rank and smaller cities have purification works in use, and in a few of the larger cities works are being constructed. In Canada there are a few comparatively small plants, and Toronto is now considering the best means of dealing with the sewage disposal problem. The difference between European and American conditions seems to a great extent to be responsible for this. On this continent as a rule our sewage is weaker, our population sparser, and we have far better dilution in our streams without the same fear of contaminating water supplies. At present many of the States in the United States are exercising control of sewage disposal, many more are considering taking such control, and in most cases of the Provinces of Canada the provincial authorities have, or are, preparing to take control in such matters. The writer is convinced of the advisability for central control over sewage disposal and water sources to insure safeguarding water supplies and to prevent a menace to public health. I am, however, of the opinion that the rational course will be to judge each case on its merits, taking into account local and neighboring conditions. I am not convinced that the time has come when the discharging crude sewage into streams should be always prohibited, regardless of the degree of dilution afforded and the use to which the water is put. In the near future sewage treatment will be in a very much more definite state, and works can be installed at far less cost than to-day. As an alternative, to which consideration should be given, is the contributing by municipalities to the expense of purifying water consumed by other municipalities affected.

Nothing is of greater importance in our municipal life than the public health, and no factor contributes more than a pure water supply.

In conclusion, I wish to advocate the assumption of active control over the municipalities in regard to sewage purification and the maintaining of pure water supplies by a central authority, either the Province or the Dominion, and that the Province or the Dominion establish an experimental sewage purification plant in charge of trained experts, who will study the subject with a view to local conditions particularly, and who will keep in touch with advances made in all parts of the world to the end that the expert knowledge so gained will be available for the use of any municipalities where in the public interest some form of sewage or water purification may become necessary.

A practical test was made by the City of Halifax, to determine the quantity of water that a ½-inch pipe would waste. Under 24 lbs. pressure an eighty gallon tank was filled in five minutes and seventeen seconds.

## NEW 3,000 HORSE-POWER HIGH-PRESSURE FIRE-SERVICE PUMPING STATION FOR PHILADELPHIA.

During March an important contract was closed by the City of Philadelphia for the equipment of a new high-pressure fire-service station, practically a duplicate of the Delaware Avenue fire station which has been in service for a number of years past with great success.

The new plant will be located at Seventh and Lehigh Avenues, in the Kensington mill district. It will use water from the old Fair Hill reservoir entirely, as it is located some distance from the river.

The work is in charge of the Millard Construction Company, which is the general contractor, while detail engineering work is being carried out by the Scofield Engineering Company.

The first contract covers ten 300 horsepower Westinghouse vertical single-acting gas engines, direct-connected to Deane triplex pumps; and in addition, a 140 horse-power unit for auxiliary purposes. The equipment is practically a duplicate of the Delaware Avenue station. It will take its fuel gas from the city gas mains, and, as in case of the Delaware Avenue station, two large holders at different points in the city are available to be drawn on for the supply.

The decision to again employ gas-engine-driven pumps for this high-pressure fire service, is distinctly interesting in view of the discussion which took place previous to and after the installation of the Delaware Avenue station, and was mostly in favor of electrically driven pumps as established in New York City.

A study of the first year's operation (1904) of the Philadelphia station, shows the character of results that are obtainable from an installation of this kind. As this was the first year's operation of the plant, it was to be expected that the maximum interference from troubles, operative and otherwise, would be encountered. The year's record shows not a single case of failure to start, either in the actual fire service, or in the numerous experimental runs which were made to test out the equipment. During the year there were 32 alarms and nine actual services of any considerable duration, the services varying from a few minutes to 24 hours. The large pumping units ran 337 hours, and the small units 198 hours, during the year, with a total pumpage of 27,000,000 gallons. The average cost per thousand gallons pumped, including all the experimental runs, which were by far the major portion of the service, was 12.5 cents; but for a large fire of five or six hours duration, the cost of pumpage is barely over five cents per thousand gallons. On the average, any unit could be put upon the system at 300 pounds delivery pressure in from 45 to 60 seconds from the time of giving the signal from fire headquarters. And, the entire station could be gotten under way in from seven to ten minutes. In ordinary operation, however, only one or two units are started on the first signal, as these are sufficient to start operation, and further units can be put on as the service may require. The cost of power is practically proportional to the pumpage. The total cost of repairs on the gas engines, totalling 3,000 horse-power, from their installation up to December 1905, was $2.05. The system of compressed air for starting the gas engines, has never given out when called upon, and the storage pressure of 200 pounds may be replaced within one or two minutes after the starting of the single engine. In fact seven large engines at Philadelphia have been started with only 98 pounds drop, without assistance from the compressor. In practice, several of the storage tanks are always held in reserve for use only in case of a serious break-down of the compressor.

Likewise, the gas supply has never failed. Considering that at least two large sources may be drawn upon, it is considered quite as dependable as electricity from underground feeders. The most interesting feature of the Philadelphia situation, is the attitude of the insurance authorities. Prior to the establishment of the Delaware Avenue station, the insurance underwriters had imposed an additional charge of 25 cents per $100. On the completion of the test of the high-pressure pipe-line, in May, 1902, a fire reduction of 15 cents per $100 was made. On the final test of the gas-power station on April 18th, 1905, the balance of the "pink slip" charge was removed and the system was declared approved. Formerly of a most decided conservatism towards gas engines, the authorities then expressed their complete confidence in the new system by suggesting extensions to the initial system. The closure of the recent contract brings these suggestions into material form, and the net result will be a general reduction in fire rates in the districts affected, in addition to the protection afforded.

The accompanying illustrations show, character of the Delaware Avenue station and the result of a test of one of the high-pressure streams at a point farthest from the pumping station, fifteen blocks from the river front. This station is under the control of the Department of Public Safety, Mr. Henry Clay, director.

## CURRENT NOTES.

(Continued from Page 681.)

As a preliminary trial to the official test, which takes place to-day, the pumping and filtration plant were operated for thirty-six hours ending Saturday night. Everything worked smoothly. The water that was supplied to a few residents, was of fine clear appearance, but an analysis will be made to see if the filtration is as guaranteed.

Verdun, which has a population of 9,000, is enabled to install its municipal water service the easier by the fact that the town owns the water mains now being used by the Water & Power Company.

**Decision in Favor of a Cesspool.**

The cesspool has been so long regarded as under the ban of sanitary science for every use, says the "Engineering Record," that it is worth while noting a decision in its favor made some time ago by the Massachusetts Board of Health. It was proposed to discharge the sewage of a country estate into 3,800 gallon septic tank and then filter its effluent on two beds, having a total area of about 200 square feet. The board condemned this plan and reported that it would be less expensive and more satisfactory to discharge the sewage into a cesspool in the gravelly soil of the vicinity, or deliver it from a tank through sub-surface drains if a proper tract of coarse sand or gravel was available, as the appearance of the surface indicated. This recommendation by the board will be gratifying to those who have noted the unwarranted neglect of this method of disposing of small quantities of sewage. It must be used with caution, of course, for a cesspool in soil from which a water supply is obtained is most dangerous, but where coarse sand or gravel occurs and there is no water drawn from these beds, nature has provided the best of facilities for satisfactory sewage disposal.

Too great stress cannot be laid upon the word of caution in the above paragraph. So-called septic tanks are too often only cesspools as above described, and are situated in districts where private wells form the supply of drinking water to the inhabitants.—Ed. Sanitary Review.

## BACTERIA REMOVAL BY OZONE PROCESS AT ST. MAUR, PARIS.*

With regard to bacteriological results, which were made with MacConkey's bile salt medium in the case of the coli tests, "so that the coli results are comparable with Dr. Houstons, London Metropolitan Water Board, presumptive B. coli test,—negative results for coli were shown.

Tables show the presence of coli in 40 c.c. of the filtered water in eleven samples, the coli being absolutely absent in all ozonized samples, while with regard to organisms per c.c. the results are as follows:—Sample 1, organisms in filtered water per c.c. 320, organisms in ozonized water 1 per c.c.

*From a paper by Dr. Rideal, (Royal Sanitary Institute).

Sample 2, 102 organisms in filtered water reduced to 2 in ozonized water. Sample 3, 72 organisms in filtered water reduced to 1 in ozonized water. There were seven other samples examined, giving similar results. Dr. Rideal states that he found no coli organisms in 1,500 c.c. of the sterilized water. "The ozonized water was found not to be sterile, but showed an average bacterial content of 1.1 per c.c. These corresponding to innocuous spere-bearing organisms of the subtilis type." The result thus shows that "coli and allied intestinal organisms are entirely eliminated."

## QUESTIONS AND ANSWERS

Questions or Suggestions are welcomed. They will be carefully considered by experts

North Vancouver, B.C.,
28th April, 1909.

Donald Cameron writes as follows:—"In reply to X in 'Questions and Answers' in the issue of the 'Sanitary Review' of the 28th inst., there is an error. Whatever the Scott-Moncrieff system may be now, at the dates given, it was simply an upward flow rough filter."

"Mr. Scott-Moncrieff wished to join me in developing our system, and that necessitated my visiting one of his installations, one serving a mansion house near London."

"I should be obliged if you would correct the mistake."
Signed "Donald Cameron."

In giving the date, 1891, with reference to the Scott-Moncrieff method of sewage purification, we were guided by plans and sections before us of both the rough upward flow tank above referred to, and also to a contrivance in addition to the above which presents layers of trays filled with coke breeze, through which the sewage was discharged drop by drop. The plans referred to bear the date 1891, and clearly show the two systems in combination, the first of which may be termed anaerobic, and the second aerobic; the one merely a septic tank filled with stones, the second a percolating filter.—Editor, "Sanitary Review."

## COST OF HIGHWAY IMPROVEMENT, ALLEN COUNTY, INDIANA.*

**By C. E. Martin, Lafayette, Indiana.**

Allen County has been noted for many years for its good roads. Having three rivers within its boundaries, and also several beds of gravel, a good supply of gravel has been easily obtainable. With this material many miles of good gravel roads have been constructed. In the past few years, however, considerable macadam road has been built. The largest improvement of this kind has been in Maumee Township, which was finished last fall.

Maumee Township lies on the east side of the county next to the Ohio line. The soil is a kind of black muck, easily cut up, and hauling over the dirt roads in the wet season was almost impossible. The town of Woodburn on the Wabash Railroad lies almost in the centre of the township, and the roads were constructed in a system leading to Woodburn, which is the market town for the township. The recently improved road was constructed on the double track system, with the macadam portion on the right for teams going toward Woodburn. The highway was forty feet wide, with the grade 26 feet wide on the top, the macadam portion being 10 feet wide from the centre line of the grade, with a three-foot bank to hold the stone in place. The stone was placed 10 inches deep on the sides and 12 inches deep in the centre. One inch of screenings was placed on top of this 7 feet wide, as a top dressing. Crusher-run stone was specified to be used, but owing to its irregular composition, ruts were formed in the road. Two and a half inch stone was then used for the lower course with quarter-inch screenings on top. The stone was furnished by the Erie Stone Company, and came from the Huntington quarries. The length of the system of roads was 60,652 feet or 11.487 miles.

The contract for the entire improvement was let to the Erie Stone Company for $32,792.50, or a cost of $2,854.75 per mile, or $1.62 per linear yard. The only grading to be done was to smooth the road off to receive the stone and furnish earth to hold it in place, except in one instance where a cut and fill of about 4 feet was made. The grading was estimated at $50 per mile, and cost about that on the average. Stone cost $1.10 per cubic yard on the cars at Woodburn. The average cost of hauling it to the road was 20 cents per cubic yard, or ten cents per cubic yard per mile. Two yards to a load were hauled, the farmers in the vicinity doing the work. Teamsters were required to help fill the wagons, though laborers were furnished at the cars to assist them. Spreading the stone on the road cost 14 cents per cubic yard. The road was drained by 4-inch tile on each side of the road where tile was not already in. This cost about six cents per linear yard. A roller was not used on the work, action of the teams hauling over it being depended upon to pack the stone.

The township was bonded for $34,080 to furnish money for the improvement. These bonds were of forty equal series of $852 each, bearing date of July 15, 1907, the first payable May 15, 1908, and one each succeeding November 15, and May 15 until all were paid. The bonds bore interest at 4½ per cent., making the interest $19.17 every six months on each bond. The entire issue was sold at par. To meet the payment of these bonds a tax levy of 48 cents per hundred dollars was made in Maumee Township.

**Resume of Cost Data.**

| | |
|---|---|
| Number of cubic yards of stone per mile.... | $18.00 |
| Cost per cubic yard of stone on cars..... | 1.10 |
| Cost of haul per cubic yard per mile..... | .10 |
| Cost of spreading per cubic yard..... | .14 |
| Cost per cubic yard of stone in place..... | 1.44 |
| Number of square yards per mile of roadway | 5,867 |
| Cost of grading per square yard..... | $ 0.09 |
| Cost of finished roadway per square yard.... | .48 |

The town of Woodburn, a place of about 300 inhabitants, seized this opportunity to improve its streets. Two streets were improved with concrete curb and gutter and two with stone alone. The improvement in the town was under separate contract with the Erie Stone Company. The average cost of grading was 15 cents per cubic yard. Stone cost $1.10 per cubic yard and hauling and spreading 40 cents per cubic yard. The actual cost for hauling and spreading was less than 25 cents per cubic yard.

Concrete curb and gutter was constructed with six-inch curb and 18-inch gutter, twelve inches deep, for 55 cents per linear foot. Headers of curbing alone were constructed for 35 cents per linear foot. Combined curb and gutter sewer inlets were placed for $7.50 each, and manhole covers for the catch basins at $4.50 each. The catch basins were built by the town. Cement sidewalk was constructed under the same contract for 12 cents per square foot.

* A paper before the Indiana Engineering Society.

The Eastern Canada Portland Cement Company is included in the list of new incorporations published in this week's "Canada Gazette." The head office is to be at Quebec, and the capital stock will be $2,750,000. Mr. Charles A. Irvin, of Ottawa, is interested.

