THIS ISSUE CONTAINS { Toronto's Engineering Problems and their Solution

Canadian Engineer

A WEEKLY JOURNAL
For CIVIL, MECHANICAL, ELECTRICAL and STRUCTURAL ENGINEERS and CONTRACTORS

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Vol. 16. Toronto, Canada, January 29th, 1909. No. 5.

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For the Assistance of Engineers, Contractors and Purchasing Agents

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PERSONAL.

MR. JOHN HADDIN has removed from Maple Creek, Sask., to Vernon, B.C.

MR. M. M. CAMPBELL, C.E., has removed from St. Claire to Poste Restante, Ont.

MR. WM. CHRISTIE, B.A.Sc., D.L.S., has for his present address Prince Albert, Sask.

MR. S. F. SMITH has been appointed C.P.R. resident engineer, with headquarters at Saskatoon, Sask.

MR. JOHN BELL has been appointed electrician and waterworks engineer for the City of Indian Head, Sask.

MR. T. HATTIE, G.T.R., master mechanic at Montreal, has been appointed

(Continued on Page 48.)

The Canadian Engineer

WEEKLY

ESTABLISHED 1893

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The Canadian Engineer

ESTABLISHED 1893.

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

Editor—E. A. James, B.A. Sc.
Business Manager—James J. Salmond

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TORONTO, CANADA, JANUARY 29, 1909.

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We will give a month's extension of subscription for a copy of the Canadian Engineer of Nov. 20th, 1908. If you do not file yours, we should be glad to have it.

UP-TO-DATE SEWAGE DISPOSAL.

In this issue will be found extracts from the engineer's report, advising a sewage disposal plant for New Toronto.

New Toronto, in the township of Etobicoke, has for some time been suffering from the want of a sewerage scheme, and some systematic method of dealing with the important trade effluents in the district. From time to time, rumors of more or less vague proposals have been published of intentions to deal with the matter. At last, however, the council, at a meeting held on the 23rd inst., unanimously agreed upon the scheme which we give in brief.

Interest in the scheme will consist in the fact that it is the first in Canada which may be strictly said to be in line with the recommendations and findings of the recent British "Royal Commission on Sewage Disposal," which was reviewed at some length in these columns at the end of last year.

The introduction of percolating continuous filters, although not by any means new in Great Britain and in Europe, is new to Canada. At Hamilton the city are instituting a form of continuous filter, with spray spreaders, which require a comparatively high head for working purposes. The introduction of the arm distributor, however, which is certainly acknowledged as the most efficient method of even distribution, and will work satisfactorily with only 6-inch hydraulic head, has been looked upon with a certain amount of suspicion in this country. It has been feared that our severe winters will put the apparatus out of gear.

Such distributors, however, have been in practical use at Berlin, Europe, for some time, and at a temperature of 7 degrees below zero have worked with satisfaction.

We note that the engineers in the case of New Toronto have designed a simple method by which the distributors can be put out of work during severe frost and another method of distribution applied below the surface of the filtering media.

We hardly think that with Toronto winters this alternative will be found necessary; certainly it will be necessary in the West. It is, however, good to know that the percolating filter can be worked by a winter alternative arrangement, as the cubic capacity of filtering media is just fifty per cent. less with percolating filters than with the older type of contact filtering beds.

The completion of the proposed works at East Toronto will be a subject of interest not only to engineers, but also to communities looking for an economical and efficient method of sewage purification.

THE CITY ENGINEER'S DEPARTMENT, TORONTO.

Toronto is no mean city. With a population of over three hundred thousand and covering an area of nearly twenty square miles, the demand on the City Engineer's Department is always heavy. Annually this department spends some two millions of money and touches so many phases of municipal operations that one is safe in naming it as the most important department of civic administration.

Since 1898, Mr. C. H. Rust, M. Can. Soc. C.E., has been head of this department, and he, together with his deputy and assistant engineers, has had the solving of some of the most difficult engineering problems that municipal engineers are called upon to solve. Their solution of a few of the simpler questions is described in this issue.

During 1908 this department laid some fifty-five miles of concrete sidewalk at an average cost of twelve cents per square foot; one-third of a mile of brick sidewalk, costing eighteen cents per square foot, and four-fifths of a mile of plank walk, costing nine cents per square foot.

The roadways department laid some forty miles of pavement during 1908. Over twenty miles of this was asphalt, costing $1.50 per square yard. The next longest stretch was bitulithic, about five and a half miles, which cost $2.25 per square yard. Of asphalt block half a mile was laid at a cost of $3.75 per square yard.

In the waterworks department the most important work of the past year was the completion of the high-pressure fire system, and the new water tunnel under Toronto Bay.

Every citizen in Toronto poses at times as an engineer, and it is to the credit of the men in the City Engineer's Department that they have carried on the work of so large a department with so little friction.

STAR MAP FOR FEBRUARY.

In this issue will be found a star map for February, together with astronomical tables. The object of this map and these tables is to give the surveyor and engineer all the data necessary to enable him to determine his latitude or time, to estabilsh a meridian line without the use of an ephemeris, and without logarithmic calculations. Explicit rules are given by which the quantities of the tables may be adapted to any time or place during the month of February. In the last issue of February there will appear a star map for March, and we hope that each succeeding month we will be able to give similar maps.

The tables and maps will be prepared by Mr. L. B. Stewart, D.T.S., Professor of Surveying and Geodesy in the Faculty of Applied Science and Engineering, Toronto University. Those who know Professor Stewart recognize that anything he undertakes will be accurate, practical and complete, and we expect this new department will be come very popular with field men desirous of securing a simple but accurate method for the determination of time or for establishing a meridian.

EDITORIAL NOTE

A severe sleet storm is nowadays a trying ordeal for more services than the telephone and telegraph companies. Montreal, on Saturday and Sunday last, afforded an example of the kind of fight man sometimes has with nature. Alternate rain and frost, succeeded by wind, wrecked many of the Water and Power Company's wires, stopping the pumps, and, therefore, the supply of city water; wrecked street railway wires, tying up the traffic much of Sunday; crippled the fire alarm system, which with the lack of water pressure in case of fire was the most serious feature of the storm; deprived most of the citizens of the use of their baths and telephones, and large portions of the city of light; and finally, by the wrecking of the telegraph wires outside the city, cut off for many hours all communication with the outside world. These are some of the hardships wrought by ice 1¼-inch thick gathering on transmission wires.

COMING MEETINGS OF ENGINEERING SOCIETIES.

Association of Ontario Land Surveyors.—February 23, 24, 25, 1909, Annual Meeting, Parliament Buildings, Toronto Killaly Gamble, secretary-treasurer, 703 Temple Building, Toronto.

Canadian Forestry Association.—Annual Meeting, February 11-12, 1909, Convocation Hall, University of Toronto. Secretary, A. H. D. Ross, Faculty of Education, University of Toronto, Toronto.

Canadian Cement and Concrete Association.—First Annual Convention and Exhibition, March 1-6, 1909, St. Lawrence Arena, Toronto. Secretary, A. E. Uren, 62 Church Street, Toronto. Manager of Exhibition, R. M. Jaffray, 1 Wellington Street West, Toronto.

Canadian Mining Institute.—March 3-5, 1909, annual general meeting, Windsor Hotel, Montreal. H. Mortimer-Lamb, secretary, Montreal.

Cement Products Exhibition Company.—February 18-24, 1909, second annual cement show, Coliseum, Chicago, Ill.

National Brick Manufacturers' Association.—February 1-6, 1909, 23rd Annual Convention, Rochester, N.Y. Secretary, Theo. A. Randall, Indianapolis, Ind.

Northwestern Cement Products Association.—March 2-4, 1909, fifth annual convention, Minneapolis National Guard Armoury, Minneapolis, Minn.

Providence Association of Mechanical Engineers.—June 22, 1909, Annual Meeting. Secretary, T. M. Phetteplace.

Ontario Provincial Good Roads Association.—March 3, 4, 1909, Annual Meeting, County of York Municipal Hall, Adelaide Street, Toronto. J. E. Farewell, Secretary, Whitby, Ont.

A CORRECTION.

Sir,—In regard to "Grounded Transmission Mediums," Article VII., your readers may number the preliminary illustrations as follows:—

Fig. 32 ....As it is.
Fig. 33 .... "
Fig. 34 .... "
Fig. 35 .... "
Fig. 36 .... "
Fig. 37 ....As Fig. 42.
Fig. 38 .... " 40

While the remaining illustrations may be consecutively numbered 39, 43, 37, 41, 44 and 38.

Yours, etc.,
J. Stanley Richmond.

Toronto, January 22nd, 1909.

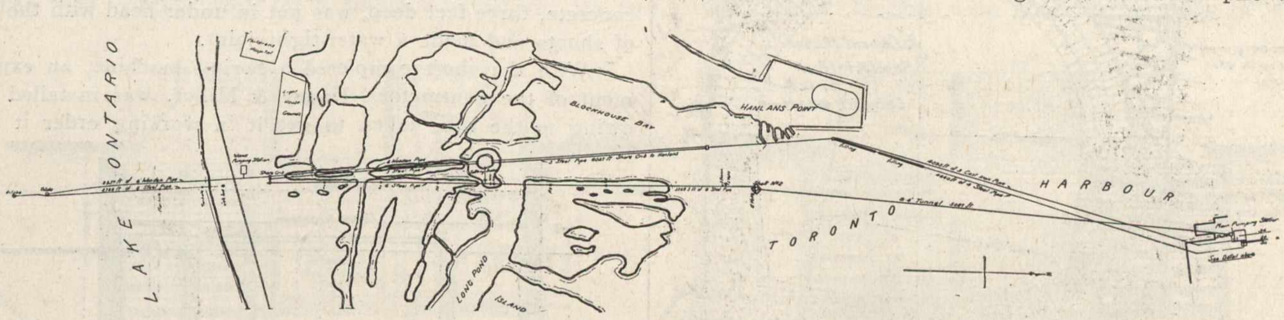
RAILWAY EARNINGS AND STOCK QUOTATIONS

NAME OF COMPANY	Mileage Operated	Capital in Thousands	Par Value	EARNINGS Week ending Jan. 21st		STOCK QUOTATIONS — TORONTO							MONTREAL						
				1909	1908	Price Jan 23, '08		Price Jan 14 '09		Price Jan. 21 '09		Sales Week End d Jan 21	Price Jan 23 '08		Price Jan. 14 09		Price Jan. 21 '09		Sales Week End'd Jan 21
Canadian Pacific Railway	8,920.6	$150,000	$100	1,039 000	1,055,000	....			175		175	241	148	150	175¾	175½	177	176	225
Canadian Northern Railway....	2,986.9	....	....	115,900	135,700	....		....		....		......	....		....		....		......
Grand Trunk Railway	3,568.7	226,000	100	624,750	619,121	....		....		....		......	....		....		....		......
T. & N. O	305	(Gov. Road)	....	17,855	11,404	....		....		....		......	....		....		....		......
Montreal Street Railway	138 30	18,000	100	65,227	63,430	....		....		....		......	179	180	207½	207⅜	208	207	420
Toronto Street Railway........	114	8,000	100	65.920	60 511		95½		111	113	113¾	592	94½	95½	110¾	110	113	112¾	1265
Winnipeg Electric............	70	6,000	100	....	....	141	145	160	159	....		194	....		160	159¼	159		5

NEW INTAKE TUNNEL.

C. W. Allen.*

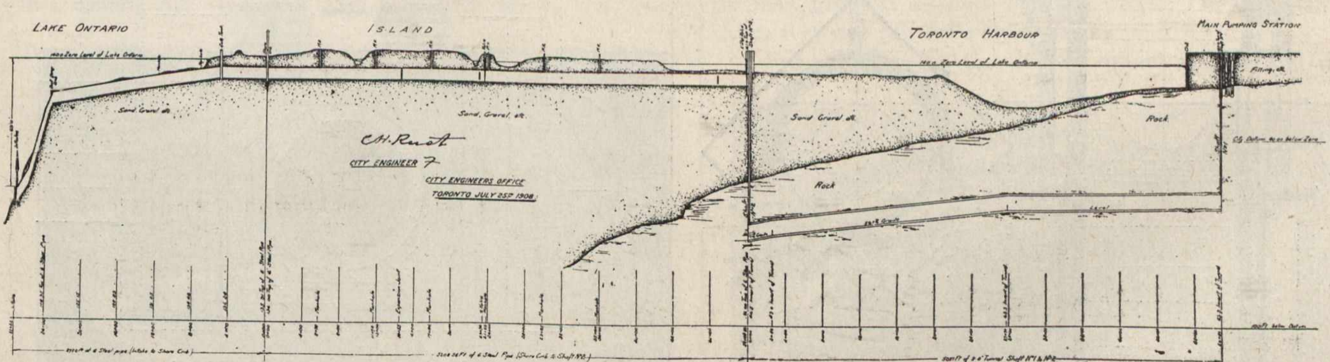
The system of conduits just completed for Toronto water supply was first recommended by Mr. E. H. Keating, then City Engineer in 1895, and as built agrees very closely with his original ideas. At that time the system consisted of 4,095 feet of 3-foot C.I. flexible jointed pipe from John Street Station to Hanlan's crib, laid in 1875; 4,400 feet of 4-foot steel pipe from John Street Station to Hanlan's crib, laid 1890 and 1891; 6,000 feet 5-foot steel pipe from Hanlan's crib to shore crib, laid in 1889 to 1891; 6,000 feet of wooden stave pipe from Hanlan's crib to shore crib (not now in use), 1875; 2,357 feet 6-foot wooden stave pipe from shore crib out into lake, laid in 1881-2 (not now in use); 365 feet 6-foot



Plan of Intake.

steel pipe from end of 6 foot wooden to 75 feet of water opening in intake crib 50 feet below zero, laid 1890 and 1891; 2,357 feet of 6-foot steel pipe from shore crib to inshore end of existing 6 foot steel pipe at intake, laid 1896-98. The laying of this latter piece of pipe out into the lake was the first work done toward following up Mr. Keating's plan of a new system of conduits for Toronto from the source of supply to the pumps.

At the completion of the laying this pipe Toronto was getting its water through 2,722 feet of 6 ft. steel; 6,000 feet of 5 ft. steel; 4,095 feet of 3 ft. cast iron (in parallel); 4,400 feet of 4 ft. steel (in parallel); a total distance of about 12,817 feet. At. 5,076 feet north of the intake the 5 foot



Profile of Tunnel.

steel pipe had been broken in a basin dredged in the sand of the island to a depth of ten feet. This increased the head at that point by two feet.

During the summer past the pumps were pumping the greatest amount of water this system would supply with the lakes standing at 46 ins. above zero about 32 million gallons in twenty-four hours, pulling the well down to 9 ft. 6 ins. below zero.

After the tunnel was put into service and the supply was coming to the pumps through 7,565 feet of 6-foot pipe and 5,087 feet of 8-foot tunnel, the pumps delivering 32 millions pulled the well down 2 feet 1 inch below zero, the water in lake standing at zero. From the completion of the 6-foot intake pipe in 1898 till 1904 nothing further had been done toward the carrying out of Mr. Keating's idea for a larger and more certain supply of water to the pumps. The city's consumption was getting dangerously near its maximum supply, when in 1904 a contract was let to a Pittsburg firm for eighty-five 60 ft. lengths of 6-foot steel pipes for $14.48 a foot Toronto, with necessary expansion joints, manholes and one ball joint. A little later the contract for laying the same, together with the furnishing of two 6 foot and two 5 foot valves was let to Mr. Frank Simpson, of Toronto, for $84,745.

These pipes were built of ½-inch railroad steel, single lap riveted and bolted together in 60-foot lengths by 44 1¼-inch bolts through 5 x 5 x 1-inch angle iron flanges. They were dipped in a coating of mineral rubber asphalt at 300 degrees and tested hydraulically to 25 lbs.

It was laid in a trench dredged by two clam-shell dredges, one land and the other floating and rested on pile bents which were driven to place in one operation by the aid of a pile driver of special design. The pipe was floated into place by a pontoon and lowered to the piles with hand winches. Joints were bolted up by divers. The only difficulty of importance in laying this pipe was in keeping it in a straight line and on the caps of the piles. The flanges which were not faced were not always true and the line the pipe was taking had frequently to be altered by the use of bevelled wooden gaskets. For the majority of the joints a lead gasket as supplied with the pipe was used.

On completion, a valve on the bay end was closed, the pipe pumped out for cleaning and on examination it was found that all the lead joints had to be caulked whereas the wooden gaskets which were built of dry pine had swelled with the action of the water and were tight.

A five-foot branch had been provided to force the supply at the settling basin so that the south half of the pipe was immediately put into service.

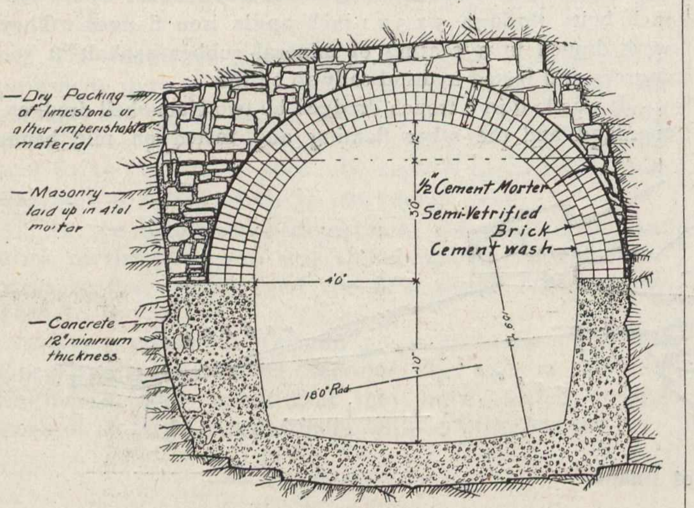
The total length of pipe as laid—5,208 feet, its grade is 4 ft. 3 in. from elevation 135.82 at shore crib to 131.6 at the island shaft. The zero level of the lake is taken as 140 above datum.

In the latter part of 1905 a contract for the construction of a tunnel under Toronto Bay, together with the necessary shafts and pipe connections was let to the firm of Haney & Miller for the sum of $269,000, and in October work was started at the island end driving piles and erecting buildings for plant. The location of the shaft was at this time in five feet of water. Under this was 64 feet of sand overlying the shale rock.

* Assistant Engineer-in-Charge of Tunnel Construction.

Very little work was done in the winter of 1905 and 1906 except to get plant in readiness, and when the sections of ten-foot steel caisson were delivered in the spring everything was in readiness to begin operations. The steel caisson, lined with 14 inches of concrete was for the purpose of carrying the shaft through the sand and into the rock. It was built in about ten foot sections with flange joints, the flanges being on the inside circumference.

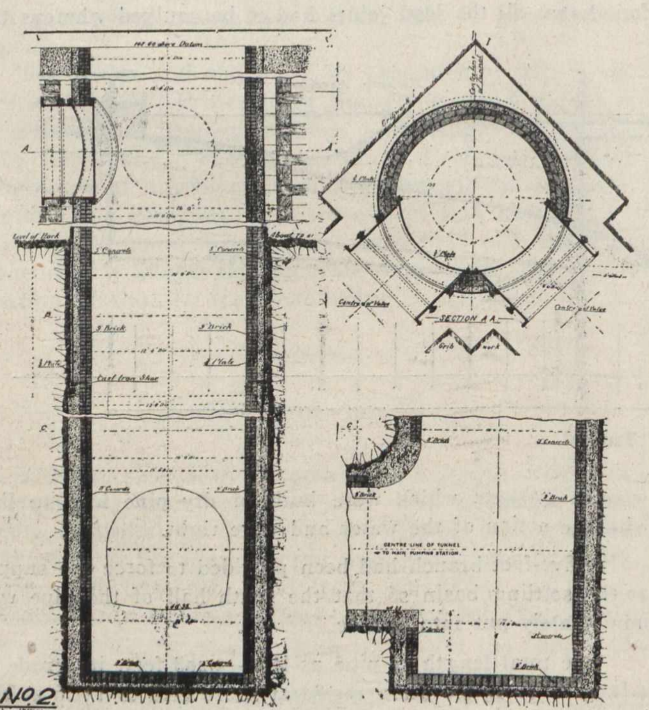
The first attempt to sink the caisson was made by means of water jets and weights with a clam-shell dredge working



Cross-section of Tunnel.

on the inside. On reaching a depth of 40 feet below the water level it sunk so slowly it was assumed that a stratum of hardpan had been encountered and dynamite was used to loosen this. The charge was either too heavy or wrongly placed, for it wrecked the bottom two sections of the caisson so badly that they had to be taken out to be repaired.

To repair these sections a double coffer-dam built of United States steel sheet piles were used. The top and outside dam was built of 35-foot 35 pound piles driven in a 40 foot square to accommodate a timber crib to be built when



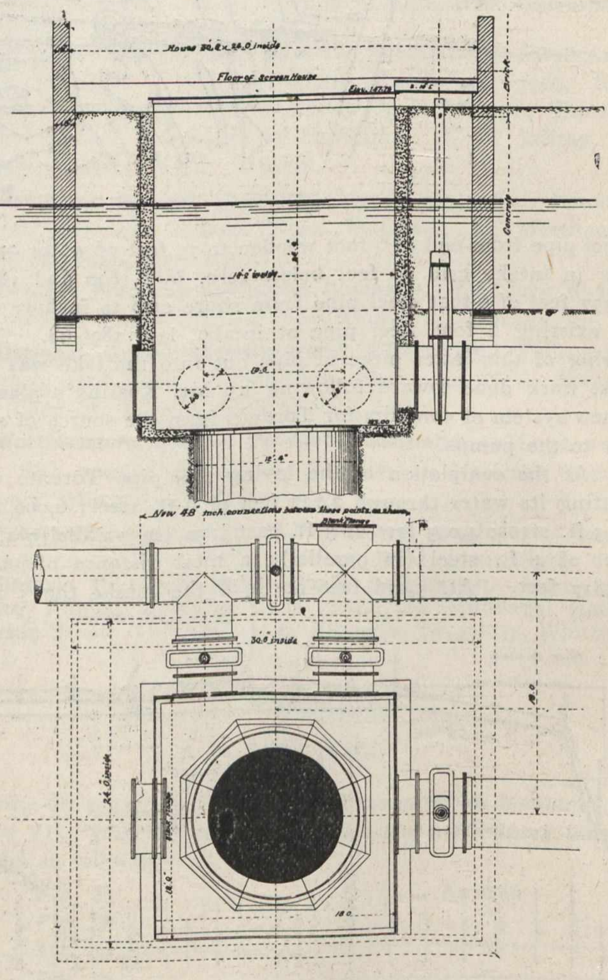
Detail of No. 2 or South Shaft.

the caission in place. This square was excavated to about 20 feet and around the caisson a 20 foot circle of 45 foot pile was driven to rocks, their tops being about 19 feet below the water level. This dam was excavated 25 feet lower, making a total depth of excavation in very fine sand of 45 feet below the water level. All the sections were uncovered and repaired and a second attempt made to reach the rock. This time the bottom section was first lined with concrete and lowered with derricks to the bottom of excavation in coffer-dam. This piece weighed nearly twelve tons. With this section in place the second was bolted to it and the lining carried up. With the added weight of the concrete the caisson sank gradually to rock. To expedite this movement it was only necessary to excavate the sand from the centre.