The re-organization of the Canadian Portland Cement Company, at Wiarton, has been perfected by Mr. E. R. C. Clarkson, liquidator, of Toronto. The assets of the company are estimated at $500,000, and the shareholders have placed an additional $100,000 at the disposal of Mr. Clarkson, which is $60,000 more than was asked for. The new company will commence operations shortly.

## REVIEW OF THE REPORT OF WILLIAM SPENCER, M.A., Ph.D., F.G.S., ON THE PHYSICS OF THE NIAGARA RIVER.*

By Isham Randolph, C.E.

You have referred to me for discussion certain questions raised by Mr. William Spencer, M.A., Ph.D., F.G.S., in relation to the effect upon Niagara Falls of the withdrawal of water for power purposes and of the tendency of this withdrawal to lower Lake Erie.

These are questions of grave moment, and anyone having the temerity to differ with Dr. Spencer—when he asserts as indisputable facts and then gives his own conclusions thereon—must be able to support his counter views with incontrovertible proofs.

Before plunging into the issues so strongly drawn a brief review is proper of the conditions in that stretch of the Niagara River between the point where it receives the effluent waters of Lake Erie and the first of the cascades over which it tumbles in its headlong course to the Falls. Mr. Spencer has described that stretch of the river, and I might quote wholly from him had he not omitted so many details necessary to a complete understanding of the hydraulic conditions.

The United States geological map, prepared in 1901, indicates that the river begins at Horse Shoe Reef, which is three and one-third miles above the International Bridge. The profile of the river prepared by the Deep Waterways Commission of 1900 has its zero opposite the angle of the Buffalo breakwater, which is nearly opposite the ruins of old Fort Erie, and is two and one-third miles above the International Bridge. This profile gives the elevation at Station O as 571 above sea level, and states that the lake level at that time was 571.5. Taking this as a starting point, I will follow the river down.

In the next 4,400 feet it drops 3.6 feet (elevation at Gauge 3, Station 44, opposite the waterworks intake, is 568.4) and the resulting hydraulic gradient is .000818 (4.32 feet per mile). The width of river here as scaled from the map (Plate No. 84, United States Deep Waterway Board of Engineers) is 1,870 feet. The elevation given at Station 70, Gauge No. 4, opposite Ferry Street, is 567.3. As the distance is 2,600 feet and the drop 1.1, the hydraulic gradient is .000423 (2.23 per mile). The width of the river here, as scaled from the map, is 1,650 feet, and is the narrowest section. The extreme depth indicated here is 27.2 feet. The next gauge taken is No. 6 at the International Bridge, Station 122. Its elevation is given as 566.8; the drop is, therefore, 0.5 in 5,200 feet and the gradient 0.0000961 (0.507 per mile). The profile indicates this as the deepest part of the river. The lowest bottom elevation given on the cross section is 519; hence the resulting depth was 47.8 feet. This bridge is 1,806 feet long; of this distance 129.5 feet is shut off by piers. There are nine spans of the following width, starting from the American side: Span No. 1, 151.5; No. 2, 154.1; No. 3, 156.2; No. 4, 234; No. 5, 235.8; No. 6, 235.3; No. 7, 186.9; No. 8, 184.3; No. 9, 138.3. For a description of this bridge and the current measurements taken for determining volume of flow see page 298 et sequitur, Vol. I., of the "Report of the Board of Engineers on Deep Waterways between the Great Lakes and the Atlantic Tide Waters," 1900.

At Station 358 (Rattlesnake Island) the elevation given is 565.6, showing a drop of 1.2 feet in 4.47 miles, a gradient of .000051 (0.269 per mile). At Station 992 + 50 (Schlosser's Dock) the elevation given is 563.05, a drop of 2.55 in 12.02 miles, or a gradient of .0000402 (0.212 per mile). The profile from which this data is taken follows the thalweg of the channel which separates Grand Island from the State of New York, to which it belongs. The shorter route is along the international boundary line, so the gradients in that channel will be slightly steeper than those given on the route taken by the profile. Schlosser's Dock is 16.49 miles down stream from the International Bridge, and, as ascertained by scaling from United States geological map, the distance therefrom to the rim of the First (or Green) Cascade is two and one-third miles, making the total distance from the bridge to the cascade 18.8 miles. It was important that this profile should be extended to Port Day, the entrance to the Niagara Falls Hydraulic and Manufacturing Company's intake, and I am enabled to do this, basing the extension upon information given me by the Niagara Falls Power Company and the Hydraulic Company. On June 2nd, 1906, the Niagara Falls Company took levels at Schlosser's Dock and at their intake gauge showing the elevation at this dock to be 562.85 and at the intake to be 560.85 (N.F.P. Co. datum); hence the drop was 1.47 feet on that day. The profile of the Deep Waterways Commission was constructed from information secured October 28th, 1897. I got from the Hydraulic Power Company their gauge reading at Port Day on October 28th, 1897, and found it to be 560.6; adding the correction to make the datum agree with United States datum prior to 1903, 0.698, I make the elevation 561.3; subtracting 1.47 from 563.05, I find the elevation at the Niagara Falls intake to be 561.58, or .28 higher than the elevation found for Port Day. The mean difference between these two gauges for October, 1897, was .15 of a foot, which, subtracted from .28, leaves a difference of .13 to be accounted for, which is inconsequential.

The mean corrected elevation of Port Day for October, 1897, was 561.70. The mean elevation at Buffalo for October, 1897, was 571.75, showing a drop of 10.05 feet. The drop on October 28th, 1907, as determined by subtracting from the lake level at Buffalo (571.5) the elevation at Port Day, 561.43 (563.05 — 1.47 + .15) was 10.07; this close check justifies me in extending the hydraulic profile from Schlosser's Dock to Port Day as I have done. The distance being 9,000 feet and the drop 1.62, the hydraulic gradient becomes .00018 (0.95 per mile). From Port Day to Goat Island the distance is about .8 of a mile and the drop 1.38. Having now constructed a characteristic profile from Lake Erie to Goat Island we have a working basis within a narrow range of possible conditions.

It must be borne in mind that the profile does not correctly represent the hydraulic gradients for all seasons of the year, as these are subject not only to changes in the level of Lake Erie, but also to modifications due to varying values of the co-efficient of roughness brought about by acquatic vegetation in the stream which serves during the period of vigorous growth to increase that co-efficient.

There are certain natural laws which must be always had in mind while considering these questions.

In any channel through which an approximately constant volume of water flows, the velocities will be determined by that volume, the area of the stream, the slope and the degree of frictional resistance offered by the bottom and sides of the channel. The volume being constant, the hydraulic gradient will vary with the natural declivity of the bed of the channel, the cross section and the frictional resistance. If the bottom of the channel is level, or if it sinks below the discharge end of the stretch considered, then the water must make its own gradient, and this it does by piling up at the intake end until it has built up a head sufficient to drive its volume through the channel. These are the basic principles involved in stream flow.

Few inland rivers have uniform hydraulic gradients throughout their entire length. I do not know of one that has. There are stretches of channel with steep gradients and low velocities ending in stretches of gentle gradients and low velocities; these again being succeeded by steep gradients and high velocities; but for a given volume of discharge there is a fixed regimen for each stretch, with its characteristic gradient. If in any stretch the fixed regimen is disturbed by a natural or artificial cause there results a readjustment of slope. If at the discharge end of any characteristic section the capacity of the channel to discharge water be increased by deepening, or the creation of collateral channels, and the volume of supply remain as before, the result will be a dropping of the water surface to an extent

* Report presented to the Commissioners for the Queen Victoria Niagara Falls Park, slightly condensed.

which reduces the cross section to an area which just cares for the supply. This means steepening the slope in the stretch of channel in which the changed conditions take place, but it does not mean that this dropping extends back up stream on a new gradient parallel to the former gradient. It means the introduction of a new water plane, the angle of whose surface to the horizon is greater than the angle of the original water plane, and this angle will intersect the original water plane at some point up stream at which the cross section is sufficient to accommodate the constant flow, and above that point the fixed regimen of the stream will not be disturbed.

In the case now under consideration we have as a fountain head Lake Erie, fed by the outflow from the upper Great Lakes and the precipitation within its own drainage basin. Its outlet is through the Niagara River. The shores of the lake converge at its north end and guide the waters into the river channel, the identity of which seems to begin at the "Horse Shoe Reef," three and one-third miles above the International Bridge. Our map, copied from the map of the United States Geological Survey, and annotated to illustrate this report, shows the course of the river, its varying widths and the obstructions in its course. The profile shows the slope or hydraulic gradients and the bottom of the channel on the line of greatest depth (the Thalweg). These do not show the cross-sectional areas, however. The relations between the levels of Lake Erie and the Port Day intake are matters of record; the United States Government has kept records of the lake levels and the Niagara Falls Hydraulic and Manufacturing Company has maintained an automatic recording gauge at Port Day for a long term of years.

With the data thus assembled and the hydraulic principles involved thus fully presented, I am now prepared to take up Dr. Spencer's report and consider it upon its merits. My discussion will be limited to Lake Erie and the Niagara River in their relations to each other. At the outset of my investigations I felt that for a complete discussion of the questions submitted to me, I should have to know as definitely as possible the amount of precipitation annually in each of the lake basins, but I became satisfied that I only have to do with Lake Erie as a basin discharging certain volumes of water, and that the sources which supplied that water were not subjects, the investigation of which need be gone into. If Lake Erie is above a mean stage we know that an excess supply has entered it; if it is below the mean level, it is certain that there is a shortage of supply. This reasoning eliminates the Chicago Sanitary and Ship Canal from the discussion. The first question to be answered is, Does the taking of water from the Niagara River above the Falls tend to lower Lake Erie?

No. 1. On Page 261, Chap. XXI.:—

"Since writing the above the International Waterways Commission has appeared. They recommend the limitation of the power on the Canadian side to 36,000 cubic feet per second, and on the New York side to 18,500 cubic feet per second, in addition to which is the discharge of 10,000 cubic feet for the Chicago Canal; in all, 64,500 cubic feet, including the Welland and Erie Canals, or nearly 37 per cent. of the low water discharge. This amount will lower the river, producing effects upon the Falls only a little less than the diversion of the full franchise volume mentioned. So, also, it will most seriously impair navigation on the Upper Lakes, as will be explained in the next chapter."

With the closing sentence of this quotation I shall take issue.

No. 2. On Pages 265-6, Chap. XXI., Part Two:—

"Below Grand Island the two branches of the river unite and form a basin, which, just below the creek entrance at Chippewa, is 5,050 feet across, with soundings, so that the area of the cross section can be determined. This is 83,000 square feet; the mean depth is sixteen feet. The discharge is that of Lake Erie, with only a small increase from the creeks at Chippewa and Tonawanda. It took fifteen to twenty minutes for floats to cover the distance from the line of soundings, where the area is measured to the first cascade, at the end of which is situated the forebay of the Ontario Power Company, showing the small descent of the river. From this basin, or above it, the power franchises allow the withdrawal of 41,200 cubic feet per second, which represents 20 per cent. of the low water flow. Accordingly, the proportional diversion represents the unmodified lowering of this basin to the extent of four feet for low water and 3.2 for average water. To this must be added 10,000 feet for the Chicago Canal, thus making a total of 51,200 cubic feet, or 25 per cent. for mean water and 30 per cent. for low water. This total diversion at or above the first cascade should be modified to an undetermined amount from confining the river to a narrower channel after the shallower rim shall have been mostly drained.

If the proposed limitation be carried out, then, from 64,500 feet must be deducted the Canadian franchises of 19,750 feet taken from below the first cascade, leaving 44,750 cubic feet to be withdrawn from above it. This would make the theoretical lowering of the basin, without corrections, amount to more than 3.5 feet for even mean water, or over four feet for low water.

The withdrawal of the water behind the rim of the first cascade has the same effect as the deepening of the outlet. It increases the velocity of the river above, which for a time lessens the amount of the subsidence in the basin until the Erie level is adjusted to the new conditions. Even now the rim of the first cascade from Goat Island is covered by only from one-half to one and one-half feet of water.

These observations were made after there had been a considerable diversion of the river, and on a day when the lake was at its mean quinquennial level. The deeper the water upon the rim at present, provided it be eventually drawn off, the more would be the lowering of the surface behind it, due to its diversion through artificial orifices; while there would be less water on the rim the discharge would be diverted into the narrower and deeper channel, causing some retardation of the current in the basin. There is nothing to lead me to expect that the lowering will be less than three feet for mean water and more for low." (See Page 272.)

No. 3. On Page 268, Chap. XXI.:—

"If the subject be considered at all, there seems to be an impression that the diversion of the water at Niagara will not affect the higher lakes. If the water were all taken from below the Greens or First Cascade at nearly fifty feet down the rapids the effect upon the upper river would be unappreciable. But most of the water under the franchise will be taken from or above the rim which forms the barrier to the basin of the upper rapids."

The truth of the "impression" stated in the first sentence of this quotation is demonstrable, and will be demonstrated.

No. 4. Chap. XXI., Part 2, Pages 272-3:—

"With the gradual lowering of the basin, a difference of one foot in the slope of the river should increase the velocity at the outlet of Lake Erie by three per cent., which in the course of a year and a half would lower Lake Erie nearly a foot, with the complete effect shown some time afterwards. While some as yet unmeasured factors may somewhat retard the velocity and increase the time, the ultimate effect must be the same after the equilibrium should be restored at a lower level of the lake. Subsequently comes the lowering of another and still another foot, or more, so that in a few years at most from the time of the complete use of the franchise power Lake Erie will be lowered by three feet or more for prevailing low water—not taking into account the effect of further deepening of the lake outlet, which may recur at any time. . . . So much for the physics of the river as the question appears to me."