Overlying the rock was a layer of stiff blue clay which formed a good water seat while working in the rock.

The caisson came to rest about five feet down into the rock and was left supported by a shelf. This shaft was then carried to grade, a heading started and a pump chamber excavated. Concreting was now started, this time from the bottom and carried up to within seven feet of the caisson. This was underpinned in two lifts with hardwood posts, the posts being left in the concrete. The connecting piece of concrete, three feet deep, was put in under head with the use of shoots and made a water-tight joint.

With the shaft completed a boring machine, an experiment of the contractors, Haney & Miller, was installed but owing to the time taken to get it in working order it was



Shaft No. 1 or North Shaft.

finally removed and ordinary methods of tunneling in rock adopted.

The city shaft at the John Street Pumping Station was started, but as the rock here lay only fifteen feet below the water the work did not present so many difficulties as the island shaft.

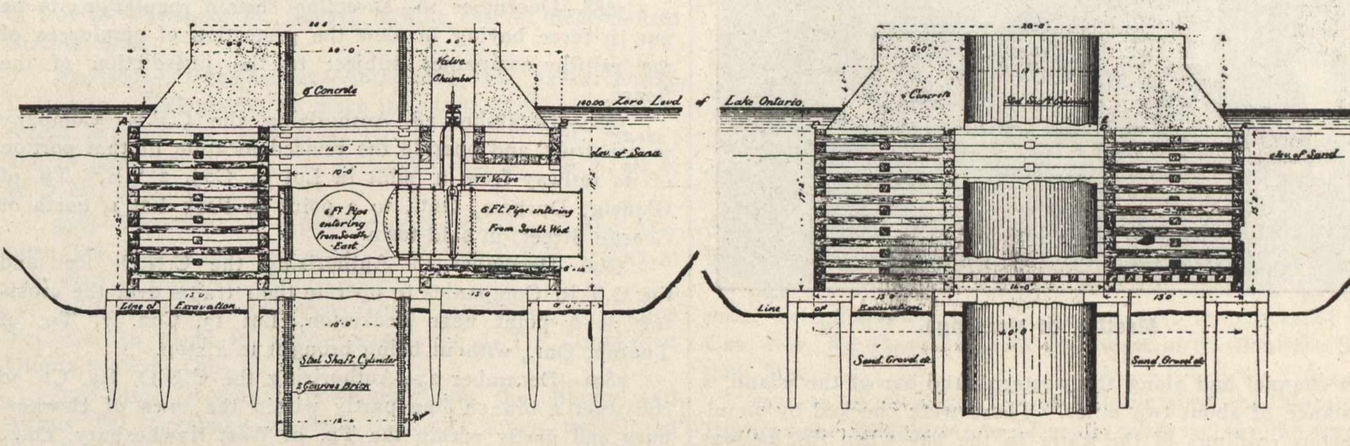
United States steel piles were again used to reach the rock, with the excavation for a large screen tank and necessary connections to the pump. These proved very satisfactory. They were the 35-foot piles used at the island end, but cut in two.

As finally built the tunnel has the common horse-shoe sections, eight feet both ways, lined with a three ring brick arch, sidewalls and invert 12 thick minimum, of 1 : 2 : 4 concrete. The overbreak over the arch was drypacked except the haunches which were laid up in mortar. The side walls and invert were concreted to the rock, the overbreak here being compensated for to some extent by the use of displacers of stone.

Tunneling operations were carried on simultaneously from both shafts, although the island heading had one month's start. Drilling was done with the standard rock drill driven by air at 90 pounds, the blasting with a dynamite called "Gelignite," which proved very satisfactory for tunnel work.

The cut was drilled at the floor grade and generally left a bench of from two to three feet on the roof. If this bench did not scale down with bars it was loosened by a light shot. Temporary timbering of the roof had to be carried close behind the heading on account of the looseness of the rock, but was removed before the brick arch was put in.

Drilling was started on October 1st, 1907, at the island end, and about one month later at John Street. The heading met July 14th, 1908, after driving a total of 5,038 feet. The best month's work for a single heading was 345 fect,



Crib Work at Shaft.

for the two headings 660 feet. The net section of excavation was 3.25 cubic yards. Work was carried on in two ten-hour shifts; 13 shifts a week. The breast was generally wet and sometimes had to be timbered before the drillers could be set up to drill the round.

Concurrently with drilling the concrete, side walls and brick arch were built, concreting being done on day shift and bricklaying at night. The great handicap to speed in this tunnel was its small area, allowing for only a single

Sheet Piling, Shaft No. 1.

track with turnouts. Gaps had to be left in the lining to accommodate them.

When the side walls had met, the invert was started at the centre and worked back towards the shafts. This work was carried on in day time, the necessary excavation and removal of tracks being done at night.

The chief difficulty in all the different operations of lining was the handling of the water which seeped through the rock. The greatest amount came through the various strata broken at the highest point of the roof. In the case of the laying of brick for the arch the work was protected as much as possible till the mortar was set by the use of screens of canvas and tar felt. Weepers of iron pipe were left in the haunches to carry this seepage off, and the lining was not subject to any hydrostatic pressure till finished and the weepers plugged. Weepers had also to be put in the side walls when water bearing seams were encountered on their level, and the invert had a drain down its centre to carry off water that found its way under the foot of the side walls. This leakage totalled to about 550,000 gallons in 24 hours.

The total overbreak amounted to 32 per cent. of the neat section of 16,500 cubic yards; 3,000 cubic yards being filled with dry packing of limestone and 2,286 cubic yards with concrete.

For carrying the centre line down the shafts fine piano wire was used, with 30-pound weights of paddle wheel type. These weights were immersed in tubs of water at

Engineering.

bottoms of shafts. The transit was set up on line on surface and sighted at a large target on the opposite shaft. The wire wound on a large reel was set by a grooved micrometer screw with a horizontal movement. The wire opposite the portal of the tunnel had to be set at least twelve inches from the wall to allow the "bob" to swing free in its tub of water. This would only allow for not more than about 8 ft. 10 ins., greatest distance between wires. On the island end 2,770 feet was run from this spacing.

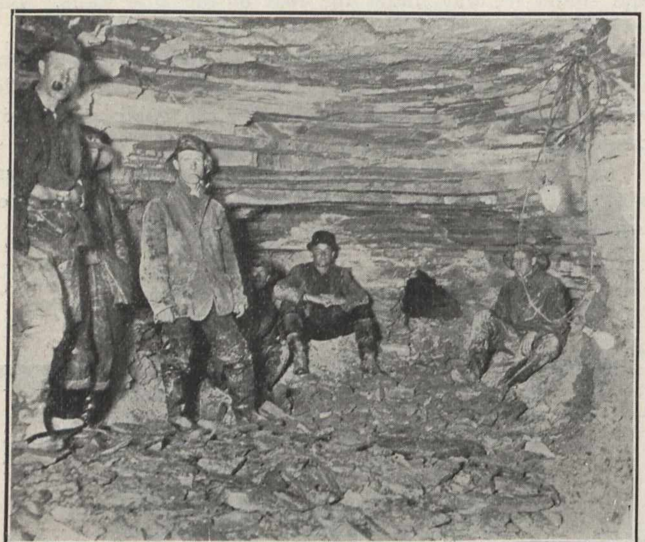
For carrying the line in the tunnel a scale and vernier

Tunnel Showing Timbering.

were used, and the average of numerous readings taken. This scale was made of brass, one inch by six, with a slotted hole at each end to fasten it to iron standards bricked into the arch. Four inches of this plate was graduated into inches and tenths. The vernier, a brass hanger with a horizontal movement on the plate, had the plumb-bob suspended from it, was moved by hand to line and read to 1-100 of an inch. All readings were booked and averaged. Only three of these verniers were provided, and were ranked "A," "B" and "C," the same vernier being always used on the same scale to eliminate errors in their graduation.

This precise line could not be carried ahead of the brick arch, which was from five to six hundred feet behind the heading, because of the loosening of rock of the roof. A rough line was kept ahead for drilling, by points in timber and was checked up frequently from the scales.

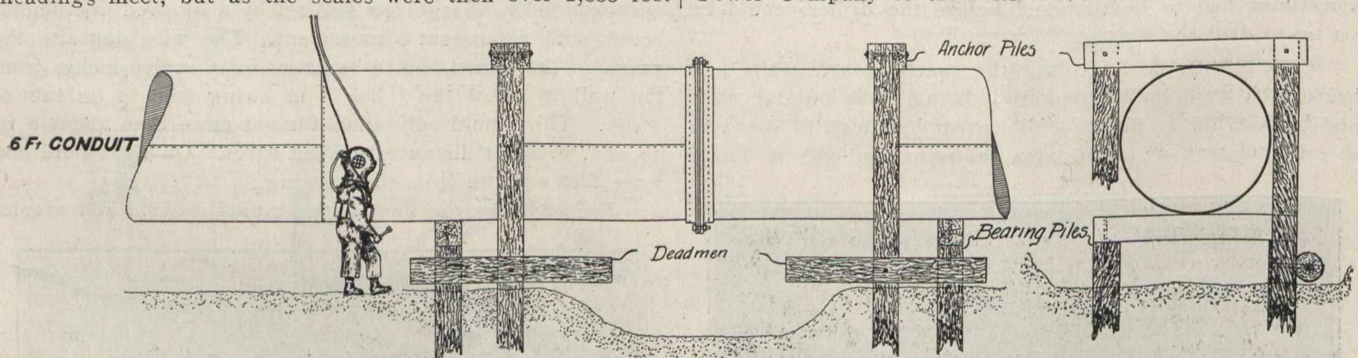
Levels were taken from a bench at John Street. For the island shaft the levels were carried around by the western channel and along the western sand bar of the island, a distance of about two miles. These were checked by simultaneous readings of the water in the bay when the ice was on and no wind blowing in the lake. This checked with the line by the channel to ¼ of an inch and the two lines in the tunnel finally by 3-16 of an inch.



Meeting of Headings.

The centre line checked to about two inches when the headings meet, but as the scales were then over 2,000 feet apart and never carried any further forward it is hardly a criterion of the accuracy of the methods employed.

This work was carried on under the more particular direction of the Deputy City Engineer, C. L. Fellows, M. Can. Soc. C.E.



Pile Bents Supporting Six-foot Intake.

ORDER OF THE RAILWAY COMMISSIONERS OF CANADA.

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

5882—December 21—Ordering the Grand Valley Railway Company to file its tariff of tolls with the Board.

5883—December 16—Authorizing the Grand Trunk Pacific Telegraph Company to erect, place and maintain its wires across the tracks of the C.P.R. west of Portage la Prairie, Man.

5884—December 17—Dismissing the application of the C.P.R. (Ontario and Quebec Railway Company) for authority to take additional lands, for railway purposes, between Mountain and Windsor Streets, Montreal, P.Q.

5885—December 22—Rescinding Order No. 5661, dated 10th November, 1908, and directing the Berlin & Waterloo Street Railway Company to pay the G.T.R. Company the sum of 85 cents per day from the 12th December, 1905, to the 1st day of May, 1907; and that the Light Commissioners of the town of Berlin pay the G.T.R. Company the sum of 90 cents per day from the 1st day of May, 1907 (wages of watchman).

5886—December 22—Authorizing the Q.M. & S. Ry. Co. to construct a spur line to the property of the Distillery Packing & Vinegar Company, St. Hyacinthe, Que.

5887—November 4—Authorizing the St. John Railway Company, upon maintaining a sempahore at the crossing, to operate its line across the tracks of the C.P.R. in the Parish of Lancaster, County and City of St. John, N.B., without installing an interlocker or other similar appliance, for a space of twelve months from the 4th November, 1908.

5888—December 16—Directing certain regulations to be put in force having in view the protection of employees of the railway companies subject to the jurisdiction of the Board.

5889—December 28—Authorizing the C.P.R. Company to construct and operate the revised location of that portion of its railway from a point in Lot 59, Con. 2 "E," Tp. of Glenelg, Durham, Ont., to a point in Park Lot 1, north of George Street, in said town.

5890—December 18—Authorizing the C.N.O. Ry. and the G.T.R. Companies to operate their trains over the crossing at a point near Beaverton, Lot 13, Con. 7, Tp. of Thorah, Ont., without being brought to a stop.

5891—December 22—Authorizing the C.N.O. Ry. Co. to construct a branch line partly within the town of Hawkesbury and partly within the Tp. of West Hawkesbury, Ont., from its main line to a junction with the G.T.R. Company's tracks at Riordan's Mills; and that said branch line be completed within two years from the date of Order.

5892—December 1—Authorizing the Toronto & Niagara Power Company to erect its wires across the track of the Toronto Suburban Railway Company at the Weston Road, County of York, Ont., subject to certain conditions.

5893—December 21—Authorizing the Can. Nor. Que. Ry. Co. to erect its wires across the track and telegraph wires of the C.P.R. Co. at the crossing of the C.P.R. east of Lorette, Que.

5894—December 21—Authorizing the Niagara, St. Catharines and Toronto Railway Company to construct a spur from its Thorold-Fonthill Line to the flour mills of the Hedley-Shaw Milling Company, in the town of Thorold, Ont.; and to complete such branch line within two years from the date of Order.

5895—December 21—Authorizing the C.N.O. Ry. Co. to place its telegraph wires across the track and telegraph wires of the G.T.R. Co. at Hawkesbury, Ont.

5896—December 23—Authorizing the G.T.R. Co. to construct a branch line and two spurs therefrom to the property of the Provincial Steel Co., Ltd., Cobourg, Ont.

5897—December 21—Authorizing the Bell Telephone Company to place its wires across the tracks of the M.C.R.R. 200 yards west of Inwood Station, Ont.

5898—December 21—Authorizing the Bell Telephone Co. to place its wires across the tracks of the C.P.R. at the Main Road, Megantic, Que.

5899—December 21—Authorizing the Bell Telephone Co. to place its wires across the tracks of the G.T.R. to reach G.T.R. tracks at Powassan, Ont.

5900 to 5903—December 21—Authorizing the Bell Telephone Co. to place its wires across the tracks of the C.P.R. at 4½ miles west of Holland Centre, Ont.; 1 mile east of Chatsworth Station, Ont.; 5 miles west of Holland Centre, Ont.; and ¼ mile east of Chatsworth Station, Ont.

5904—December 21—Authorizing the Claremont & Ashburn Tel. Co. to place its wires across the C.P.R. tracks at Claremont, Ont.

5905—December 21—Authorizing the Saskatchewan Government Telephones to erect its wires across the track of the C.P.R. between Sec. 10 and 15, Tp. 8, R. 5, W. 2 M., Sask.,

5906—December 21—Authorizing the Bell Tel. Co. to place its wires across the G.T.R. tracks at western boundary of Lot 18, Parish of Pt. Claire, ⅞ mile east of Beaconsfield Station, Que.

5907-5908—December 21—Authorizing the Saskatchewan Government Telephones to place its wires across the C.P.R. tracks between Sec. 8 and 11, Tp. 8, T. 4, W.P.M., Sask.; and between Sec. 18, Tp. 8, R. 5, and Sec. 13, Tp. 8, R. 6, W. 2 M., Sask.

5909—December 21—Authorizing the Claremont and Ashburn Tel. Co. to place its wires across the C.P.R. tracks at side road at Dagmar, Ont.

5910—December 21—Authorizing the Barrie & Angus Tel. Co. to place its wires across the G.T.R. tracks at Utopia Station, Ont.

5911-5912—December 21—Authorizing the Barrie and Angus Tel. Company to place its wires across the Grand Trunk Railway tracks at town line between Vespra and Essa, ½ mile north of Colwell Station, Ont.; and at Angus Village, Ont.

5913—December 21—Authorizing the Bell Telephone Co. to place its wires across the G.T.R. tracks ¼ mile west of Strathmore Station, Que.

5914—December 21—Authorizing the C.P.R. Company to construct a branch line to the premises of the Sunbeam Incandescent Light Company, Toronto; and that said branch line be completed within two years from the date of Order.

5915—December 24—Authorizing the British Columbia Tel. Co. to place its wires across the track of the V. V. & E. Ry. Co. at Sapperton, B.C.

5916—December 24—Authorizing the British Columbia Tel. Co. to place its wires across the tracks of the C.P.R at Kamloops, B.C.

5917—December 22—Granting leave to the G.T.P. Ry. Co. to carry freight over the portion of its line from Winnipeg to Battle River, Alta., notwithstanding that such portion of its line has not been opened for the carriage of traffic, in accordance with the Railway Act, Sec. 261; and cancelling Order No. 3780, dated the 11th October, 1907.

5918—December 22—Granting leave to the G.T.P. Ry. Co. to carry freight over its line of railway from Ft. William to the end of track, mileage 0.00 to 188.77, Ontario, notwithstanding that such portion of its railway has not been opened for carriage of traffic in accordance with Sec. 261 of the Railway Act.

5919—December 10—Authorizing the C.P.R. Co. to open for the carriage of traffic that portion of its line known as the Moose Jaw North-West Branch, in the Province of Saskatchewan, subejct to the condition that the company shall not operate its trains at a greater speed than 15 miles per hour.

5920—December 26—Authorizing the Bell Telephone Co. to place its wires across the C.P.R. tracks ¼ mile west of Strathmore Station, Ont.

5921—December 26—Authorizing the Vancouver Power Company to place its wires across the C.P.R. tracks at or near Barnet, District Lot 213, Group 1, New Westminster District, British Columbia.

5922—December 26—Authorizing the C.P.R. Company to place its telegraph wires across the G.T.R. track in Lot 4, Con. 1, Tp. of Bentinck, County of Grey, Ont.

5923—December 28—Authorizing the town of Cobourg, Ont., to lay, at its own expense, an 8-inch tile pipe under the G.T.R. tracks on Ontario Street, Cobourg, Ont.

5924—December 22—Granting leave to the Montreal Ter. Ry. Co. to cross the C.N.Q. Ry. Co. in the Parish of Longue Pointe, opposite the Vulcan Cement Company's Works.

5925—December 22—Directing that the Q.M. & S. Ry. Co. be at the expense of changing the derails at the junction of its line of railway with the Rutland R.R. Co. and the G.T.R. at Noyan Junction, Que.

5926—October 20—Authorizing the M.C.R.R. Co. to construct a suitable crossing over its railway on the boundary line between the farms of Charles and Fred Slade, Tp. Raleigh, Kent County, Ont.

5927—December 24—Authorizing the M.C.R.R. Company to construct a bridge at Charing Cross, Kent County, Ont.

5928—December 28—Rescinding Order No. 5803, dated December 10th, 1908, and authorizing the C.N.Q. Ry. Co. to construct a branch line to the Argenteuil Lumber Company's Mills, on the Comon River, at Morin Flats, Que.; and that the company complete such branch within two years from the date of this Order.

5929—December 28—Authorizing the G.T.R. Ry. Co. to construct a double track passenger bridge across the Assiniboine River, at Winnipeg.

5930—December 28—Authorizing the Manitoba Government Telephones to place its wires across the tracks of the Can. Nor. Ry. Co. 10½ miles north-east of St. Boniface Station, Man.

5931 to 5933—December 28—Authorizing the Manitoba Government Telephones to place its wires across the tracks of the C.N.R. at 8 miles north-east of St. Boniface Station, Man.; 9 miles north-east of St. Boniface Station, Man.; and at ½ mile east of Swan Lake, Man.

5934—December 28—Approving deviation of the G.T.R. branch line from a point on the west side of King Street, in the town of Chesley, Bruce County, Ont., to the premises of the Chesley Rake & Novelty Company, Chesley, Ont.

5935—The Order will come later.

5936—December 22—Approving No. 8 Miller Chemical Frost Proof Fire Extinguisher for use in the cars of the Central Ontario Railway Company.

5937—December 22—Authorizing the Okabena Tel. Assn. to place its wires across the C.P.R. Company's tracks in the S.W. Quarter Section 32, Tp. 15, R. 23, W. 2 M., Sask.

5938—July 15—Authorizing the Walkerton & Lucknow Ry. Co. to construct branch lines of railway in the town of Hanover, Ont., to the premises of the Knechtel Furniture Co. and also two spurs for the purpose of reaching the Hanover Portland Cement Co.

5939—October 6—Authorizing the G.T.R. Co. to construct a branch line of railway, with spurs therefrom, to the premises of the Simonds Canada Saw Company, Jenkins Bros., the Lang Mfg. Co., and other industries, Montreal.

5940—December 22—Authorizing the C.N.O. Ry. Co. to construct its line across and divert the Montreal Road and the side-road between the Counties of Russell and Prescott, Ont., at about mileage 28 west from Hawkesbury.

5941—December 23—Granting leave to the G.T.P. Ry. Company to divert the following highways in the Province of Manitoba: (1) on the N.E. Quarter Sec. 9, Tp. 11, R. 3, W. 1 M.; (2) on the N.E. Quarter Sec. 20, Tp. 11, R. 4, W. 1 M.; (3) on the S.W. Quarter Sec. 35, Tp. 11, R. 5, W. 1 M.

5942—December 23—Approving road diversion of the G.T.P. Ry. Co. in the north-east Quarter Sec. 32, Tp. 12, R. 22, W. 1 M., Man.

5943—December 16—Directing the St. Johns Electric Light Company, Ltd., to forthwith remove the wire or wires over the C.P.R. track at Stevenson Street, in the City of St. Johns.

5944—December 23—Authorizing the C.P.R. Company to construct a branch line of railway, or spur, at Lethbridge, to the premises of the Royal Collieries Company, Ltd.; and that said branch line be completed within two years from the date of this Order.

5945—December 23—Authorizing Charles E. Knister, of Comber, Ont., to place his wires across the tracks of the M.C.R.R. at the 12th and 13th Side Road, Tp. Tilbury West, Ont.

5946—December 23—Approving by-law passed by the M.C.R.R. Company authorizing Charles F. Daly, vice-president, in respect of freight and passenger traffic, and O. W. Ruggles, general passenger agent, in respect of passenger traffic, and W. C. Rowley, general freight agent, and N. D. Chapin, Chief of Tariff Bureau, in respect of freight traffic, to prepare and issue tariffs of tolls to be charged in respect of the railway owned and operated by the M.C.R.R. Co.

5947—December 22—Authorizing the G.T.P. Ry. Company to construct a bridge between Watson Island and Kaien Island, B.C.

5948—December 23—Approving location of the C.P.R. Company's station at Coldwater, Ont.

5949 to 5952—December 23—Authorizing the Saskatchewan Government Telephones to place its wires across the tracks of the Can. Nor. Ry. Co. at 2 miles west of Findlater, Sask.; at Findlater, Sask.; ½ mile north-west of Bethune, Sask.; and 1 mile north-west of Bethune, Sask.

5953—December 14—Dismissing application of the municipality of Chapple, Ont., for an Order directing the C.N.R. Co. to place an agent at Barwick.

5954—December 21—Directing the railway companies subject to the Board's jurisdiction to file, within three months from the date of this Order, the exact distances, to not exceeding two decimal points, between their station such tables to bear a C.R.C. number in both freight and passenger tariff series, and to be in the form, size, and style prescribed by the Board for freight and passenger tariffs.

5955—December 15—Directing that the Canadian Northern and Canadian Pacific Railway Companies agree upon and file, not later than the 1st day of February, 1909, a printer's proof of a joint tariff to apply on such grains and grain products as are covered by the C.P.R. Company's special tariff C.R.C. No. W. 543 from points on the Qu'A., L.L., and Sask. Ry. & Steamboat Company line of railway to the Pacific Coast terminal points and intermediate stations in British Columbia.