No. 5. Chap. XXI., Pages 274-5:—

"A marked increase in the rainfall has occurred since 1900, as compared with the mean rainfall during the decade ending with that year. On examining the tables of the fluctuations of level and rainfall, and taking into account the effects of the Chicago Canal upon the different basins, I find from the results that Lake Erie should have risen 0.46 of a foot more than it actually has done when compared with both Lake Erie and Lake Huron. What is the cause of this

failure to raise the level of the Erie basin where the rainfall has increased not only over the amount of the previous period, but also in excess of that of the other basins? Certainly there is but one explanation, namely, the excess has been diverted by the power uses from above the rim of upper rapids during the five years ending with 1905 over the mean of the ten preceding years of low water. Adding to this the effect of the Chicago Drainage Canal, the fall which the lake has experienced from the artificial diversion amounts to 0.68 of a foot in height, or about eight inches. At the close of 1905 the total diversion of water was equivalent to the lowering of Lake Erie by about nine inches. Here, then, is direct evidence that the diversion of water has lowered Lake Erie to more than eight inches, while as yet not over one-quarter of the franchise power has been brought into use.

But the superficial observer would not see the change on account of the increased rainfall, by which the actual present level of Lake Erie is not lowered below that of previous years. Had not the diversion occurred while a corresponding rise actually took place in Lake Ontario and Lake Huron, Lake Erie would have been raised 0.68 of a foot (.46 at Niagara and 0.22 at Chicago)."

Not all of Dr. Spencer's faulty reasoning is embodied in the quotations made, but enough is quoted to bring out the fallacy of his conclusions and to enable me to demonstrate the facts to be counter to his statement of them.

Let us first deal with the effect upon Lake Erie of withdrawing water from Niagara River above the rim of the first cascade. This withdrawal in franchise volume, the Doctor tells us, will lower Lake Erie "three feet, or more, for prevailing low water."

I have set forth the habits of obedience to the laws of hydraulics universally found among rivers. Dr. Spencer substitutes the speculations of a geologist for the deductions of the hydraulician, and reaches conclusions which do violence to all hydraulic law. Niagara River illustrates most beautifully the laws of hydraulics. Take this very stretch of the river that the Doctor calls the basin above the first cascade. He describes a cross section bounding this basin on the east, "just below the creek entrance at Chippewa" (see Quotation No. 2), where the width is 5,050 feet, the mean depth 16 feet, and the cross section area 83,000 feet. The surface elevation here must be approximately that of Chippewa Creek, or on a given date 562.80. Now, the fall from Chippewa to the west end of the intake works of the Ontario Company is approximately 4 feet, and the distance about .8 of a mile; the gradient per mile would, therefore, be 5 feet. The cross section described below the entrance to Chippewa Creek is at the down-stream end of a 12-mile stretch of channel in which distance the drop is 2.55 feet, or a gradient of 0.212 per mile. It is plain to see that the drop of 4 feet from Chippewa to the Ontario intake is absorbed in a distance of .8 of a mile, and that the regimen in the 12-mile stretch above is not disturbed by the drop to the intake of the Ontario Power Company. This is a sufficient demonstration to dispose of the theory that a drop of one, two or more feet at the first cascade would accelerate the velocity in the narrow and precipitous channel above the International Bridge. The United States Government has in its employ men trained in the science of hydraulics, and they have the experience gained by long years of application of their professional knowledge to the problems we are considering. Some of these men have been charged with the duty of studying the Niagara River in its relations to Lake Erie, and their determinations of the volume of discharge discard all consideration of the effect of the rapids above the Falls upon that discharge, because they know that Lake Erie influences the condition at the rapids above the Falls by the volume of water which it sends down to them, but that these rapids in no way affect the volume of outflow from the lake. These engineers have set forth formulae for determining the discharge of Lake Erie, and these take no account of the conditions nineteen miles down stream. The discharge formula adopted by the Board as set forth in their report of 1900 is:—

$$Q = 168812 + 17762\ (Y) + 1409\ (Y)^2.$$

In this formula 168812 is the volume of discharge for a lake elevation of 570.00; Y is the difference between 570 and the elevation of the lake at the time the discharge must be determined; 17762 is the rate of increase for one foot of rise above 570 increased by 1409 multiplied by the square of the rise above 570, and Q is the resulting volume of flow.

The formula used by the engineers of the United States Lake Survey is found on page 2,857 of the Report of the Chief of Engineers, U.S.A., for 1903, and is:—

$$Q = 158500 + 22462\ (C\text{-}57).$$

In this formula C is the elevation of Lake Erie above sea level at the time the discharge is figured. 158,500 c.f.s. is the discharge for a lake stage of 570 and 22462 is the discharge for each foot of rise above 570. The results of computations for any given stage of lake by these two methods vary by a small percentage, and the latest formula gives the smallest discharge for any given elevation of the lake. An examination of the table shows the highest mean elevation of Lake Erie in the six years prior to 1894 to have been reached in 1890, and the highest mean stage in any month that year to have been in June. The mean elevation for the year was 573.23, and for the month was 574.02. Using the Lake Survey formula for discharge we find the flow for the month of June to have been 248,797 c.f.s. The Port Day gauge reading for that month was 563.15, showing a drop of 10.87 feet. The Niagara Falls Company began drawing water for power purposes in 1906. The highest stage of water since that year was reached in 1907. In July of that year the mean level of Erie was 573.33, which by discharge formula gives an outflow of 233,289 c.f.s. The annual mean elevation for 1907 was 572.80. The mean elevation for Port Day in the month of July was 562.09, showing a drop of 11.24 feet. Comparing the differences between Lake Erie and Port Day, with flows of 248,797 c.f.s. and 233,298 c.f.s., 10.87 in 1890 and 11.24 in 1906, we find only 0.37 of a foot. In 1890, the Niagara Falls Hydraulic Company was drawing so little that conditions above the first reef were practically those of unmolested nature. In 1907, the Niagara Falls Hydraulic Company was drawing about 4,000 c.f.s., and the Niagara Falls Power Company about 8,500 c.f.s. It is proper here to bring out a fact which has a bearing upon this discussion. The Port Day gauge does not correctly indicate the general level of the water in the basin above the first cascade. This gauge is at the intake to the hydraulic canal. Water entering that canal must be at a lower level at the entry than it is some distance away in, or else there would be no flow from the main body of water into the canal. This is axiomatic and needs no demonstration. In quotation No. 5, after discussing the low stage of Lake Erie, notwithstanding an excess of rainfall, he gropes for an explanation. The Doctor says: "Certainly there is but one explanation, namely, the excess has been diverted by the power uses from above the rim of upper rapids during the five years ending with 1905 over the mean of the ten preceding years of low water."

This recalls a housekeeping experience which came within my knowledge. A lady wishing to take a vacation with her husband arranged with his younger sister to keep house for the family while she was gone After the vacation, upon the mother's resuming the household duties, the sister presented her housekeeping accounts and insisted that they be audited. Beefsteak was an item much in evidence. The question arose, Why did she buy so much beefsteak? The answer was: "Oh, whenever I could not remember what I paid money for, I put down beefsteak."

The Doctor feels bound to account for the disappearance of the water, so he puts down, "Power uses from above the rim of the first cascade."

Having discussed the effect upon Lake Erie of the withdrawal of water from the Niagara River above the Falls and shown conclusively that navigation is not in the least menaced by that withdrawal, I will take up other phases of the question presented by Doctor Spencer. He says on Page 260, Chap. XXI.:—

"Of the franchised diversion two companies on the New York side and the Ontario Company on the Canadian, take

their water from above the first cascade, and consequently affect the river common to both countries. . . ."

"It is the diversion of water from the rim of the first cascade which will further shrink Niagara Falls."

When the Doctor says that two companies on the New York side take their water from above the first cascade, he asserts a fact. When he includes in that statement the Ontario Power Company on the Canadian side he falls into error, for at Port Day, the intake to the Niagara Falls Hydraulic Company, the elevation of water surface is nearly four feet higher than it is at the east end of the Ontario Power Company's intake, which indicates that the onflowing stream must have crossed the crest of the first cascade before it can enter the intake. There is room for argument, however, as the exact location of the reef which forms the lip of the first cascade, but there is no possible doubt of the fact that the Doctor is in error in his assertion that more water is drawn from above the lip of the first cascade through the intake which admits water to the gathering basin of the Ontario Power Company than was drawn before the construction of those works.

In reaching an intelligent understanding of this situation a study of the conditions within the area enclosed between the location of the now existing intake through which water is admitted to the gathering basin of the Ontario Power Company is very instructive, and serves to invalidate Mr. Spencer's contention that a greater volume of water is being drawn over the lip since the completion of the Ontario intake than was the flow over this portion of the channel in its natural condition. In a state of nature the sweep of the river was along the convex shore, and the impetuosity of the current was such that it had indented the uniform curvature of the west shore and secured a small channel around the resisting uplift known as Dufferin Islands. Where this sweep to the west occurs we have contours showing the surface of the rock floor. These range from 548 to 549, or an average of 548.5. Surface water elevations were taken before the building of any obstruction to free flow, and these range from 554.9 to 555.5, or an average of 555.2. The length of the present obstruction to free flow is about 600 feet. With this data to work from we find an approximate cross section of 4,020 feet. The velocity may be assumed with some degree of certainty at 6 feet per second; hence, we would have a flow of 24,120 second feet. Since the construction of the head works of the Ontario Power Company we have an altered condition. These head works have a total length of 596 feet, and are designed to control the flow into the gathering basin. There are fifty openings, each 9 feet 5 inches by 6 feet = 56½ square feet, or a total opening of 2,825 square feet. Under no possible conditions could a volume of water enter the gathering basin through these openings as great as that which formerly swept over this course.

Exhibit V. is a plat showing a stretch of the river beginning at the head of Goat Island and extending down below the Falls. On this plat the international boundary line is shown, and lines are drawn parallel to the east boundary line (produced) of the Queen Victoria Niagara Falls Park at intervals of 200 feet. In these lines on the down-stream side the distances are marked from the boundary line to their intersections with the original shore line, and where they cross the line of the intake the distance to it from the boundary line is marked on the up-stream side. This exhibit brings out very clearly the extent to which the channel has been contracted by the intake.

Exhibit VI. is an elevation of the intake showing the openings through it, and on its face a hydraulic profile shows the recent flow line, and in dotted lines are approximate water surface of 1902 before the works had changed natural conditions. The openings in the intake are designed to admit ample water to supply the three conduits which are to carry water from the gathering basin to the power house below the Horse Shoe Falls. Only one of these steel conduits is now in place; it is 18 feet in diameter; hence, its cross-sectional area is 254.57 square feet. The velocity figured on in this conduit was 15 feet per second; hence, the volume of flow should be 3,818 feet per second. Three times this volume of flow would be 11,454 cubic feet per second. This volume must be taken into the gathering basin with enough more to insure a good entry head into the conduits, a requirement far below the volume which formerly swept over the area now enclosed by the structures of the gathering basin.

The facts set forth herein and illustrated by the exhibits prove beyond contradiction that the works of the Ontario Power Company do not tend to lower the water above the first cascade. This being true, the only water extracted for power purposes which tends to lower the water above the first cascade is taken by the Niagara Falls Power Company and the Niagara Falls Hydraulic and Manufacturing Company on the New York side. The volume taken by the first of these companies is 8,500 cubic feet, and by the second is 4,000 cubic feet, or a combined volume of 12,500 cubic feet; somewhat less than the 44,750 cubic feet per second upon which Dr. Spencer predicted his argument. (See Chap. XXI., Part 2, Page 266.)

That the water taken from the river for power purposes above the Falls must to the degree of taking diminish the volume tumbling over the precipice is indisputable. This diminution has not as yet marred the scenic beauty of this wonderful work of nature, but the volume of diversion cannot be much increased without marring that beauty. It is within the range of accomplishment to greatly increase the volume of water to be converted into power and still preserve the sublimity, grandeur and beauty of the Falls, and the expenditure necessary would be amply justified by the results. This is an idea which need not be amplified here, but it leads up to the great question of the conservation of the waters in the drainage areas of the Great Lakes. This conservation calls for international co-operation. In these lakes we have our seasons of surplus water and our seasons of deficient flow. The surplus is allowed to run to waste, and when the low period comes there is no relief. These lakes are capable of storing all of the surplus waters, and it is for man to build the works which will bring that capability into play. The mean between the high and low waters is what our commerce needs. In the days of Pharoah there was a Joseph to interpret the monarch's dream on the fat and lean kine. And the monarch appointed the interpreter to store the overabundance of seven years of plenty therewith to avert seven years of famine when the crops failed. We are not confronted with dreams needing an interpreter. The seasons have told their story year by year, and we know it as far back as the records of the Great Lakes have been preserved. We know that each year there is an outflow from the lakes far in excess of any human need, and afterwards comes a period when the deep-laden ships drag their keels upon the bottoms of the inter-lake channels. This need not be, it ought not to be, and it can be averted by the construction of controlling works at the head of the St. Mary's River and at the head of the Niagara River, which would make possible absolute control of the waters, so that there need never be a low stage of water, and a constant mean flow could be maintained. The cost of these works is insignificant compared with any other method of providing deep navigation. The time to be consumed in building the works would be shorter by years than that needed for any other mode of relief, and the benefits in all of the upper lakes would be immediate.

## CONSUMPTION OF WATER.

The daily per capita consumption of water for the year, July, 1907, to July, 1908, six municipalities, is given in the following table:—

| Corporation. | U. S. Gallons Supplied, July 1, 1907 to June 30, 1908, inclusive. | | Est. No. Persons Supplied. | Gallons Per Capita Daily. |
|---|---|---|---|---|
| | Total. | Daily Average. | | |
| Detroit, unmetered ..... | 18,159,171,467 | 49,615,223 | 426,592 | 167.8 |
| Detroit, metered ..... | 8,386,105,508 | 22,912,857 | | |
| Highland Park, metered .... | 64,260,680 | 175,576 | 3,956 | 59.5 |
| River Rouge, metered ..... | 118,008,968 | 322,430 | 4,119 | 78.4 |
| Ecorse, metered ..... | 6,195,684 | 16,928 | 1,447 | 11.7 |
| Hamtramck, metered ..... | 99,457,896 | 271,743 | 3,366 | 80.9 |
| Palmer Park, metered ..... | 23,938,992 | 65,407 | ..... | .... |

# CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc. Printed forms for the purpose will be furnished upon application.

## TENDERS.

**Nova Scotia.**

GLACE BAY.—Tenders for fittings, Glace Bay, public building, will be received until Tuesday, May 25th. Plans may be seen on application to Daniel Ross, Glace Bay, N.S., and at the Department of Public Works, Ottawa. Napoleon Tessier, Secretary.

**Quebec.**

JOLIETTE.—Tenders for hot water heating system will be received until May 28th, 1909. Mr. A. Durand, architect, Joliette, P.Q. Napoleon Tessier, Secretary, Department of Public Works, Ottawa.

MONTREAL.—The Roads Committee of the City Council have decided to call for tenders for the construction of an asphalt plant. Estimated cost $27,500.

**Ontario**

FORT WILLIAM.—Tenders for wharves at Mouth of Mission River will be received until June 4th. Napoleon Tessier, Secretary, Department of Public Works, Ottawa. (Advertised in The Canadian Engineer.)

GLENCOE.—Tenders for electric wiring and fittings for the Post Office, Armory, etc., will be received until Friday, May 28th. Mr. J. E. Hall, Clerk of Work, Glencoe. Napoleon Tessier, Secretary, Department of Public Works, Ottawa.

GUELPH.—The City Council will receive tenders for tar and cement macadam. J. Hutcheon, City Engineer.

LONDON.—Tenders for an asphalt pavement on Adelaide Street, from Dundas Street to Dufferin Avenue, will be received at this office up to four o'clock on Thursday, May 27th. A. O. Graydon, City Engineer.

OTTAWA.—Tenders will be received up to noon May 22nd, for 170,000 gallons lighthouse illuminating oil. Specifications can be procured from the Collectors of Customs at Toronto, Petrolea, Sarnia, from agents of the Department at Montreal, Quebec, St. John, and Halifax, and from the Department here. G. J. Desbarats, Acting Deputy Minister of Marine and Fisheries, Ottawa.

OTTAWA.—Tenders will be received up to 31st May, 1909, for work required in connection with the abutments and approaches of the new bridge below the waste weir at Kingston Mills Lock Station on Rideau Canal. L. K. Jones, Secretary, Department of Railways and Canals.

PETERBORO.—Tenders will be received until June 14th, for pumping equipment. W. Henderson, Superintendent Waterworks; S. R. Armstrong, Secretary, Water Commissioners. (Advertised in The Canadian Engineer.)

TORONTO.—Tenders will be received up to Tuesday, May 18th, for the supply of lumber, for the period commencing June 1st, 1909, and ending May 31st, 1910. Specifications may be obtained at the offices of the Property Department, City Hall, Toronto. John J. Ward, Vice-Chairman Board of Control.

TORONTO.—Tenders will be received up to June 1st, 1909, for the reconstruction of the bridges on Dundas Street, over the tracks of the Grand Trunk and Canadian Pacific Railways. John J. Ward, Vice-Chairman, Board of Control. (Advertised in The Canadian Engineer).

TORONTO.—Tenders will be received until June 1st for the erection of several bridges at various points in Ontario. H. F. McNaughten, Secretary, Department of Public Works, Toronto. (Advertised in The Canadian Engineer.)

TORONTO.—Tenders will be received until May 27th for road grading. J. O. Reaume, Minister of Public Works, Toronto. (Advertised in The Canadian Engineer.)

WELLAND.—Tenders for heating apparatus for public building will be received until May 26th. Edgar Rounds, Clerk of Works, Welland, Ont. Napoleon Tessier, Secretary, Department of Public Works, Ottawa.

**Manitoba.**

DAUPHIN.—Tenders for the erection of a twelve-room school building will be received until May 28th. J. H. Bossons, architect.

WINNIPEG.—Tenders will be received up to May 25th for the supply of the following soft copper plate of No. 16 Birmingham gauge: 1,350 pieces 24 inches by 36 inches plain; 1,350 pieces 4 inches by 6 inches, each punched with two 11-16-inch holes. M. Peterson, Secretary, Board of Control, Winnipeg.

**Saskatchewan.**

MOOSE JAW.—Tenders will be received until May 31, for sewer, water main, manholes, etc. J. Darlington Whitmore, city engineer. (Advertised in The Canadian Engineer).

MOOSE JAW.—Tenders will be received until May 31st for the sinking of a test well for gas, oil or water. John D. Simpson, city clerk. (Advertised in The Canadian Engineer.)

**Alberta.**

LETHBRIDGE.—Tenders received up to June 5th for all plant, material, labor in the erection of a courthouse. Plans, etc., may be seen at engineer's office of the Department of Public Works, Edmonton, Calgary, or inspector of building, Lethbridge. John Stocks, Deputy Minister of Public Works, Edmonton.

## CONTRACTS AWARDED.

**Quebec.**

MONTREAL.—The Outremont Council accepted the tender of Wm. Evely, $1,375, for alterations to the town hall.

MONTREAL.—The new factory for The Canadian Spool and Cotton Company, Montreal, is being equipped with panelboards and cabinets, manufactured by The Hill Electric Switch and Manufacturing Company, Limited, of Montreal.

MONTREAL.—The Montreal Locomotive Company has received instructions to make nine locomotives for the New York Central Railway.

MONTREAL.—The Water Committee received the following tenders for 12,000 tons steam coal: T. F. Moore, $3.65 per ton; Montreal Light, Heat & Power Company (smokeless coke), $3.75; L. Cohen & Son, $3.48, and J. O. Labrecque & Company, $3.48. The contract was divided between the two last-named tenderers. The coal is to be laid down on the wharves at the rate quoted.

**Ontario.**

GUELPH.—The following tenders for Winter Fair addition were accepted, being the lowest: G. A. Scroggie, carpenter work, $22,400; H. Benallick, stone work, $12,677; McCormick & Robinson, tin work, $4,290; H. Occomore, roofing, $1,000; W. Scrivens, painting, $367; P. Martin, plastering, $4,200.

HAMILTON.—The following tenders were received by the sewer committee for the Barton Street sewer: John Armstrong, $1.20 a foot; Andrew Mercer, $1.38; City Engineer, $1.37½. The contract was awarded to Mr. Armstrong.

OTTAWA.—The City Council accepted the tender of the General Contracting Company, Limited, Toronto, for the the construction of the new grand stand at the Exhibition grounds, their tender of $77,875, being the lowest of the three

received. Other tenders were received as follows: Courtney and Brown, of Ottawa, $83,179 and $98,753.

ST. CATHARINES.—The Public School Board have awarded the following contracts: Heating and ventilating St. Patrick's Ward School, John Peart, $3,650; Longley and Rymer, retaining wall, $75. John Carlson, fence, $70. In each case the tenders accepted were the lowest received.

ST. THOMAS.—The following contracts were awarded Saturday, May 15th, for bridges and culverts in Yarmouth: McKellar bridge, Ira Pier, $725; Carr bridge, J. W. Chivers, $1,500; Hepburn culvert, Powells and Gunning, $167; O'Brien culvert, Powells and Gunning, $183; Taylor culvert, Ira Pier, $32 7; Sommerville culvert, Joseph Vincent, $300; school house culvert on the L. & P. S. gravel road, Powells and Gunning, $263; New Sarum bridge, C. C. Stafford, $839.

TORONTO.—The following tenders for Avenue Road School were accepted: Masonry, Orr Bros., $22,550; carpentry, Crocker & Le Drew, $8,671; plaster, Blackburn & Sons, $1,150; painting, J. Pinnemore, $715; plumbing, Keith & Fitzsimons, $1,213; steam heating, J. R. Seager, $2,100; sheet metal, Forbes Roofing Company, $896; structural steel, Jenks-Dresser Company, $1,045; reinforced steel, Expanded Metal Company, $675; and electric wiring, Keith & Fitzsimons, $35, making a total of $39,050.

**Manitoba.**

WINNIPEG.—Charles W. Sharpe & Company have been awarded the contract for the erection of a building for the Great West Life Assurance Company. The contract price is $170,000 and the successful tenderer was the lowest among the seven who figured. The entire cost of the building is expected to be $230,000. It will be of steel frame construction and entirely fireproof with porous tile terra cotta partitions. The exterior will be of British Columbia marble.

**Saskatchewan.**

SASKATOON.—The fire, water and light committee recommended that the contract for bricking boilers be awarded to H. F. Moore for the sum of $2,000.

**Alberta.**

EDMONTON.—At the last City Council meeting the contract for grading five and one-half miles of streets for street car line was awarded to Lubbock and Matheson, whose tender was the lowest. The tenders were Lubbock & Matheson, $1,925 per mile; Manders & Miller, $1,950 per mile; S. E. Patton, $2,985 per mile. The specifications call for the grading of the roadbed, laying of ties and steel ready for the rolling stock. The tender of the Globe Lumber Company, Rollstoke, B.C., for three cars of 35-foot poles and a double car of 40-foot poles was accepted. The following tenders were received for the structural steel for the new power house extension and for the elevated coal bins of 350 tons capacity. The prices are for completed steel-work f.o.b. Edmonton, and erected on foundations:

| Name. | Building. | Coal bin. | Total. |
|---|---|---|---|
| Can. Bridge Company.... | $14,423 | $3,198 | $17,621 |
| Edmonton Ironworks .... | 14,404 | 2,365 | 16,460 |
| Wisconsin Bridge Co. ... | ..... | ..... | 16,460 |
| North Supply Co. . ..... | 13,419 | 4,600 | 18,019 |
| Dominion Bridge Co. ... | 16,200 | ..... | ..... |
| Edmonton Dis. Co. ..... | 14,368 | 2,400 | 16,768 |

The contract was given to the Edmonton Iron Works for $16,460. The purchase of a street railway water sprinkler from the Preston Car Company, Preston, Ont., for $2,740 was ordered.

**Foreign.**

NEW YORK.—The Hydraulic Properties Company, of Providence, R.I., have awarded the exclusive agency for all construction of Ranson & Hoadley's reinforced concrete dams, to the Frank B. Gilbreth organization, No. 60 Broadway, New York City.

## RAILWAYS—STEAM AND ELECTRIC.

**Ontario.**

CARLSBAD SPRINGS.—Track-raising operations are in full swing here, an even six inches being given.

MOOSE CREEK.—The G.T.R. intend shortly to commence operations on the new station to be built here. The engineers were over the ground this week. The G.T.R. have purchased a large plot of land for use as a ballast pit.

OTTAWA.—The C.P.R. have started operations on the Wellington Street viaduct. It is to cost $75,000, and will be finished by July.

OTTAWA.—The G.T.R. have over 150 men employed on the annex to the new station here. The work will be rushed to completion, and it is expected that at least half of the annex will be completed by November next.

OTTAWA.—The G.T.R. are negotiating for the purchase of Cassidy's land along the River Rideau.

TORONTO.—A despatch from Winnipeg says: The passenger business on the G.T.P. west has so developed that the company will put on a regular passenger service, beginning May 23rd, and running as far west as Biggar, over 500 miles out.

**Manitoba.**

WINNIPEG.—The Transcontinental Railway Commissioners are preparing to file the plans of their route through the city with the civic officials and the Railway Department. As soon as these have been approved by the city and the Railway Commission construction will be proceeded with as rapidly as possible.

WINNIPEG.—Contracts have been let for the construction of 414 miles of new line for the Canadian Northern Railroad. The Cowan Construction Co. and the Northern Construction Co. were awarded the work. Perhaps the most important of the new lines is an extension from Vegreville to Calgary, 235 miles. Other new branches are: An extension from Maryfield, Sask., south-westerly one hundred miles; Goose Lake extension, sixty-five miles west from Saskatoon; extension from Russell westward twenty-five miles; from Prince Albert, thirty miles west; from Ochre River, through St. Rose du Lac, a distance of twelve miles, a branch line twenty miles north; from Oak Park, a branch twenty miles north from Morinville. A contract was granted to N. K. Boyd for an extension of the Wakopa line twelve miles west.

**British Columbia.**

VANCOUVER.—The British Columbia Electric Railway has been authorized by the London board of directors to spend two and a half million dollars on the coast in the next year. The Vancouver extensions are those to Shaughnessy Heights, Point Grey and Hastings.

VICTORIA.—That tenders will be invited in a few days for the grading and construction of the Alberni extension of the E. and N. Railway from French Creek to Alberni is assured. It was definitely and authoritatively announced recently that the revised survey route, submitted to the Railway Commission, had been approved.

## LIGHT, HEAT, AND POWER.

**Quebec.**

MONTREAL.—The Fire and Light Committee of the city council propose making a new offer to the Montreal Light, Heat and Power Company of $75 per arc lamp per annum on a ten-year contract, and a proposal that gas be furnished to the public at the rate of ninety cents per 1,000 feet.

MONTREAL.—Notice of the incorporation of Western Canada Power Company appears in the "Canada Gazette" for May 15th. The company will have a capital of $5,000,000, and the chief place of business is to be at Montreal.

**Ontario.**

TORONTO.—In the rooms of the Toronto Electric Light Company Mr. F. R. Pendleton has been giving lectures on "Scientific Illuminating." Mr. Pendleton showed the advantages to be gained from the use of Tungsten filaments and prismatic reflectors.

**Foreign.**

ANDOVER, MASS.—Plans for a new power plant for W. T. Stevens & Sons Co., North Andover, Mass., have been completed by Charles T. Main, mill engineer and architect, of Boston. The plant is to consist of turbine generator, boiler

and pump-rooms, with coal pocket in the rear. The walls are to be of brick. In the 25 by 50 feet turbine room will be installed a 360 k.w. Westinghouse turbine generator, with two exciters and a motor-driven Le Blanc condenser. The boiler-room will be 40 by 50 feet, and equipped with two H.R.T. 72-inch Bigelow boilers, with forced draft. Space is provided for a duplicate boiler installation. The pump-room is to contain both the boiler feed pump and a 1,000 gallon fire pump. The stack is to be of brick, 150 feet high, with 6-foot flue.