5956—December 22—Directing the Q.M. & S. Ry. Co. to prepare plans for new stations at Sorel and Pierreville, Que., for the approval of the Board, within two months from the date of this Order; that the Q.M. & S. Ry. Co. operate its trains according to the time-tables published, unless prevented from doing so by reason of accidents, snow storms, or causes of a like nature; that all frogs on its line of railway be packed in accordance with the Railway Act; that signboards be erected; and that the Q.M. & S. Ry. Co. shall be liable to a penalty of $50 per day for a breach of any of the terms of this Order.

5957—July 14—Authorizing the G. & G. Ry. Co. to cross the tracks of the G.T.R. spur at Listowel, Perth Co., Ont.

5958—December 23—Authorozing the Saskatchewan Government Telephones to place its wires across the tracks of the C.N.R. Co. two miles west of Disley, Sask.

5959—December 15—Dismissing application of the City of Chatham for an Order directing the C.P.R. Co. to provide gates at the crossings of its railway on Wellington and Centre Streets, and electric bells or other systems of warning at the crossings on Princess, Colborne, Jeffrey, Raleigh, West, and Lacroix Streets.

5960—December 23—Authorizing the Saskatchewan Government Telephones to place its wires across the C.N.R. tracks at Chamberlain, Sask.

5961—December 22—Certifying that there is an error in the plan and book of reference in connection with Order of the Board No. 4498, dated March 24th, 1908, wherein, through mistake, Joseph Charron is named as the owner of the lands described in said Order No. 4498, instead of Francois Charron; and substituting the name of Francois Charron in the said plan and book of reference for that of Joseph Charron, as the owner of said lands.

5962—December 23—Authorizing the C.P.R. Co. to operate bridges on the Fort William sections of its railway, at the following mileages, namely: 30.44; 64.4, 58.5, 72.27, 31.98, 88.73, 30.08, 31.62, 111.45, 112.89, 68.01, 139.98, 28.63, 101.11, 106.17, 48.24, 97.83, and 94.06.

5963—December 23—Extending until the 1st day of June, 1909, the time within which the C.N.Q. Ry. Co. shall do the work as required in Order No. 5742, dated December 1, 1908.

5964—December 29—Dismissing application of the Grenfell Milling & Elevator Company, Grenfell, Sask., for leave to erect its electric light wires across the C.P.R. tracks at Grenfell, Sask.

5965—December 29—Dismissing application of the City of Saskatoon for permission to lay a water main under the C.N.R. tracks in the City of Saskatoon, Sask.

5966—December 29—Authorizing the Manitoba Government telephones to place its wires across the tracks of the C.N.R. 4½ miles north-east of St. Boniface Station, Man.

5967—December 29—Dismissing application of the Village of Mannville, Alberta, for an Order directing the C.N.R. Company to provide a suitable street crossing where the company's railway intersects the Village of Mannville, in the S.E. Quarter Sec. 25, Tp. 56, R. 9, W 4 M.

5968—December 29—Authorizing the Manitoba Government Tel. to place its wires across the tracks of the C.N.R. Co. two miles west of Altamount, Manitoba.

5969—December 29—Authorizing the Bell Telephone Co. to place its wires across the tracks of the C.N.R. Co. at the siding at Second Avenue, Prince Albert, Sask.

5970—December 29—Authorizing the C.P.R. Co. to place a stop-block at a point approximately 267 feet from the switch leading to the McIntosh-Gullet Company's siding at North Toronto, the key of which shall be in the custody of the McIntosh-Gullet Company, who shall be responsible for seeing that the said stop-block is at all times closed and locked when not in use.

5971—December 24—Approving revised location of the G.T.P. Ry., Prince Rupert, easterly, mileage 10.64 to mileage 50, Coast District, B.C.

5972—December 18—Approving Standard Passenger Tariff C.R.C. No. 20 of the Orford Mountain Railway Co.

5973—December 23—Authorizing the M.C.R.R. Co. to adopt and use the interlocking plant at the crossing of its railway just west of Ross Street, St. Thomas, Ont.

5974—December 23—Authorizing the Manitoba Government Telephones to place its wires across the tracks of the C.N.R. Co. at the station grounds, Oakville, Man.

5975—December 29—Authorizing the C.N.R. Co. to open for the carriage of traffic that portion of its line from Lumsden to Disley, Sask., the C.N.R. Co. undertaking to do before July 1st, 1909, all the fencing necessary.

5976—December 29—Dismissing the application of the Hinton Electric Co., Ltd., for leave to erect its wires across the C.P.R. Company's tracks in the town of Enderby, B.C.

5977—December 29—Granting leave to remove the east derail and home semaphore at Walkerville Junction, 375 and 428 feet respectively, from the crossing of the Pere Marquette with the C.P.R.

5978—December 29—Directing the C.N.R. Co. to construct and complete certain highway crossings over its railway (Oak Point Branch); and directing that, pending the completion of a permanent highway crossing at mileage 27, the C.N.R. provide at once a temporary crossing and put it in such shape that teams may make the crossing in safety during the winter months.

Gross earnings of Winnipeg Street Railway in 1908 were $899,632.61. These earnings show an increase of nearly $38,000 over last year, the largest proportionate increase of any other city in Canada. The company paid a dividend of 10 per cent. last year, without considering the revenue from gas and commercial lighting.

GROUNDED TRANSMISSION MEDIUMS.

VIII.—Concluded.

TRANSVERSE STRAY TRANSMISSION.

J. Stanley Richmond, Consulting Engineer, Toronto.

Having treated in a somewhat cursory way of the general conditions, apparatus, tests and improvements connected with the subject of the electrolytic corrosion of metals earthed in the neighborhood of grounded returns, the writer will now endeavor to take up a very interesting phase of this question. This is the factor which he has termed "Transverse Stray Transmission."

Referring to a previous chapter under the heading of "Stray Transmission," it can be taken for granted that the

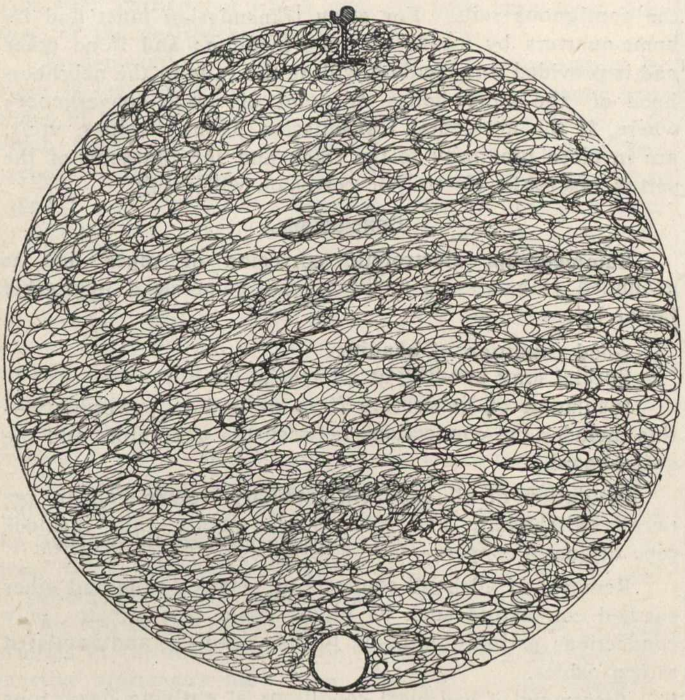


Fig. 45.

relative rail, pipe line and earth resistances constitute the really important factor affecting the question at issue; and particular is this the case when one remembers how very much greater is the resistance of a given length of pipe-line than that of a given length of laid rail provided that the bonding of the latter is maintained in a good condition.

In order to deal in an approximately correct way with this relativity of return resistances by the use of plain arithmetic, it is necessary to allow that a certain portion of the earth acts as a connection between the rails and a contiguous pipe-line, and this portion may, for convenience, be termed "Soil," while the remainder of the earth affected may be termed "Earth." Bearing on this subject, Professor Blake, in the "Electrical World and Engineer," (New York), of December 16th, 1899, gave the following data in respect to the resistance of cast-iron pipe and pipe joints:—

Class of pipe:—Six-inch cast-iron.

Length of pipe sections:—Twelve feet.

Average resistance of each length of pipe:—0.000,345 ohm.

Time pipe had been in use:—Thirteen years.

Average resistance of each joint:—0.0092 ohm.

Total resistance of joints (58):—0.535 ohm.

Total resistance of pipe-line (687 feet):—1.091 ohms. 1,000 feet of such pipe-line would have, therefore, a resistance of 1.588 ohms.

For rail resistances, the following data may be assumed:

Class of rail:—Girder.

Resistance of 1,000 feet of rail:—0.006 ohm.

Length of each joint:—Three feet.

Number of joints to 1,000 feet of laid rail:—Thirty-three.

Equivalent in straight rail of each joint:—Eighteen feet.

Equivalent in straight rail of 1,000 feet of laid rail:—1,500 feet.

Resistance of 1,000 feet of laid rail:—0.009 ohm.

A lower "Soil" resistance than is generally allowed is forty ohms for a block three feet deep with connecting faces of three feet by three feet. On this basis, however, assume a rail laid parallel to and ten feet away from a six-inch cast-iron water main; in which case, though the cross-section of the soil directly connecting the rail and pipe as shown by the dotted lines in Fig. 32, is ten feet by only a narrow connecting face, it must not be forgotten that the real cross-section of the connecting soil, due to by-paths, is equivalent to soil with a much greater width of connecting face. Consider, therefore, that the cross-section of the connecting "Soil" in the example chosen is equivalent in area to that of a circle having a diameter of ten feet, or, roughly, to a block of soil having a depth of ten feet and a width of eight feet. This is a liberal allowance; and it is probable that tests properly carried out would show that the equivalent area is less, and the resistance, therefore, greater. The resistance of the "Earth" for limited areas may be safely taken as nil.

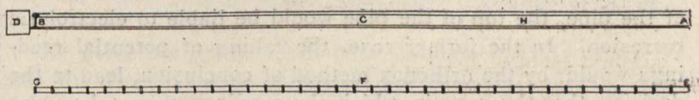
Now if soil three feet deep with connecting faces three feet by three feet has a resistance of forty ohms, a block of "Soil" ten feet deep with connecting faces eight feet wide by three feet long will have a resistanc of $40 \times \frac{10}{3} \times \frac{3}{8} = 50$ ohms.

As to the factor of one or more rails, it must be remembered that the stray transmission between one rail and a pipe line with a load 1x will be, approximately, the same as that between two rails and a pipe-line when the load on each rail is ½x, or between four rails and a pipe-line when the load on each rail is ¼x. For all practical purposes, therefore, it can be assumed that there is only one rail, and that it is carrying the full load.

Now consider that Fig. 33 represents, diagrammatically, 10,000 feet of rail laid parallel to and ten feet away from 10,000 feet of pipe-line; in which figure AB is the rail with its middle point at C, D is the power-house and EG the pipe-line with its middle point at F.

Consider a return ampere-load of 2.50 amperes evenly distributed along AB. This would be equivalent to a return-load of 250 amperes applied at the middle of AB at the point C. As a result, this load would have, roughly speaking, three paths to the power-house D. The first path would be by means of the rail from C to B. The second path (as transmission would be, practically speaking, downward from half of the rail to "Earth," and then upward to the other half of the rail from C to B) would be backward by means of the rail between C and A, the soil between AC and EF to the "Earth," from the "Earth" through the soil between FG and CB to the rail between C and B, and the rail to the power-house at D. The third path would be similar to the second path with the exception that the pipe-line EG would replace the earth.