## SEWERAGE AND WATERWORKS.

**Ontario.**

GUELPH.—The sewerage beds, plans for which were approved of by the Board of Health some time ago, are to be constructed by day labor at a cost of $25,000.

PRESCOTT.—An extension of the sewerage connections here is about to begin. From a plan and estimate drawn up by Mr. Galt the cost will be about $18,000.

WATERLOO.—Superintendent Hymmen has a big staff of men at work on the contract of laying 2,700 feet of four-inch water mains on Mill Street.

**Alberta.**

CALGARY.—City Engineer Childs has recommended sewer improvements to cost approximately $10,000.

NANTON.—Messrs. Galt & Smith, consulting engineers, Toronto, Ont., and Vernon, B.C., have been engaged by the municipality to report on a sewerage disposal scheme for the town.

**British Columbia.**

VANCOUVER.—Steps towards providing the municipalities of South Vancouver, Point Grey, Burnaby and Richmond with water have been taken. Messrs. Cleveland & Dutcher have received instructions to survey and report estimates on the construction of an intake and pipe line from Seymour Creek to the above districts. The combined water rights of these districts amount to 800 miners' inches, a quantity sufficient to supply over 100,000 persons. It is roughly estimated that the cost of the new undertaking will amount to about $400,000. Messrs. Cleveland & Dutcher will commence the survey at once, and if the plans are approved of construction will start next spring, and will take about two years to complete.

VICTORIA.—The Provincial Government will install a new water system at Prince Rupert. At the present time negotiations are in progress with the G.T.P. with regard to the financial end of the matter. The work will be undertaken jointly, and later, when the place is incorporated, may be taken over by the municipality.

## FINANCING OF PUBLIC WORKS

**Ontario.**

OWEN SOUND.—On May 15th the property owners voted on four by-laws. The expenditure of $125,000, to take in part of the Sydenham River, construct a sedimentation basin and a filtration plant, adding a million gallons daily to the supply, was endorsed by a majority of 50. The extension of the electric light plant by an expenditure of $30,000 was also ratified, the majority being 88. R. McDowell, City Engineer.

WELLAND.—Welland has sold $23,600 4½ per cent. 10-year sewer debentures and $20,642 4½ per cent. 20-year sidewalk debentures.

**Manitoba.**

WINNIPEG.—At the City Council meeting on Tuesday, May 11th, by-laws authorizing the expenditure of $400,000 on bridges, $150,000 on parks and $50,000 on a fire alarm system were read a third time. Polling will take place on June 24th.

**Saskatchewan.**

NORTH BATTLEFORD.—On May 25th, the ratepayers will vote on a by-law authorizing the issue of $100,000, 5 per cent., 40-year sinking fund bonds to install waterworks, sewerage and electric light systems.

**British Columbia.**

VICTORIA.—The ratepayers will vote on a by-law authorizing the raising of $125,000 for waterworks improvements.

## CURRENT NEWS.

**Ontario.**

OTTAWA.—The Canada Gazette for May 15th contains a notice of a change in the corporate name of Metcalf Engineering, Limited, to John S. Metcalf Company, Limited.

**Alberta.**

EDMONTON.—Two Dominion Government survey parties engaged in Alaskan boundary survey work sailed for the north on the Princess Beatrice recently. One of them, under Mr. F. H. Mackie, of Ottawa, with Grizzly Bates as assistant, will disembark at Fort Wrangle and proceed inland to locate monuments in the valleys of the Stickina and Iskoot Rivers. Another party is in charge of Mr. N. J. Ogilvie, of Ottawa, with Mr. H. S. Mussell as assistant.

**British Columbia.**

VANCOUVER.—Waddell & Harrington have submitted to the Council plans and specifications for the structure and superstructure to replace the temporary ends of the Granville Street bridge as now constructed. The estimated cost is $124,000.

**Foreign.**

DETROIT, MICH.—The Detroit Foundry Supply Co. has purchased the business of the Detroit Platers and Polishers Supply Co., who has manufactured various compositions, such as tripoli, crocus, Vienna lime, etc., together with the handling of platers' and polishers' supplies, and that they contemplate manufacturing this material in the future.

## MISCELLANEOUS

**Quebec.**

MONTREAL.—On May 19th tenders were opened by the Outremont Council for 30,000 feet of concrete sidewalks.

**Manitoba.**

ST. BONIFACE.—An extensive programme of local improvements has been drawn up by the City Engineer. Pavements, sidewalks, water mains and sewers, to cost $250,000, are included.

## PERSONAL.

MR. A. MATHISON, of Madison City, Ia., has been appointed city electrical engineer of High River, Alta.

MR. A. GILLIES, B.A.Sc., has been placed in charge of the power plant on the Montreal River Beach's Camp Gillies Depot, Ont.

MR. WILLIS CHIPMAN, C.E., who for many years has carried on a large consulting practice in both Eastern and Western Canada, has in addition to his Toronto office opened offices in Winnipeg, Man.; Saskatoon, Sask., and Calgary, Alta.

MR. A. C. DAVIS, F.C.S., Assoc. Inst. C.E., managing director of the Saxon Portland Cement Co., of New Cambridge, Eng., who is now visiting Eastern Canada and the United States with a view of familiarizing himself with the condition of the trade and industry in North America, paid a visit to our Toronto oce this week.

MESSRS. EDMUND WRAGGE, of Toronto, and C. BERESFORD FOX have entered into partnership as Civil and Consulting Engineers under the name of Wragge & Fox, at 613 Traders Bank Building, Toronto; and are acting

as correspondents of Messrs. Sir Douglas Fox & Partners, London, England.

MR. PERRY BARKER, M.S., member American Chemical Society, recently Assistant Engineer United States Geological Survey at Fuel Testing Plants, St. Louis and Jamestown, and later at Experimental Gas Plant, Ann Arbor, in charge of Tests of Gas Coals, has been made Assistant Chemical Engineer on the staff of the Fuel Engineering Department of the Arthur D. Little Laboratory of Engineering Chemistry, Boston, Mass. Mr. Barker, who is a graduate in chemical engineering of the University of Illinois, was formerly chemist to the Peabody Coal Company, Chicago, and research chemist at the Illinois State Engineering Experiment Station.

## OBITUARY.

MR. J. B. LAFLAMME, noted through Canada as a superintendent of construction, is dead at his home on St. Catherine Street East, Montreal. Mr. Laflamme first distinguished himself in his line of work in Texas and Mexico in the eighties, when he had charge of the construction of a railway for the late Sir R. G. Reid. This work was successfully carried out under most adverse conditions, among which were the treachery of rivers to be bridged, which became very much swollen and rapid at times without warning, and the hostility of the Indians. The work had to be carried out under military guard to keep the builders from being massacred. Mr. Laflamme had charge of the construction of the section of the C.P.R. along the north shore of Lake Superior for Mr. Reid, and afterwards entered the employ of Mr. W. J. Poupore, contractor, of this city.

## MARKET CONDITIONS.

Montreal, May 19th, 1909.

So far as the United States is concerned, the pig-iron market is steady at the recent advance. The views of the majority of makers now range 25c. to 50c. per ton higher for future delivery on foundry iron, and 50c. to $1 per ton higher for basic. This greater advance on the basic is due to the fact that only within the past few days it had been selling at a lower range than foundry grades, and this should bring it on an even basis. There are now large orders pending and a fair tonnage is being turned over on the aggregate. Southern furnaces seem at last to have become united in asking higher prices than heretofore, some makers being disposed to cut to secure attractive specifications. A heavy tonnage has been booked in bar iron and steel, and structural steel, and it is thought that a heavy aggregate tonnage is still pending, many big inquiries being out and a number of large contracts being almost due. Considerable building is going on. Orders for steel rails are in larger proportion, the tonnage booked within the past few weeks being heavy. Prices are firm. Structural shapes, bar steel, etc., have advanced 5c. per 100 lbs. from recent low figures.

Trade reports from England indicate that the pig-iron market continues to show the strength which has characterized it for the past few weeks, more or less buoyancy being displayed. Notwithstanding some temporary and unimportant relapses, the market has been moving upward, generally, and demand has increased, buyers being led to the conclusion, apparently, that they have nothing to gain by procrastinating. They are consequently showing more readiness to do business, both for prompt and future delivery. Exports are increasing, and it seems probable that stocks in store—which have been accumulating less rapidly of late—may shortly show a decrease. There is good reason for the more sanguine view, apparently. Prices show considerable fluctuation, but this is entirely due to speculation. Makers continue to hold firm, and are asking higher prices for future deliveries. In the local market, a good demand continues for pig-iron. Several good sales have been made within the past week, notwithstanding the fact that a heavy tonnage is now being received on import, and is being distributed to purchasers. Canadian furnaces are said to be fairly well booked ahead, and are asking somewhat higher prices. The general foundry business seems to be improving, this being evidenced by the fact that the smaller concerns throughout the country are making fairly liberal purchases. Orders are arriving from all over, although nothing in the nature of a boom has yet been realized.

The following list of prices gives a fair range, the market being on the firm side, generally speaking, and demand being fairly active:—

**Antimony.**—The market is dull at 8½ to 8¾c.

**Bar Iron and Steel.**—Prices are steady and trade is better. Bar iron, $1.85 per 100 pounds; best refined horseshoe, $2.10; forged iron, $2; mild steel, $1.85; sleigh shoe steel, $1.85 for 1 x ⅜-base; tire steel, $1.90 for 1 x ⅜-base; toe calk steel, $2.35; machine steel, iron finish, $1.90; smooth finish, $2.70; imported, $2.20.

**Boiler Tubes.**—The market is steady, quotations being as follows:—1½ and 2-inch tubes, 8½c.; 2½-inch, 10c.; 3-inch, 11½c.; 3 1-2-inch, 14¾c.; 4-inch, 19c.

**Cement.**—Canadian cement is now so cheap that it holds the market. Quotations are for car lots, f.o.b., Montreal. Canadian cement is readily available at $1.30 to $1.45 per 350-lb. bbl., in 4 cotton bags, adding 10c. for each bag. Good bags re-purchased at 10c. each. Paper bags cost 2½c. extra, or 10c. per bbl. weight.

**Building Paper.**—Tar paper, 7, 10, or 16 ounces, $1.60 per 100 pounds; felt paper, $2.40 per 100 pounds; tar sheathing, No. 1, 35c. per roll of 400 square feet; No. 2, 35c.; dry sheathing, No. 1, 45c. per roll of 400 square feet, No. 2, 28c. (See Roofing; also Tar and Pitch).

**Chain.**—The market is steady as follows:—¼-inch, $5.30; 5-16-inch, $4.05; ⅜-inch, $3.65; 7-16-inch, $3.45; ½-inch, $3.20; 9-16-inch, $3.15; ⅝-inch, $3.05; ¾-inch, $3; ⅞-inch, $2.95; 1 inch, $2.95.



**Copper.**—Prices are firm at the recent decline to 14 to 14½c.

**Explosives and Accessories.**—Dynamite, 50-lb. cases, 20 per cent. proof, 15c. in single case lots, Montreal. Blasting powder, 25-lb. kegs, $2.25 per keg. Special quotations on large lots of dynamite and powder. Detonator caps, case lots, containing 10,000, 75c. per 100; broken lots, $1. Electric blasting apparatus:—Batteries, 1 to 10 holes, $15; 1 to 20 holes, $25; 1 to 30 holes, $35; 1 to 40 holes, $50. Wire, leading, 1c. per foot; connecting, 50c. per lb. Fuses, platinum, single strentgh, per 100 fuses:—4-ft. wires, $3; 6-ft. wires, $3.54; 8-ft. wires, $4.08; 10-ft. wires, $5. Double strength fuses, 4-ft., $3.75; 6-ft., $4.29; 8-ft., $4.83; 10-ft., $5.37. Fuses, time, double-tape, $6 per 1,000 feet; explohmeters, fuse and circuit, $7.50 each.

**Galvanized Iron.**—The market is steady. Prices, basis, 28-gauge, are:—Queen's Head, $4.40; Comet, $4.25; Gorbal's Best, $4.25; Apollo, 10¾ oz., $4.35. Add 25c. to above figures for less than case lots; 26-gauge is 25c. less than 28-gauge. American 28-gauge and English 26 are equivalents, as are American 10¾ oz., and English 28-gauge.

**Galvanized Pipe.**—(See Pipe, Wrought and Galvanized).

**Iron.**—The outlook is steady. The following prices are for carload quantities and over, on cars, Montreal, delivery from dock being 35c. less; Canadian pig, $18.50 per ton, Montreal; No. 1 Summerlee, $18.75 to $19; selected Summerlee, $18.25 to $18.50; soft Summerlee, $17.75 to $18; Clarence, $17 to $17.25 per ton.

**Laths.**—See Lumber, etc.

**Lead.**—Prices are about steady, at $3.60 to $3.65.

**Lead Wool.**—$10.50 per hundred, $200 per ton, f.o.b., factory.

**Lumber, Etc.**—Prices on lumber are fo1 car lots, to contractors, at mill points, carrying a freight rate of $1.50. Red pine, mill culls out, $18 to $22 per 1,000 feet; white pine, mill culls, $22 to $25. Spruce, 1-in. by 4-in. and up, $16 to $18 per 1,000 ft.; mill culls, $14 to $16. Hemlock, log run, culls out, $14 to $16. Railway Ties; Standard Railway ties, hemlock or cedar, 35 to 45c. each, on a 5c. rate to Montreal. Telegraph Poles: Seven-inch top, cedar poles, 25-ft. poles, $1.35 to $1.50 each; 30-ft., $1.75 to $2; 35-ft., $2.75 to $3.25 each, at manufacturers' points, with 5c. freight rate to Montreal. Laths: Quotations per 1,000 laths, at points carrying $1.50 freight rate to Montreal, $2 to $3. Shingles: Cedar shingles, same conditions as laths, X, $1.50; XX, $2.50; XXX, $3.