With the data and explanations which have been given, it is now possible to calculate, approximately, the proportional



Power House Track and Water Pipe, Fig. 46.

amperage which will be transmitted by each of the three available paths.

First Path.

The rail between C and B. Length, 5,000 feet. Resistance of 5,000 feet of laid rail = 0.009 × 5, or 0.045 ohm controlling the amperage of this path.

Second Path.

The backward transmission by AC of part of an amperage load applied at C will be controlled by resistance as if this part of the load were applied at H, the central point between A and C; and this resistance will be equal to the resistance between H and C. From H to C is 2,500 feet. 2,500 feet is equivalent in resistance to 0.009 × 2½, or 0.0225 ohm. The resistance of the soil between AC and EF has been calculated as 0.03 ohm. The earth is 0 ohm. The resistance of the soil between FG and BC has been calculated at 0.03 ohm. The controlling resistance of CB in this case will be similar to that of AC, or 0.025 ohm. Summed up, these controlling resistances will be:

$$0.0225 + 0.03 + 0 + 0.03 + 0.0225, \text{ or } 0.1050 \text{ ohm.}$$

Third Path.

The resistance controlling the amperage of the third path will be similar to that controlling the second path plus half the resistance of EF and half the resistance of FG. The resistance of EF will be, at 1,588 ohms per thousand feet, 7.94 ohms; while the resistance of FG will be the same, that is, 7.94 ohms. Summed up, the controlling resistance of the third path will be $0.105 + \frac{7.94}{2} + \frac{7.94}{2}$, or 8.045 ohms.

Terming these three paths, respectively, as rail-return, earth-return and pipe-return, the resistances controlling the division of amperes will be, proportionately;

Rail-return	45
Earth-return	105
Pipe-return	8,045

from which, with a load of 250 amperes, the division may be calculated as;

Rail-return	174.32 amperes.
Earth-return	74.71 amperes.
Pipe-return	0.97 amperes.

It can thus be understood that longitudinal transmission by means of pipe-lines is so small that the hue and cry which has been raised about it has been very much a case of making "A mountain out of a mole-hill." Assuming six car lines with parallel water-pipes, each line about two miles long, and all the lines converging together in the neighborhood of a power-house, would, on the foregoing basis of calculation and a total load of 1,500 amperes, only give a collected pipe transmission at the point of convergence of 5.82 amperes, which is much higher, except in one or two special cases, than the writer has been able to find by tests carried out in the case of a city in which the assumed case practically represents the actual conditions that existed at the period during which the tests were made. The calculations, which have been given, though, are only hypothetical, but it may be taken for granted that they come, approximately, close to the truth.

It is reasonable to conclude, therefore, that though a transmission medium may show no drop along a considerable length of it and is, therefore, not acting as a transmission medium longitudinally it may be acting as a considerable transmission medium transversely. Transverse stray transmission, therefore, plays a more important part in the general question at issue that has been generally supposed; and it may be defined as the stray transmission which takes place from the top to the bottom of the pipes or, "vice-versa," from the bottom to the top of the pipes. In the former case, as stray transmission would enter at the top and leave at the bottom of the pipe, the bottom of the pipe would be liable to electrolytic corrosion; while, in the latter case, as the stray transmission would enter at the bottom and leave at the top of the pipe, the top of the pipe would be liable to electrolytic corrosion. In the former case, the taking of potential readings would, by the orthodox method of conclusion, lead to the decision that the area in which the readings were taken was a non-danger area; and thus the finding in several cases of pitted pipes in a so-called non-danger area may be satisfactorily explained by the assumption that the portion of the amperage transmitted by the earth-return is partially transmitted between the "Soil" and the "Earth" by means of pipes laid close to the rails. Unfortunately, this transverse stray transmission takes place in the outlying sections of a traction system in which no method of "pipe-drainage" can be adopted. Fortunately, however, the load is light in these outlying sections and any damage which results can almost invariably be traced to localized points and as due to abnormal or what may be termed special conditions. The cure is to so treat the abnormal conditions as to render pipes, etc., at these points immune, which is by a no means difficult task to one who is well-informed in regard to the various factors controlling the situation.

Transverse transmission at points in the neighborhood of where the tracks converge at the power-house, which is usually the danger area defined by potential readings, does not lead to any apparent contradiction of the finding that such is a danger area; and to render the pipes in this area immune is a simple task. For if the generators in the power-house be insulated from "Earth" in the power-house and their low-voltage side be connected by insulated cables to suitable track points (chosen so that these points will be, practically speaking, equi-voltage points—arbitrary zero points), and the loss of voltage (drop) on these insulated cables be, say, 15 volts, then a couple or so of hundred feet of insulated cable laid alongside of the pipe-line and connected to the pipes about every fifty feet can be connected by an insulated cable to the low-voltage side of the generators, the cable being of such size that the loss of voltage (drop) on it would be about 12 volts. By this method not only will the pipes be drained, but they will also be lower in voltage than the contiguous rails. For stray transmission must find its home-quarters by means of some medium; and if no other one is provided this medium will be the rails in the neighborhood of the power-house or point of track convergence; where, if the accidental transmission agents, (pipes, etc.), are in close proximity to the track and the character of the soil is favorable, electrolytic corrosion will result.

Conclusions.

Summed up, electrolytic corrosion of pipes due to grounded transmission mediums can be made a negligible factor by:—

Good condition of bonding.

Special long bonding at all special work.

Insulation of generators from ground in power-house—this includes the connections between the generators and the switchboard.

Insulation of all sufficient auxiliary return copper between switchboard and equi-voltage points—this includes pipe drainage copper.

Removal of all bond connections between rails and other earthed conductors such as pipes, cable sheaths, etc., only connections permissible being to pipe drainage and insulated return cables.

Treatment of bad local conditions at outlying dangerous points.

N. B.—Negative boosters are a bluff.

As for the protection of cable sheaths, which is more important to many traction interests than to electric light and telephone interests, the best advice the writer can give and has been constantly giving for years is "Don't." This, in so far as the question of bonding is concerned. What should be done is to run an insulated "stray transmission cable" in a duct by itself. To this cable ought to be bonded, in each manhole, all the cable sheaths, the connection between the bonded sheaths and the insulated "stray transmission cable" being by means of an insulated jumper. To drain the "stray transmission cable" it ought to be connected to the low-voltage side of the generators in the power-house, but not to the pipe drainage cable.

Finally, the writer would say to the embryo expert "Don't think that to be an expert is to lie on a bed of roses." For to be an expert one must never prevaricate or attempt to make facts out to be other than what they are. For the brain cells of the prevaricator become perverted in their action (motion) in time, and thus lose the ability to work correctly. And he whose brain cells cannot work correctly is not and cannot be an expert. Again, an expert is like the wheat between the millstones whereby others obtain the flour and precious little of himself is left but the husks.

All the advice given may be summed up in concrete form as—Do everything possible to prevent assisting earthed conductors to collect stray transmission. Do everything possible to collect all stray transmission in earthed conductors at a lower voltage than the voltage of contiguous rails. Do everything possible to keep each and every portion of the return in a first-class condition—a bad return system costs considerable money every year in the form of wasted power. For in any centralized system of electric traction, such as that of a city, plenty of insulated return copper is an A No. 1 investment for the traction company.

TORONTO HARBOR.

W. J. Fuller, C.E.*

To discuss Toronto Harbor and give it thorough consideration from an engineering point of view one would require a great deal of information which at present does not exist, and which can only be had by a careful and thorough examination of the ground. Such an examination would include a survey of shore lines, with soundings and borings, over the whole of the harbor and Ashbridge's Bay and the foreshore from Humber Bay to Scarboro' Heights.

Many writers and engineers have proposed works for the protection and improvement of the Island and harbor, basing their proposals on pet theories as to the formation of the Island and its manner of growth and tendency to change to the depreciation of the harbor. Some such proposed works have been carried out which may not have been most suitable for the desired results.

Transportation of bulky produce and merchandise by water is fast becoming one of the most vital economic problems of the day, and coincident with the enormous growth which this traffic will undoubtedly attain all the natural harbors along its route will be utilized by it to their fullest capacity. It is evident, therefore, that the peculiar local conditions and characteristics of each harbor should be analyzed to their minutest detail, so that general plans, including the greatest possible harbor area, and disposing of same in the most economic manner possible consistent with correct interpretation of governing natural conditions, may be laid down and adopted for all future work. Toronto Harbor has surely a grand future before it, but its success will probably largely depend on whether or not such a comprehensive scheme is planned and adopted in the near future.

It should be interesting to you who are residents of Toronto to hear some of the history of the harbor as regards the engineering problems which have arisen from time to time, of the discussion of same, of theories advanced, and of subsequent improvements and works undertaken.

No two of the earlier investigators could agree in their theories of the formation of the harbor, and some very exhaustive arguments have been published, giving diametrically opposite views.

† In 1788 this harbor was minutely described by Deputy Surveyor-General J. Collins in a report to Lord Dorchester, Governor-General, on the military posts and harbors on Lakes Ontario, Erie and Huron. Mr. Collins stated it to be "near two miles in length from the entrance to the isthmus between it and a large morass to the eastward. The breadth of the entrance is about half a mile, but the navigable channel for vessels is only about 500 yards, having from 3 to 3½ fathoms water. The north or main shore the whole length of the harbor is a clay bank, from 12 to 20 feet high, and gradually rising behind, apparently good land and fit for settlement. The water is rather shoal near the shore, having but one fathom depth at 100 yards distance, two fathoms at 200 yards, and when I sounded here the waters of the lake were very high."

The first survey of the harbor was made by Bouchette in 1793. The illustration is a copy of his plan.

In his work on "British Dominions in North America," published in 1832, Mr. Bouchette describes the harbor of Toronto as follows: "The Harbor of York is nearly circular, and formed by a very narrow peninsula stretching from the western extremity of the Township of Scarborough in an oblique direction for about six miles, and terminating in a curved point nearly opposite the garrison, thus enclosing a beautiful basin about a mile and a half in diameter, capable of containing a great number of vessels, and at the entrance of which ships may remain with safety during the winter. The formation of the peninsula itself is extraordinary, being a narrow slip of land, in several places not more than sixty yards in width, but widening towards its extremity to nearly a mile. It is principally a bank of sand, slightly overgrown with grass. The widest part is very curiously intersected by many large ponds, that are the continual resorts of large quantities of wild fowl. A few trees scattered upon it greatly increases the singularity of its appearance: it lies so low that the wide expanse of Lake Ontario is seen over it. The termination of the peninsula is called Gibraltar Point, where a blockhouse has been erected. A lighthouse at the western extremity of the beach has rendered the access to the harbor safely practicable by night. The eastern part of the harbor is bounded by an extensive marsh, through which the River Don runs before it discharges itself into the basin.

"No place in either Province has made so rapid a progress as York. In the year 1793 the spot on which it stands presented only one solitary Indian wigwam. In the ensuing spring it was selected by Governor Simcoe as the seat of Government for Upper Canada."

Captain Bonnycastle's report, 1835, on the preservation of the harbor of York, Upper Canada:—

"The peninsula opposite the southern face of the Town of York appears to me to be a more ancient formation than is generally imagined. It is composed of sand in various states of cohesion, the surface being usually disintegrated, and increasing only on firmness and tenacity as it increases in depth. It is probably one of the many ridges of the bottom of the vast lake, which existed before the present Ontario and Erie were formed out of its drainage; nor has the shape of this peninsula materially altered for a vast length of time.

"The French entered the basin and fancied it a river when they first explored the country under the guidance of Hennepin, and the oldest surveys show little or no difference in its outline."

It is not necessary, however, with the object at present in view to enter into a geological disquisition to prove that the peninsula was made during the sedimentary deposition of the tertiary periods, but it is useful to that purpose to ascertain that it is not comparatively new or in the constant habit of receiving great accessions to its bulk and extension.