**Nails.**—Demand for nails is poor, but prices are steady at $2.30 per keg for cut, and $2.25 for wire, base prices.

**Paints.**—Roof, barn and fence paint, 90c. per gallon; girder, bridge, and structural paint for steel or iron—shop or field—$1.20 per gallon, in barrels; liquid red lead in gallon cans, $1.75 per gallon.

**Pipe.—Cast Iron.**—The market continues steady at $33 for 8-inch pipe and larger; $34 for 6-inch pipe; $34 for 5-inch, and $34 for 4-inch at the foundry. Pipe, specials, $3.10 per 100 pounds. Gas pipe is quoted at about $1 more than the above.

**Pipe.—Wrought and Galvanized.**—The market is steady, moderate-sized lots being: ¼-inch, $5.50 with 63 per cent. off for black, and 48 per cent. off for galvanized; ⅜-inch. $5.50, with 59 per cent. off for black and 44 per cent. off for galvanized; ½-inch, $8.50, with 69 per cent. off for black, and 59 per cent. off for galvanized. The discount on the following is 72½ per cent. off for black, and 62½ per cent. off for galvanized; ¾-inch, $11.50; 1-inch, $16.50; 1¼-inch, $22.50; 1½-nch, $27; 2-inch, $36; 2½-inch, $57.50; 3-inch, $75.50; 3½-inch, $95; 4-inch, $108.

**Rails.**—Quotations on steel rails are necessarily only approximate and depend upon specification, quantity and delivery required. A range of $30.50 to $31 is given for 60-lb. and 70-lb.; 80-lb. and heavier, being $30; rails, per gross ton of 2,240 lbs., f.o.b. mill. Re-laying rails are quoted at $27 to $29 per ton, according to condition of rail and location.

**Railway Ties.**—See lumber, etc.

**Roofing.**—Ready roofing, two-ply, 70c. per roll; three-ply, 95c. per roll of 100 square feet. (See Building Paper; also Tar and Pitch).

**Rope.**—Prices are steady, at 9c. per lb. for sisal, and 11c. for Manila. Wire rope, crucible steel, six-strands, nineteen wires; ¼-in., $2.75; 5-16, $3.75; ⅜, $4.75; ½, $6; ⅝, $7.25; ¾, $8.50; ⅞, $10; 1-in., $12 per 100 feet.

**Spikes.**—Railway spikes are in dull demand and prices are steady at $2.30 per 100 pounds, base of 5½ x 9-16. Ship spikes are also dull and steady at $2.85 per 100 pounds, base of ⅝ x 10-inch, and ⅝ x 12-inch.

**Steel Shafting.**—Prices are steady at the list, less 25 per cent. Demand is on the dull side.

**Steel Plates.**—The market is steady. Quotations are: $2.15 for 3-16; $2.25 for ⅛, and $2.15 for ¼ andthicker; 12-gauge being $2.30; 14-gauge, $2.15; and 16-gauge, $2.10.

**Telegraph Poles.**—See lumber, etc.

**Tar and Pitch.**—Coal tar, $3.75 per barrel of 40 gallons, weighing about 500 pounds; roofing pitch, No. 1, 90c. per 100 pounds; and No. 2, 50c. per 100 pounds; pine tar, $8.50 per barrel of 40 gallons, and $4.75 per half-barrel; pine pitch, $4 per barrel of 180 to 200 pound. (See building paper; also roofing).

**Tin.**—Prices are unchanged, at 32½ to 33c.

**Zinc.**—The tone is steady, at 5½ to 5¾c.

* * * *

Toronto, May 20th, 1909.

Building materials generally are meeting with good demand. Cement is in request in small parcels; there seems to be no new contracts for large quantities. Bricks move freely. Lime and plaster of paris are very active. Lumber maintains its price and there is a steady consumptive demand.

All metals, with the exception of antimony, are moving with moderate freedom, and maintain a steadiness of quotation. Iron and steel in the Old Country have a better outlook. Of hardware the movement is not brisk, orders being limited strictly to spring requirements. And spring comes on but slowly.

(Continued on Page 43).

# CONTRACTOR'S SUPPLIES





















### NEW INCORPORATIONS.

**London, Ont.**—Dickison, Nicholson & Company, $50,000; G. J. Aust, W. G. Coles, J. F. Grant. Greene Swift, $250,000; R. Greene, S. D. Swift, W. E. Greene.

**Ottawa, Ont.**—Alumni Mines Company, $1,000,000; M. Schwarts, M. Rosston, W. F. Hetherington. Bonsall Mines, $3,000,000; L. M. Heal, Misses E. J. Morrison, G. V. Jamieson.

**British Columbia.**—Campbell River Power Company, $50,000; Island Dock & Warehouse Company, $500,000; Lemon, Gonnason Company, $150,000; Nahmint River Lumber Company, $250,000; North-West and British Columbia Timber Company, $150,000; North Kootenay Land and Timber Company, $750,000. Abbotsford Timber & Trading Company, $300,000; Bar Harbour Lumber and Brokerage Company, $10,000; J. W. McMillan & Company, $100,000; Johnson Shaw Lumber Company, $6,000; Lucky Jim Zinc Mines, $2,500,000; Malahat Sand & Gravel Company, $25,000; Pitt River Lumber Company, $50,000; Prince Rupert "Gold" Toredo-Proof Pile Company, $50,000; Western Engineering Company, $10,000; Westminster Elevator Company, $250,000; Wolverton & Company, $100,000.

# TENDERS CALLED FOR

## TENDERS

Sealed Tenders addressed to the undersigned, and endorsed, "Tender for Wharfs at Mouth of Mission River," will be received at this office until 4.30 p.m. on **Friday, June 4th, 1909,** for the construction of wharfs at the mouth of the Mission River, at Fort William, District of Thunder Bay, Ont. Plans, specification and form of contract may be seen at the offices of H. J. Lamb, Esq., Resident Engineer, London, Ont.; J. G. Sing, Esq., Resident Engineer, Confederation Life Building, Toronto; W. P. Merrick, Esq., Resident Engineer, Fort William, Ont.; A. R. Decary, Esq., Resident Engineer, Post Office, Quebec; J. L. Michaud, Esq., Resident Engineer, Merchants Bank Building, St. James Street, Montreal, and at the Department of Public Works, Ottawa.

Persons tendering are notified that tenders will not be considered unless made on the printed forms supplied and signed with their actual signatures, with their occupations, and places of residence. In the case of firms, the actual signature, the nature of the occupation and place of residence of each member of the firm must be given.

An accepted cheque on a chartered bank, payable to the order of the Honorable the Minister of Public Works, for thirty-five thousand dollars ($35,000.00) must accompany each tender. The cheque will be forfeited if the party tendering decline the contract or fail to complete the work contracted for, and will be returned in case of non-acceptance of tender.

The Department does not bind itself to accept the lowest or any tender.

By order.
NAPOLEON TESSIER,
Secretary.

Department of Public Works, Ottawa, May 5th, 1909.

Newspapers will not be paid for this advertisement if they insert it without authority from the Department.

## ROAD GRADING CONTRACTS

Sealed Tenders, addressed to the undersigned, will be received up till twelve o'clock noon on **Thursday, May 27th, 1909,** for grading the following sections of the Sudbury to Sault Ste. Marie Trunk Wagon Road, third section, from Station 40 to Station 153, a distance of 2.14 miles (between Sudbury and Copper Cliff). Sixth Section—From mile post 5 to mile post 12, a distance of 7 miles (Copper Cliff Station to Naughton). Plans and specifications and tender forms, prepared for the purpose by Demorest, Stull & Low, Engineers, Sudbury, are to be seen at their office, or at this Department. Cut and fill stakes are placed on the ground, and parties tendering are requested to examine the same. The work is to be completed by the 15th of August, 1909. Tenders must be made on forms provided for the purpose, and each tender must have the bona fide signatures of two persons as sureties for the due fulfilment of the contract. The lowest or any tender will not necessarily be accepted.

J. O. REAUME,
Minister of Public Works.

Department of Public Works, Toronto, May 10th, 1909.

## TENDERS FOR BRIDGES

Sealed Tenders, whole and separate, for substructures and superstructures for the several bridges proposed to be erected in the following places in the Province of Ontario, endorsed "Tenders for Bridges," addressed to the undersigned, will be received at this Department until noon on **Tuesday, June 1st, 1909.**

**Wabigoon River, at Dryden**—Steel superstructure on concrete abutments or **Reinforced Concrete Arch.**

**Vermillion River, at Whitefish**—Steel superstructure on concrete abutments.

**Burnt River, Township of Snowdon**—Steel superstructure on concrete abutments or **Reinforced Concrete Arch.**

**Spanish River, Township of Nairn**—Steel superstructure on concrete abutments.

**Murdoch River and Courchace Bay, Township of Bigwood**—Two timber bridges.

**Rossport, District of Thunder Bay**—Concrete culvert and earth filling.

Plans and specifications may be seen and forms of tender obtained at this Department, at the offices of Mr. A. L. Quarterman, Architect, Kenora; Mr. A. L. Russell, Civil Engineer, Port Arthur, and Messrs. Demorest, Stull & Lowe, Civil Engineers, Sudbury.

## TENDERS CALLED FOR

An accepted bank cheque payable to the order of the Hon. J. O. Reaume, Minister of Public Works, for five per cent. of the amount of the tender and the bona fide signatures and addresses of two sureties, or the bond of a Guarantee Company, approved of by this Department, must accompany each tender.

The Department will not be bound to accept the lowest or any tender.

By order.
H. F. McNAUGHTEN,
Secretary of Public Works.

Department of Public Works Ontario, Toronto, May 15th, 1909.

Newspapers publishing this advertisement without authority will not be paid for it.

## CONDUIT

The city of Toronto will shortly call for tenders for the laying of about 300,000 duct feet of underground conduit. For specifications, apply to the Electrical Department, City Hall.

## WATER WORKS PLANT

**Peterborough, Ontario, Canada.**

Sealed tenders will be received by the undersigned up to Monday, the fourteenth day of June next, at noon, for the manufacture and installation in place of one, and two pumping units of three millions imperial gallons each per twenty-four hours with turbine water wheels, etc., complete.

Specifications can be obtained at the office of W. Henderson, Superintendent, Water Commissioners, Peterborough, Ontario.

No tender necessarily accepted.

S. R. Armstrong,
Secretary, Water Commissioners,
Peterborough, Ontario, Canada.

6th May, 1909.

## CITY OF MOOSE JAW, SASKATCHEWAN

Tenders will be received by the City of Moose Jaw, addressed to the undersigned, on Monday, May 31st, at 8 o'clock p.m. for the sinking of a Test Well for Gas, Oil, or Water, the contractor to undertake to complete the Well before being entitled to any portion of his contract and to provide a schedule showing the allowance he will make on his full contract price if the city call him to stop work at less than the depth agreed upon; the Contractor to provide everything necessary except the well casing now in possession of the City, which he shall take over and allow for at a price to be named in his tender. Tenders are to be accompanied by a deposit of 5 per cent. on the contract price, said deposit to be returned to the Contractor as soon as the plant has been put in operation on the ground.

Alternative tenders are required for a well 2,500 feet and 3,000 feet respectively, the lowest or any tender not necessarily accepted.

JOHN D. SIMPSON, City Clerk.

Moose Jaw, April 27th, 1909.

## CITY OF MOOSE JAW, SASKATCHEWAN

**TENDERS FOR LAYNG SEWER AND WATER MAIN.**

Sealed tenders addressed to Alderman Matthews, Chairman Water and Sewer Committee, City Hall, Moose Jaw, will be received in the Council Chamber up to 8.30 p.m. Monday, May 31st, 1909, for Labor and certain Materials in connection with laying approximately 15,000 feet of 8-inch tile Sewer and 6-inch C.I. Water Main, Manhole, etc. The lowest or any tender not necessarily accepted.

Plans and specifications can be seen in the office of the undersigned.

J. DARLINGTON WHITMORE,
City Engineer, City Hall.



## MARKET CONDITIONS.

(Continued from Page 700).

The following are wholesale prices for Toronto, where not otherwise explained, although for broken quantities higher prices are quoted:—

**Antimony.**—No very active demand, and market weaker at sav $9.25.

**Axes.**—Standard makes, double bitted, $8 to $10; single bitted, per dozen, $7 to $9.

**Boiler Plates.**—¼-inch and heavier, $2.20. Boiler heads 25c. per 100 pounds advance on plate.

**Boiler Tubes.**—Orders continue active. Lap-welded, steel, 1¼-inch, 10c.; 1½-inch, 9c. per foot; 2-inch, $8.50; 2¼-inch, $10; 2½-inch, $10.60; 3-inch, $12.10; 3½-inch, $15; 4-inch, $18.50 to $19 per 100 feet.

**Building Paper.**—Plain, 30c. per roll; tarred, 40c. per roll. An increased demand is reported.

**Bricks.**—Business is very active, price at some yards $9 to $9.50, at others, $9.50 to $10, for common. Don Valley pressed brick move also freely. Red and buff pressed are worth, delivered, $18; at works, $17.

**Cement.**—The supply is far beyond the demand, and every maker seems to have his storage capacity occupied to the full. There is no reason, therefore, to look for any immediate change in the present quotation of $1.70 per barrel, including bags, or $1.30 without bags, car lots; for smaller quantities $1.40 to $1.50 per barrel in load lots delivered in town and bags

extra. In paper packages, price would be, including paper bags, $1.40 to $1.50. Very many small parcels have gone out the last two weeks.

**Coal Tar.**—In much greater request at former price, $3.50 per barrel.

**Copper Ingot.**—The firmness continues, and indeed prices are higher, at $13.75 to $14.05. The demand is good.

**Detonator Caps.**—75c. to $1 per 100; case lots, 75c. per 100; broken quantities, $1.

**Dynamite,** per pound, 21 to 25c., as to quantity.

**Roofing Felt.**—A very decided increase in business this month, prices not yet advanced; we quote $1.80 per 100 lbs.

**Fire Bricks.**—English and Scotch, $30 to $35; American, $27.50 to $35 per 1,000. The demand is good, and, as is usual in spring, stocks are low.

**Fuses.**—Electric Blasting.—Double strength, per 200, 4 feet, $4.50; 6 feet, $5; 8 feet, $5.50; 10 feet, $6. Single strength, 4 feet, $3.50; 6 feet, $4; 8 feet, $4.50; 10 feet, $5. Bennett's double tape fuse, $6 per 1,000 feet.

**Galvanized Sheets.**—Apollo Brand.—Sheets 6 or 8 feet long, 30 or 36 inches wide; 10-gauge, $3.05; 12-14-gauge, $3.15; 16, 18, 20, $3.35; 22-24, $3.50; 26, $3.75; 28, $4.20; 29, $4.50; 10¾, $4.50 per 100 lbs. Fleur de Lis—28-gauge, $4.30; 26-gauge, $4.05; 22-24-gauge, $3.50. Queen's Head—28-gauge, $4.50; 26-gauge, $4.25. Sheets continue in active request.

**Iron Chain.**—¼-inch, $5.75; 5-16-inch, $5.15; ⅜-inch, $4.15; 7-16-inch, $3.95; ½-inch, $3.75; 9-16-inch, $3.70; ⅝-inch, $3.55; ¾-inch, $3.45; ⅞-inch, $3.40; 1-inch, $3.40.

**Bar Iron.**—$1.95 to $2, base, from stock to wholesale dealer. Market well supplied.

**Iron Pipe.**—Black, ¼-inch, $2.03; ⅜-inch, $2.26; ½-inch, $2.63; ¾-inch, $3.16; 1-inch, $4.54; 1¼-inch, $6.19; 1½-inch, $7.43; 2-inch, $9.90; 2½-inch, $15.81; 3-inch, $20.76; 3½-inch, $26.13; 4-inch, $29.70; 4½-inch, $38; 5-inch, $43.50; 6-inch, $56. Galvanized, ¼-inch, $2.86; ⅜-inch, $3.08; ½-inch, $3.48; ¾-inch, $4.31; 1-inch, $6.19; 1¼-inch, $8.44; 1½-inch, $10.13; 2-inch, $13.50. Prices firmly maintained.

**Lead.**—Prices steady outside. This market holds firm at $3.80 to $3.90, with an active movement.

**Lime.**—Retail price in city 35c. per 100 lbs. f.o.b., car; in large lots at kilns outside city 22c. per 100 lbs. f.o.b., car. More is moving, in medium to small lots.

**Lumber.**—A fairly steady demand for domestic pine. Southern pine and hemlock, as well as for shingles and lath, with prices in the main unchanged. For hemlock there is a fair demand, with a scarcity of the longer lengths. It is noticeable that 32-inch lath are rising in price, as we foreshadowed a week or two ago, sales of several cars have been made lately at $1.50. Prices are rather stiff, all along the line. Dressing pine quotes $32 to $35 per M; common stock boards, $26 to $30; cull stocks, $20; cull sidings, $17.50; Southern pine dimension timber from $30 to $45, according to size and grade; finished Southern pine according to thickness and width, $30 to $40. Hemlock in car lots, $16.50 to $17; spruce flooring in car lots, $22; shingles, British Columbia, $3.20; lath, No. 1, $4.25; No. 2, $3.75; for white pine, 48-inch; for 32-inch, $1.50.

**Nails.**—Wire, $2.25 base; cut, $2.70; spikes, $3. Moving freely.

**Pitch.**—The demand continues slow, perhaps because buildings are not far enough advanced yet. Price so far unchanged at 70c. per 100 lbs.

**Pig Iron.**—There is more activity and prices are maintained. Clarence quotes at $20.50 for No. 3; Cleveland, $20.50 to $21; in Canadian pig, Hamilton quotes $19.50 to $20.

**Plaster of Paris.**—Calcined, wholesale, $2; retail, $2.15. Trade normal.

**Putty.**—In bladders, strictly pure, per 100 lbs., $2.25; in barrel lots, $2.05.

**Ready Roofing.**—In very active request at prices per catalogue. It is impracticable to quote figures, so great is the variety of this kind of goods, but prices are firmly held.

**Roofing Slate.**—Most of the slate used in Canada comes now from Pennsylvania or Maine, the Canadian supply being slender and mostly from the Rockland quarries of the Eastern Townships in Quebec. There is a great variety of sizes and qualities, so that it is difficult to indicate prices. But No. 1 Pennsylvania slate 10 x 16 may be quoted at $7.25 per square of 100 square feet, f.o.b., cars, Toronto.

**Rope**—Sisal, 9½c. per lb.; pure Manila, 12½c., Base.

**Sewer Pipe.—**

| | 4-in. | 6-in. | 9-in. | 10-in. | 12-in. | 24-in. |
|---|---|---|---|---|---|---|
| Straight pipe per foot ..... | $0.20 | $0.30 | $0.65 | $0.75 | $1.00 | $3.25 |
| Single junction, 1 or 2 ft. long | .90 | 1.35 | 2.70 | 3.40 | 4.50 | 14.65 |
| Double junctions ..... | 1.50 | 2.50 | 5.00 | .... | 8.50 | ..... |
| Increasers and reducers .... | .... | 1.50 | 2.50 | .... | 4.00 | ..... |
| P. traps ..... | 2.00 | 3.50 | 7.50 | .... | 15.00 | ..... |
| H. H. traps ..... | 2.50 | 4.00 | 8.00 | .... | 15.00 | ..... |

Not much moving; price, 73 per cent. off list at factory for car-load lots; 65 per cent. off list retail. Small lots subject to advance.

**Steel Beams and Channels.**—Quiet. We quote:—$2.50 to $2.75, according to size and quantity; if cut, $2.75 to $3; angles, 1¼ by 3-16 and larger, $2.50; tees, $2.80 to $3 per 100 pounds. Extra for smaller sizes of angles and tees.

**Steel Rails.**—80-lb., $35 to $38 per ton. The following are prices per gross ton, for 500 tons or over: Montreal, 12-lb. $45, 16-lb. $44, 25 and 30-lb. $43.

**Sheet Steel.**—Market steady, at the former prices; 10-gauge, $2.50; 12-gauge, $2.55; American Bessemer, 14-gauge, $2.35; 17, 18, and 20-gauge, $2.45; 22 and 24-gauge, $2.50; 26-gauge, $2.65; 28-gauge, $2.85. Quite a quantity of light sheets moving.

**Tank Plate.**—3-16. $2.40 100 lbs.

**Tool Steel.**—Jowett's special pink label, 10½c. Cammel-Laird, 16c. "H.R.D." high speed tool steel, 65c.

**Tin.**—Market firm and demand good. The price continues at 31c. to 31½c.

**Wheelbarrows.**—Navvy, steel wheel, Jewel pattern, knocked down, $21.60 per dozen; set up, $22.60. Pan Canadian, navvy, steel tray, steel wheel, per dozen, $3.30 each; Pan American, steel tray, steel wheel, $4.25 each.

**Zinc Spelter.**—A very active movement is to be noted, and the market is higher at $5.50 to $5.75.

* * * *

Winnipeg, 18th May, 1909.

With the advent of favorable weather, operations in the building and contracting lines are now proceeding continuously. Rapid progress on the works under construction is being made. City permits in increasing numbers are being granted, and this also applies to the entire West, so that a record month of May in this direction is confidently expected. Everything, indeed, points to an exceptionally busy building season.

The contract for the erection of the giant McArthur building at the corner of Portage Avenue, has been let to the Carter Halls Aldinger Company. The Dominion Bridge Company have obtained the contract for the manufacture of the structural steel, and for the supplying of material in connection with the building, which will be the highest in the city. The total sum involved is about $250,000. The Dominion Bridge Company have also secured the contract for the structural steel to be used on the new Alberta Block at Edmonton.

Work on the great Fort Garry depot is being concentrated on the walls, which have now reached the third course of stone. Good progress is also being made on the Horse Show building. Six of the sixteen huge spans are now in place, while six more will be erected in a few days. Each span is 130 feet in width, and weighs ten tons.

There is practically no change to report in prices of material. Lumber dealers report a satisfactory business, with no increase in prices so far.

Winnipeg quotations are as follows:—

**Anvils.**—Per pound, 10 to 12½c.; Buckworth anvils, 80 lbs., and up, 10¾c.; anvil and vice combined, each, $5.50.

**Bar Iron.**—$2.50 to $2.60.

**Beams and Channels.**—$3 to $3.10 per 100 up to 15-inch.

**Building Paper.**—4½ to 7c. per pound. No. 1 tarred, 84c. per roll; plain, 60c.; No. 2 tarred, 62½c.; plain, 56c.

**Bricks.**—$11, $12, $13, per M, three grades.

**Cement.**—$2.25 to $2.50 per barrel, in cotton bags.

**Chain.**—Coil, proof, ¼-inch, $7; 5-16-inch, $5.50; ⅜-inch, $4.90; 7-16-inch, $4.75; ½-inch, $4.40; ⅝-inch, $4.20; ¾-inch, $4.05; logging chain, 5-16-inch, $6.50; ⅜-inch, $6; ½-inch, $8.50; jack iron, single, per dozen yards 15c. to 75c.; double, 25c. to $1; trace-chains, per dozen, $5.25 to $6.

**Dynamite.**—$11 to $13 per case.

**Hair.**—Plaster's, 80 to 90 cents per bale.

**Hinges.**—Heavy T and strap, per 100 lbs., $6 to $7.50; light, do., 65 per cent.; screw hook and hinge, 6 to 10 inches, 5¼c. per lb.; 12 inches up, per lb., 4¼c.

**Iron.**—Swedish iron, 100 lbs., $4.75 base; sheet, black, 14 to 22 gauge, $3.75; 24-gauge, $3.90; 26-gauge, $4; 28-gauge, $4.10. Galvanized—American, 18 to 20-gauge, $4.40; 22 to 24-gauge, $4.65; 26-gauge, $4.65; 28-gauge, $4.90; 30-gauge, $5.15 per 100 lbs. Queen's Head, 22 to 24-gauge, $4.65; 26-gauge English, or 30-gauge American, $4.90; 30-gauge American, $5.15; Fleur de Lis, 22 to 24-gauge, $4.50; 28-gauge American, $4.75; 30-gauge American, $5.

**Lead Wool.**—$10.50 per hundred, $200 per ton, f.o.b., Toronto.

**Pipe.**—Iron, black, per 100 feet, ¼-inch, $2.50; ⅜-inch, $2.80; ½-inch, $3.40; ¾-inch, $4.60; 1-inch, $6.60; 1¼-inch, $9; 1½-inch, $10.75; 2-inch, $14.40; galvanized, ½-inch, $4.25; ¾-inch, $5.75; 1-inch, $8.35; 1¼-inch, $11.35; 1½-inch, $13.60; 2-inch, $18.10. Lead, 6½c. per lb.

**Picks.**—Clay, $5 dozen; pick mattocks, $6 per dozen; clevishes, 7c. per lb.

**Pitch.**—Pine, $6.50 per barrel; in less than barrel lots, 4c. per lb.; roofing pitch, $1 per cwt.

**Plaster.**—Per barrel, $3.

**Roofing Paper.**—60 to 67½c. per roll.

**Lumber.**—No. 1 pine, spruce, tamarac, British Columbia fir and cedar—

**Nails.**—$4 to $4.25 per 100. Wire base, $2.85; cut base, $2.90.

**Tool Steel.**—8½ to 15c. per pound.

**Timber.**—Rough, 8 x 2 to 14 x 16 up to 32 feet, $34; 6 x 20, 8 x 20, up to 32 feet, $38; dressed, $37.50 to $48.25.

**Boards.**—Common pine, 8-inch to 12-inch wide, $38 to $45; siding, No. 2 white pine, 6-inch, $55; cull red or white pine or spruce, 6-inch, $24.50; No. 1 clear cedar, 6-inch, 8 to 16 ft., $60; Nos. 1 and 2 British Columbia spruce, 6-inch, $55; No. 3, $45.

## SOCIETY NOTES.

**Sons of Jove.**—On Friday at noon last week a jovial luncheon was held in the Green Room at McConkey's, Toronto. The following members of the family heartily enjoyed what was provided for them. A spirit of good fellowship permeated around the board: T. J. E. Papineau, purchasing agent, Toronto Electric Light Company; D. Irving, with A. H. W. Joyner, manufacturer's agent; Alfred Landau, Electrical Specialties, Limited; L. W. Morden, Canadian Westinghouse Company; D. O. McKinnon, "The Canadian Manufacturer;" Jos. Rogers, Rogers Electric Company; H. L. Shepherd, Allis-Chalmers-Bullock Company; M. S. Pearce, Northern Electric & Manufacturing Company; Thos. C. Walsh, Jr., Faries Manufacturing Company, Decater, Ill.; J. F. Alexander, Babcock, Wilcox Company; A. C. Towne, Robertson Cataract Company; A. W. Lovell, Canadian Westinghouse Company.

The following visitors were present:

A. N. Kirschmann, "The Canadian Engineer;" W. H. Eisenbeis, Canadian Westinghouse Company.

It is stated in the Constitution of the Sons of Jove that the purpose of the organization is to gather together in a fraternal bond or union all persons engaged in any of the branches of the science of electricity, or with any of its allied industries which may be considered so closely interwoven with the business of electricity as to make them practically a part thereof.

The object of the Order "is the cultivation of the spirit of fraternity and good fellowship, from which may be evolved practical plans of commercial co-operation for the promotion and popularization of electricity in the world's work." The slogan: "All together, all the time, for everything electrical."