The opinions entertained as to the best method of making the space contained within this natural barrier to the storms of the lake answer the purpose of a secure and effectual harbor for the larger steam vessels, as well as for the small but deeply-built schooners used on this lake are to be divided into three general propositions:—

1st. That of damming up the western estuaries of the Don.

2nd. That of cutting a navigable canal through the narrows of the peninsula to the eastward or near where it joins the great marsh.

3rd. The project, partly executed, of forming a pier or breakwater on the north shore of the channel at the Garrison, and converging the entrance by another breakwater over the whole length of the shoal from Gibraltar or Blockhouse Point to the buoy."

He gives his opinion that only the very lightest material from the Don finds its way into the bay, and this mostly finds its way ultimately out into the lake; and, therefore, it was not important to shut the Don away from the harbor, especially when quantities of refuse, sewage and drainage were poured into it.

As to the second proposition, he could see no harm in trying the experiment, provided the canal were restricted and protected by extensive piers, but thought that vessels would not be tempted in strong gales to risk shipwreck by trying to make harbor through such a channel.

As to the third proposition, that of contracting the western entrance so as to obtain a greater force of undercurrent to keep the channel clear, he says:—

"The breakwater (present Queen's Wharf) has been carried out from near the Garrison in a direction to resist the effects of the ice and the heavy gales as much as possible to a distance of 800 feet from the shore, which contracts the channel at the entrance of the basin to about 850

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* Assistant Engineer Dominion Department of Public Works, Toronto, Ont.

† "Toronto of Old," by Dr. Scadding, p. 16.

feet between its extremity and the buoy. Its utility is evident: the currents in the mouth of the channel have been surprisingly increased, and we have had this winter the extraordinary occurrence of the inner channel being kept open nearly half way down to the lower wharves in the most intense frosts and whilst the rest of the basin was bound in solid ice." It is, however, only a part of the suggestion for contracting the mouth of the harbor, and to complete this proposed end it will be necessary to carry a breakwater from Gibraltar or Blockhouse Point 1,000 yards in a direct line towards the edge of the shoal.

"Having had time since giving in the above report to examine and consider upon the project for draining the marsh, I have further to report that, as the levels of the marsh appear to be favorable, I should consider that the best possible mode of affecting the drainage would be by canalling the Don River through the said marsh, by which that object would be gained and a more favorable site obtained for farming a canal than at the Narrows. I also beg to remark that, in making the sewers for the city, it would be very advisable to construct one main sewer through the whole length down to the marsh instead of lateral ones into the Bay."

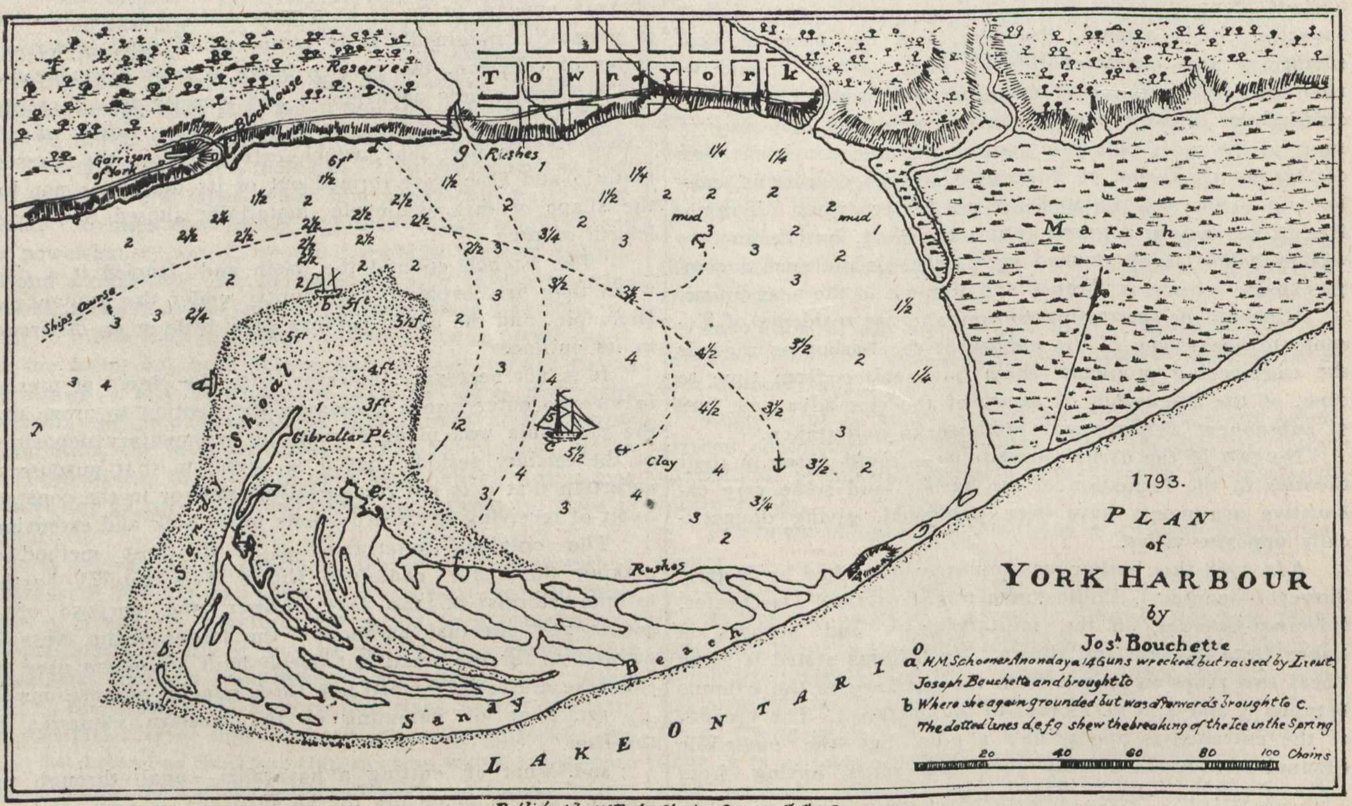
Report of C. S. Gzowski, of Commissioners of Public Works, laid before Legislative Assembly, 1847:—

"From the data that could be obtained from several masters of vessels who have certain permanent marks (now existing) to guide them coming in and going out of this harbor, it was ascertained that within these last seven years the bar has made a distance of 280 feet and narrowed the channel to 250 feet.

"There can be no doubt that the making of the bar is caused by the wash and drift of sand from the southern portion of the peninsula, which is carried when the wind is from the east, and which, from want of sufficient current from the Bay when the wind changes from the west, is not carried out, but remains, forming the bar referred to, and which, if not prevented by the construction of works and increasing and confining the current, will very soon destroy the entrance to the harbor."

In a letter published in 1853 Mr. W. Shanly gives his opinion that the western sandbar was formed and the accretion to it was due to the sediment and debris brought down by the Humber, Etobicoke, the Credit and other streams, which was carried easterly by the current caused by the prevailing south-westerly winds. Mr. Shanly stated that, from the observations and soundings recorded during twenty years by the harbormaster, it was ascertained that the bar had advanced north-westerly across the entrance at the rate of 19 feet yearly, and that the available depth of the channel was scarcely 200 feet in width. He believed that unless protection works were undertaken that in a very few years one would be able to walk from Queen's Wharf to the Island dryshod. The remedy he proposed was dredging and the construction of cribwork on the southern side of the channel to define and maintain its width and to deflect the Don into Ashbridge's Bay.

In connection with the Don he says: "While the lake and its tributaries are united in the work of blockading the entrance to your port, there is a less potent but insidious and patient enemy busy at its eastern extremity—the River Don—bearing down every spring vast quantities of rich alluvial silt from Scarborough Heights, to find a final resting-place in Toronto Bay, and so surely as it has formed hundreds of acres of land between that and Ashbridge's Bay, so surely will it continue to work cut the same mission to the detriment of the former until the hand of man shall interfere to give another direction to its labors.



Published by W. Faden Charing Cross Augt. 12th 1815.

"Doubtless the evils to be apprehended from the action of this stream are distant and insignificant as compared with those to be remedied at the entrance to the harbor; but, having more than once heard the opinion expressed that an effect beneficial to the channel, in aiding to keep it unobstructed, is due to the influx of the Don water, I wish here to record my dissent from such an opinion, being convinced that the Bay is the recipient of, and "cesspool" for, most of the matter carried down by the Don, and that the natural currents that do exist at seasons and check the more speedy formation of the bar are to be traced to an entirely different source."

In 1850 the harbor was placed in commission, Capt. Richardson being harbormaster. This gentleman submitted in his reports to the Commissioners much practical information. He seems to have had a very pessimistic turn of mind, at least in respect to the future of the habor. His report of 1854 mentions "the breach which has existed at the Narrows for a twelvemonth. . . . On the 13th August I found it 140 feet wide."

He gave his opinion with great emphasis that the western entrance was kept open by reason of the alternating in-and-out current, due to the constant and frequent rise and fall of the lake level, caused by the winds, and that a channel or breach at the Narrows would destroy such a current. To impress his views he goes on to say:—

"When, twenty years ago, upon close observation and reflection, I publicly asserted the harbor to be in an advanced stage of decay, twenty years later observation confirms my assertion.

"The present breach by the lake at the Narrows is similar to the warning shock of an earthquake before volcanic eruptions—it forebodes coming events; and an eruption of sand into the harbor during some extraordinary gale may be found as destructive to it as an eruption of lava to vineyards and villages.

"The remedy here is prevention by raising dykes and securing the integrity of the peninsula."

Under date 14th March, 1854, the following notice was issued:—

"The Commissioners of Toronto Harbor, having decided upon offering premiums for the best reports upon the improvement and preservation of the harbor and appropriated the sum of £112 10s. for that purpose, and the Common Council of the City of Toronto having also voted a similar sum for the same object—

Notice is Hereby Given

"That three premiums of £100, £75 and £50 respectively will be given for the three best reports. Such reports to embrace the following subjects:—

"The effects which have been produced, or are likely to be produced, by the present breach at the eastern extremity of the Bay of Toronto, particularly with reference to the bar at the entrance of the Bay. If prejudicial to the harbor, suggest the best means of closing it, and of strengthening that part of the peninsula against further encroachments by the waters of the lake.

"Furnish also a statement of probable cost of such works.

"If, on the other hand, a permanent opening at that end of the harbor should be shown to be a benefit rather than an injury, furnish full particulars as to the best mode of making a canal and the probable cost thereof.

"Also, as to the advisability or otherwise of enlarging the opening between the harbor and Ashbridge's Bay, or by making a permanent opening into the lake from Ashbridge's Bay, and the cost thereof."

First premium report was by Prof. Hy. Youle Hind, Professor of Chemistry of Trinity College. It begins as follows:—

"The questions proposed by the Commissioners respecting the means to be adopted for its preservation and improvement involve as a primary consideration the origin and distribution of the entire mass of accumulated materials from near the town line of Scarborough and York to within a few hundred yards south of the Garrison wharf, thus embracing the whole of the sand and shingle beach enclosing Ashbridge's Bay and the swamps of the Don together with the peninsula boundary of Toronto Harbor and its westerly subaqueous formation westerly towards the Humber Bay. . . . Notwithstanding a discussion in which so many have taken part, and which has extended over a period of fifteen to twenty years, the subject does not appear to be exhausted, and, perhaps, still offers room for additional speculations. It is essentially a geological subject, involving the purest active operation of those forces which in a scale of greater magnitude, have recorded their existence and power on the shores of every tidal and tideless expanse of water. Nor can the preservation of the harbor with any propriety be considered apart from the limits of geological science; the remedial measures proposed would then resemble guesses at a remedy for an unknown and dangerous disease."