A rejuvenation of the Sons of Jove will be held at Quebec during the convention of the Canadian Electrical Association, June 16th, 17th and 18th, and the Montreal members trust to hold a rejuvenation in Montreal before that date.

In testing for ferric iron, though no oxidation has taken place, a slight pink coloration may be produced which does not disappear after continued boiling with c.p. zinc. The coloration is probably due to slight impurity in the chemicals used.

# WHERE TO BUY

## An Engineering Trades Directory.

FOR INDEX TO ADVERTISERS SEE PAGE 3.

**Air Compressors**
Mussens Limited, Montreal, Que.
Reavell & Co., Ltd., J. F. B. Vandeleur, agent, Toronto, Ont.

**Anvils**
Leslie & Co., A. C., Montreal, Que.

**Arc Lamps**
Northern Electric & Mfg. Co., Limited Montreal, Que.

**Automatic Railways**
Babcock & Wilcox, Ltd., Montreal.

**Bars, Steel**
Priddle, Arthur, San Francisco, Cal.

**Belting**
McLaren, D. K., Ltd., Montreal, Que.
McLaren Belting Co., J. C., Montreal.

**Boilers, Marine, Stationary and Water Tube**
Babcock and Wilcox, Ltd., Montreal.
Petrie, H. W., Ltd., Toronto, Montreal, Vancouver.

**Bonding for Concrete**
Canada Wire Goods Mfg. Company, Hamilton, Ont.
Priddle, Arthur, San Francisco, Cal.

**Books, Technical**
John A. Hart & Co.

**Boring Tools**
Armstrong Bros. Tool Co., Chicago, Ill., U.S.A.
Mussens Limited, Montreal, Que.

**Bridges, Roof Trusses, etc.**
Canadian Bridge Company, Ltd., Walkerville, Ont.
Cleveland Bridge & Engineering Co., Ltd., Darlington, Eng.
Dominion Bridge Co., Ltd., Montreal.
Hamilton Bridge Works Co., Ltd., Hamilton.
Manitoba Bridge & Iron Work, Ltd., Winnipeg, Man.
Pennsylvania Steel Co., Steelton, Pa.
Stewart, James A., Hamilton, Ont.
Structural Steel Co., Ltd., Montreal, Que.

**Buckets (Clam Shell, Coal and Concrete)**
Mussens Limited, Montreal, Que.

**Cableways**
Mussens Limited, Montreal, Que.

**Car Hauls (Wire Cable and Chain)**
Jeffrey Mfg. Co., Montreal, Que.

**Cement, Machinery**
Mussens Limited, Montreal, Que.

**Coal Cutters**
Jeffrey Mfg. Co., Montreal, Que.

**Coal Crushers**
Babcock & Wilcox, Ltd., Montreal.

**Coal Handling Machinery**
Northern Engineering Works, Detroit, Mich.

**Coal Tipples and Screens**
Jeffrey Mfg. Co., Montreal, Que.

**Concrete Mixers**
Dominion Equipment & Supply Co., Winnipeg, Man.
Mussens Limited, Montreal, Que.
Rogers Supply Company, Toronto.

**Contractors**
Cleveland Bridge and Engineering Co., Ltd., Darlington, Eng.

**Contractors' Supplies.**
Dominion Equipment & Supply Co., Winnipeg, Man.

**Converters, Rotary**
Toronto & Hamilton Electric Company, Hamilton, Ont.

**Conveyors**
Babcock & Wilcox, Ltd., Montreal.
Jeffrey Mfg. Co., Montreal, Que.

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# WHERE TO BUY.

(Continued from Page 48).

**Cranes**
Advance Machine Works, Ltd., Walkerville, Ont.
Dominion Bridge Co., Ltd., Montreal.
Mussens Limitied, Montreal, Que.
Northern Engineering Works, Detroit, Mich.
Pennsylvania Steel Co., Steelton, Pa.
Structural Steel Co., Ltd., Montreal, Que.

**Crossings, Railway**
Ramapo Iron Works, Ltd., Niagara Falls, Ont.

**Damper, Regulators**
Babcock & Wilcox, Ltd., Montreal.
D'Este Co., Julian, Boston, Mass.

**Derricks**
Dominion Bridge Co., Ltd., Montreal.
Manitoba Bridge & Iron Work, Ltd., Winnipeg, Man.
Mussens Limited, Montreal, Que.
Northern Engineering Works, Detroit, Mich.
Structural Steel Co., Ltd., Montreal, Que.
Keuffel & Esser Co., Hoboken, N.J.

**Draughting Supplies**
Berger & Sons, C. L., Boston, Mass.
Hart Co., John A., Winnipeg, Man.
Keuffel & Esser Co., Hoboken, N.J.

**Drawing Material**
Keuffel & Esser Co., Hoboken, N.J.

**Drills**
Canadian Buffalo Forge Co., Montreal and Toronto.
Mussens Limited, Montreal, Que.

**Dust Separators**
Canadian Buffalo Forge Co., Montreal and Toronto.

**Drying Apparatus**
Canadian Buffalo Forge Co., Montreal and Toronto.

**Dynamos**
Laurence Scott & Co., Ltd. (J. F. B. Vandeleur, agents, Toronto, Ont.)
Northern Electric & Mfg. Co., Limited, Montreal, Que.
Toronto & Hamilton Electric Co., Hamilton, Ont.

**Economizers**
Babcock & Wilcox, Ltd., Montreal.

**Electric Apparatus**
Hill Electric Mfg. Co., Montreal, Que.
Northern Electric & Mfg. Co., Limited, Montreal, Que.
Toronto & Hamilton Electric Co., Hamilton, Ont.

**Electrical Supplies**
Hill Electric Mfg. Co., Montreal, Que.
Phillips, Eugene F., Electrical Works, Ltd., Montreal, Canada.

**Elevators**
Jeffrey Mfg. Co., Montreal, Que.
Northern Engineering Works, Detroit, Mich.

**Engineers, Consulting**
Barber, F.
Beaubien, Gaspe de, Montreal.
Cleveland & Dutcher, ancouver, B.C.
Francis, W. J., Montreal, Que.
Fuce, Ed. O., Galt.
Gagne & Jennings, Toronto, Ont.
Haffner, H. J., Calgary, Alta.
Mitchell, C. H., C.E., Toronto, Ont.
Nold, Henry N., Hamilton.
Rebbeck, J. R., Victoria, B.C.
Richmond, J. Stanley, Toronto.
Standard Inspection Bureau, Limited, Toronto, Ont.

**Engineering Instruments**
Keuffel & Esser Co., Hoboken, N.J.

**Engines**
Canadian Buffalo Forge Co., Montreal and Toronto.
Mussens Limited, Montreal, Que.
Northern Engineering Works, Detroit, Mich.
Reavell & Co., Ltd. (J. F. B. Vandeleur, agent, Toronto, Ont.)
Petrie, H. W., Ltd., Toronto, Montreal, Vancouver.

**Fans and Blowing Apparatus**
Canadian Buffalo Forge Co., Montreal and Toronto.

**Feed Water Heaters and Purifiers**
Babcock & Wilcox, Ltd., Montreal.

**Fence, Fencing, Wire**
Owen Sound Wire Fence Co.

**Fire Brick and Clay**
Leslie & Co., A. C., Montreal.

**Forgings, Drop**
Coghlin & Co., B. J., Montreal, Que.

**Foundry Supplies**
Mussens Limited, Montreal, Que.

**Frogs, Railway**
Ramapo Iron Works, Ltd., Niagara Falls, Ont.

**Generators, Alternating and Direct Current**
Northern Electric & Mfg. Co., Limited, Montreal, Que.
Toronto & Hamilton Electric Company, Hamilton, Ont.

**Heating and Ventilating Machinery**
Canadian Buffalo Forge Co., Montreal and Toronto.

**Hoists, Electric and Pneumatic**
Northern Engineering Works, Detroit, Mich.

**Hydraulic Machinery**
Canadian Buffalo Forge Co., Montreal and Toronto.

**Iron Bar, etc.**
Leslie & Co., A. C., Montreal.

**Inspections**
Standard Inspection Bureau, Limited, Toronto, Ont.
Dominion Bureau, Montreal, Que.

**Ladles**
Northern Engineering Works, Detroit, Mich.

**Locomotives (Electric)**
Jeffrey Mfg. Co., Montreal, Que.

**Mechanical Draft Motors**

**Measuring Tapes**
Keuffel & Esser Co., Hoboken, N.J.
Canadian Buffalo Forge Co., Montreal and Toronto.

**Motors**
Fleming Electrical Engineering Co., Ltd., Toronto, Ont.
Laurence Scott & Co., Ltd. (J. F. B. Vandeleur, agent, Toronto, Ont.)
Mussens Limited, Montreal, Que.
Northern Electric & Mfg. Co., Limited, Montreal, Que.
Toronto & Hamilton Electric Company, Hamilton, Ont.

**Patent Attorneys**
Budden, Hanbury A., Montreal, Que.
Ridout & Maybee, Toronto, Ont.

**Planer Tools**
Armstrong Bros. Tool Co., Chicago, Ill., U.S.A.
Mussens Limited, Montreal, Que.

**Poles, Telegraph and Telephone**
Lindsley Bros. Co., Spokane, Wash.

**Portland Cement**
Hartranft Cement Co., Wm., Montreal, Que.

**Posts**
Lindsley Bros. & Co., Spokane, Wash.

**Presses, Hydraulic and Power**
Mussens Limited, Montreal, Que.
Wood & Co., R. D., Philadelphia, Pa.

**Pressure Regulators**
D'Este Co., Julian, Boston, Mass.

**Prison Work**
Canada Wire Goods Mfg. Company, Hamilton, Ont.

**Pulleys**
Mussens Limited, Montreal, Que.

**Pumps—Steam and Power**
Canadian Buffalo Forge Co., Montreal and Toronto.
Mussens Limited, Montreal, Que.
Petrie, H. W., Ltd., Toronto, Montreal, Vancouver.
Reavell & Co., Ltd. (J. F. B. Vandeleur, agent, Toronto, Ont.)
Wood & Co., R.D., Philadelphia, Pa.

**Purifiers**
Babcock & Wilcox, Ltd., Montreal.
Wood & Co., R. D., Philadelphia, Pa.

**Rail Joints.**
Rail Joint Co., of Can., Ltd., Montreal.

**Railway Supplies**
Coghlin & Co., B. J., Montreal, Que.
Mussens Limited, Montreal, Que.
Koppel Co., Arthur, New York City.

**Railways, Industrial and Portable**
Koppel Co., Arthur, New York City.

**Ratchet Drills, Universal**
Armstrong Bros. Tool Co., Chicago, Ill, U.S.A.
Mussens Limited, Montreal, Que.

**Reinforcing Materials**
Canada Wire Goods Mfg. Company, Hamilton, Ont.
Priddle, Arthur, San Francisco, Cal.

**Rock Crushers**
Mussens Limited, Montreal, Que.

**Rope, Manilla and Wire**
Mussens Limited, Montreal, Que.

**Screens**
Canada Wire Goods Mfg. Company, Hamilton, Ont.

**Separators, Steam**
Babcock & Wilcox, Ltd., Montreal.

**Sewage Disposal**
Cameron Septic Tank Co., Chicago, Ill., U.S.A.

**Sewer Pipe**
Hamilton & Toronto Sewer Pipe Co.

**Sheet Metal Work**
Canadian Buffalo Forge Co., Montreal and Toronto.

**Shovels, Steam**
Dominion Equipment & Supply Co., Winnipeg, Man.
Mussens Limited, Montreal, Que.

**Springs**
Coghlin & Co., B. J., Montreal, Que.
Montreal Steel Works, Montreal, Que.

**Steel, Speedicut High-speed**
Montreal Steel Works, Montreal, Que.

**Steel, Structural**
Cleveland Bridge & Engineering Co., Ltd., Darlington, Eng.
Dominon Bridge Co., Ltd., Montreal.
Hamilton Bridge Works Co., Hamilton, Ont.
Pennsylvania Steel Co., Steelton, Pa.
Structural Steel Co., Ltd., Montreal.
Montreal Steel Works, Montreal, Que.
Mussens Limited, Montreal, Que.
Allen & Co., Edgar, Sheffield, Eng.

**Stokers, Mechanical**
Babcock & Wilcox, Ltd., Montreal.

**Stone Crushers and Screens**
Mussens Limited, Montreal, Que.

**Surveying Instruments**
Berger & Son, C. L., Boston, Mass.
Hart Co., John A., Winnipeg, Man.
Keuffel & Esser Co., Hoboken, N.J.

**Switches, Railway**
Ramapo Iron Works, Ltd., Niagara Falls. Ont.

**Tanks, Steel and Iron**
Structural Steel Co., Ltd., Montreal.
Wood & Co., R. D., Philadelphia, Pa.

**Ties, Railroad**
Lindsley Bros. Co., Spokane, Wash.

**Tool Grinders**
Armstrong Bros. Tool Co., Chicago, Ill., U.S.A.

**Track Jacks**
Montreal Steel Works, Montreal, Que.
Mussens Limited, Montreal, Que.

**Transformers**
Toronto & Hamilton Electric Company, Hamilton, Ont.

**Transmission Machinery**
Mussens Limited, Montreal, Que.
Toronto & Hamilton Electric Company, Hamilton, Ont.

**Trenching Machines**
Harris, J.W., Mfg. Co., Ltd., Montreal.

**Trucks**
Northern Engineering Works, Detroit, Mich.

**Valves**
Babcock & Wilcox, Ltd., Montreal.
Wood & Co., R. D., Philadelphia, Pa.

**Waterworks Supplies**
Wood & Co., R. D., Philadelphia, Pa.

**Wire**
Coghlin & Co., B. J., Montreal, Que.

**Wire Rope**
Coghlin & Co., B. J., Montreal, Que.
Mussens Limited, Montreal, Que.

**Wirework**
Canada Wire Goods Mfg. Company, Hamilton, Ont.