Prof. Hind proceeds to describe the cliffs at Scarborough Heights, which, he says, are 160 to 320 feet high, and affords abundant supply of detritus to explain the formation of the sand and shingle beaches constituting the peninsula. He describes the stratification of the promontory as observed by himself in one of the gullies as follows:—

	Feet.
Yellow clay and vegetable mould	2
Stratified sand and gravel	16
Blue clay	25
Stratified sand	50
Blue clay concealed measures to water's edge	..

" . . . Coarse and fine sand, beautifully stratified, occur in vast quantities; in fact, the cliffs present every requisite feature for rapid destruction.

"They did not present these features fifty years ago, and there can be no question but that the operations of the settler have exercised a vast influence upon the recent rate of progress with which the destruction of the cliffs has taken place and (as a not very remote consequence) the alarming rapidity with which the peninsula boundary of Toronto Harbor has increased during late years. In fifty-eight years upwards of 30 acres have been added to the peninsula in deep water beyond the lighthouse, on Lighthouse Point. . . .

" . . . Now, all these enormous changes in a space of so short a time imply the existence of no ordinary forces or supply of materials, for they have occurred in deep water, and involve the removal of many million tons of shingle and sand."

The origin and formation of the peninsula appears to the writer to have been as follows: At a period far within the limit of the Christian era the coast line of the townships of Scarborough and York was continued without interruption round the north shores of Ashbridge's Bay and Toronto Harbor. The Don flowed then directly into the lake, like the Humber, Mimico, etc., at the present time, without depositing any more "delta" or bar than other rivers of its class are observed to do, and exercising no influence whatever upon the formation of any portion of the sand beaches and shoals under consideration.

Sandbars would frequently be formed under the influence of the protecting headland, about four miles from Toronto, and as frequently washed away by storms during periods of high water, their materials being distributed far and wide. With these sandbars pebbles and shingle would be occasionally mingled, and time after time might be deposited, from their great specific gravity, to form a basis for a permanent sandbar. A period of high water arrives, like the one just terminating, like the period of 1838, and during that period a sandbar of larger growth was deposited under the protecting headland. A period of low water follows, like that of 1819 or that of 1848, and during that period the sand shoal was washed up into a sand beach.

This beach would undergo numerous modifications, according to the height of water, which fluctuates in Lake Ontario to the extent of five or six feet, but as soon as its western extremity had progressed beyond the influence of the protecting headland it would be swept round to the north shore, forming the spit from the peninsula beach to near the windmill. Now, all this might have occurred during one period of low water (a few years), or it might have occupied several periods. It is, however, probable that the beach surrounding Ashbridge's Bay and the Marsh was thrown up and round during one period of low water in the lake. Now begins the existence of the marsh, which is described as consisting mainly of a floating bog, but which has been making rapid progress of late years.

The materials of which the beaches are composed have travelled along the beach of Ashbridge's Bay, impelled by wind and waves. The materials originated in the continued destruction of the Scarborough cliffs. This portion of the theory of Toronto Harbor is entirely due to Mr. Sanford Fleming, to whom the credit of having first given it to the public is unquestionably due.

Prof. Hind refers to one of the charts accompanying his report, on which he shows what he claims are the successive epochs of additions to the peninsula, stating that they are the visible and permanent records of the periods of low and high water which have distinguished the recent history of

Lake Ontario. These epochs are represented by beaches curving successively from the east gradually to the north-westward. Five of these beaches are distinctly seen between the Narrows and the south-westerly point of the Island. He further discusses his theories at considerable length, and recapitulates as follows:—

1. The harbor, in its utmost extention, is altogether a modern formation.

2. Its formation is due to the present existing protecting headland of the west commencement of Scarborough Heights.

3. Its original form was a sandbar or shoal, deposited under the protecting headland, in a position a little to the south of its present situation. The materials of which the sand shoal were composed were derived from the east, being impelled by easterly winds during a period of high water, and then washed up into a beach during a period of low water.

4. The Don exerted no influence whatever on the original formation or extension of the sand beach, but the beach was extended westerly under the headland by the same causes which originated it until it advanced so far as to be removed from the influence of the protecting headland. Subsequently, it was swept round in a northerly direction, more particularly by south and west winds, until it enclosed the space now occupied by the marshes of the Don and Ashbridge's Bay.

5. The whole valley of the Don was excavated ages before the enclosure took place, and the marshes have been produced by the same vegetable growth which now converts the ponds of the peninsula into reedy swamps. The detritus of the Don has accelerated the formation of its marshes, but that detritus consists only of the fine mud which can be mechanically suspended in water.

6. The peninsula proper has been formed by "travelling beaches" impelled along the boundary of the present Ashbridge's Bay and its westerly extension. There is every probability for supposing that each successive beach as shown on the chart are permanent records of low lake levels.

7. The boundaries of the peninsula have been immensely extended during the last fifty-eight years, and the addition of so many acres in deep water beyond the lighthouse implies the subaqueous extension of the shoals forming the sloping lake sides of the peninsula to a very considerable degree southwards.

8. The materials have been obtained by the destruction of Scarborough Cliffs. (Mr. Fleming.)

9. The operation of settlers during the last forty years in clearing the crests of the cliffs in Scarborough have occasioned the immense recent destruction there visible, and have produced, to a great degree, the alarming progress of the peninsula boundary of the harbor.

10. Previously to the settlement of the country the cliffs were much protected from atmospheric influences by trees, underbrush and grass growing on their crests and down their sides, and the beach by natural groynes of fallen timber; also by the large fragments of shale and boulders washed out of the drift, which have been removed for building purposes.

11. The progress of the travelling beaches may be arrested by groynes. (Mr. Fleming.)

12. The groynes must penetrate into a depth of water beyond the influence of the great waves upon the bottom, and the maximum and minimum level of the lake must be taken into consideration in ascertaining the depth to which they ought to be constructed.

13. The effect produced upon the beach by waves washing over it, or, in some instances, creating openings, is merely to change its position and move it a few yards to the north. This is a consequence of a vast extension of the sloping beach southwards.

14. There is no danger of a permanent breach being made by the waves of the lake.

15. Breaches are due to the concurrence of storm and high lake levels, and no breach would have been made near the Peninsula Hotel during low lake levels.

16. Evidence tends to show that the maximum level of the lake lasts for one or two years only, whereas the minimum lasts for several years.

17. (In this the writer discusses the prevention of the accretion to the western sandbar towards the Queen's Wharf as follows): A groyne must be constructed at Lighthouse Point into forty feet of water, which will cause the sand to "back up" against it and extend the dimensions of the shoal southwards; in a few years a second groyne must be constructed to the east and south, and after another interval of time a third groyne still further to the east and south, and so on. The effect of this system of groynes will be to extend the shoal southwards into deeper and deeper water, and gradually "back up" the progressing materials to their source, thus immensely strengthening the peninsula and making it a permanent and stable neck of land.

18. It is most desirable to produce a current through the channel at the Queen's Wharf. In order to effect this the Don must still be permitted to enter the Bay, but not by its present mouths. They should be closed and a mouth opened at "H" (a point two-thirds the distance to Fisherman's Island), and a channel cut for the Don to the south-eastward; the channel might be conveyed to different parts of the marsh. The waters of the Don would then percolate through the marsh, where the reeds would act as filters and effectually arrest all silt. The sewage of the town should be made to flow into the Don; in the marsh it would become inoffensive, being rapidly consumed by vegetation. The waters of the Bay would thus be greatly purified. The passage of the Don through Ashbridge's Bay could not be maintained.

Any opening in the form of a canal between a few hundred yards to the east of Lighthouse Point and the eastern extremity of Ashbridge's Bay could not be kept open without the construction of works into deep water and of groynes into deep water east and west of it.

A paper read before the Canadian Institute in 1850 by Sir Sanford Fleming, accompanied by a later report, was given the second premium, and the following are some paragraphs and extracts from them:—

"The origin of the now wealthy and flourishing city of Toronto is, in common with that of many other cities and towns, clearly traceable to certain natural advantages possessed by their localities. A waterfall, or rapid stream, the navigable termination of a river, or its junction with a lake or other open navigation, will frequently account for the position of a town or village in an agricultural or manufacturing district; but a natural harbor of easy access will generally, if not universally, point out the locality of a thriving commercial nucleus in all countries open to settlement and civilization.

"To none of these circumstances, except the last, can we attribute the origin of Toronto, and to the unequalled excellence of this harbor, forming on the north shore of Lake Ontario the most facile outlet for the productions of the back country, is principally due the rapid and uninterrupted progress in commerce and in wealth of the western capital. To maintain this harbor in its original state, or, if practicable, to improve thereon, so as to insure a continuance of prosperity, becomes, therefore, of the utmost importance.

"Few persons visiting Toronto for the fist time but are struck with the singular appearance of the neck of land or peninsula stretching out into the lake in front of the town, so curiously shaped and so different from the land on shore that many are doubtless led to theorize a little on its formation. Some who have probably arrived in the Province by way of Niagara, and crossed over with their minds filled with the contemplations of the mighty cataract, at once and without much consideration attribute to the descending torrents of that river the power of elevating from the depths of the lake or of carrying across in suspension the drift deposited here—a theory wild and incapable of defence, though some are bold enough to venture it.

"Others again, who have probably arrived from the west, or whose business takes them frequently in that direction, and from the steamer generally calling at the mouths of the various small rivers emptying into the lake between this and Hamilton, may be induced to think that these streams have had the effect of drifting the debris of the uplands outwards, which, with the assistance of an imaginary eastward current of the lake, is carried until meeting a contrary current, supposed to be of the Don, then the matter held in suspension is supposed to have been deposited at their junction line opposite Toronto. The advocates of this theory have yet to prove that such currents of the lake as these exist in reality. All these streams, with the exception of the Don, enter the lake nearly at right angles, and it is impossible that they can flow into a large and deep body of water such as exists between their mouths and the point in question without being entirely diffused; nor could the drift brought down by them be carried wholly or chiefly in one particular direction without a most powerful current, but would, if ponderous, be deposited at their outlet, and, if light, would be distributed far and wide.

"More especially it is reasonable to infer that the peninsula is neither now affected in any way by these western streams and the imaginary currents in conjunction with them, nor has been formed by their drift, since the material composing it, sand and gravel, could not, in accordance with existing laws, be held in suspension and transported for miles over still water 60 and 100 feet deep.

"Were the deposit, or any part of it, of an argillaceous nature, there would have been some slight reason to think that these streams might have been auxiliaries, but such is not the case."

The writer goes on through a lengthy argument to set forth his theory of travelling beaches, with source of supply, at Scarborough Heights in a manner somewhat different but fundamentally the same as pursued by Prof. Hind, quoted above, who gives Sir Sanford Fleming full credit of founding this theory and first promoting the idea of placing groynes on the beach to check the westward flow of sand, and thereby prevent the northward march of the western sandbar, or Gibraltar Point, as it was called in the early days, thus preventing the filling up of the channel, and also to widen and strengthen the neck of the peninsula at the south-easterly end of the harbor.

It must be remembered by the present day reader that in 1850-4, when these last two reports were written, there were no works whatever in connection with the peninsula, or, as now called, Toronto Island and Fisherman's Island, except Queen's Wharf, and the southern beach was unbroken by the present Eastern Gap, or rather, that this latter had just begun to exist. Also, that the western sandbar was advancing northward at phenomenal speed; in fifty years it had encroached on the channel over 1,000 feet, depositing therein upwards of 1,000,000 cubic yards of sand. Hence, the liveliest question relating to the harbor in 1850 was the preservation of the channel.

Sir Sanford Fleming advocated the building of the cribwork on the south side of the western channel to check the flow of sand, and this was done later. After discussing the particular locations of groynes referred to a plan, he goes on to discuss the problem of the proposed eastern entrance, preluding the subject by important paragraphs, as follows:—

"If the destruction of the harbor entrance, and the formation of the peninsula generally, be satisfactorily determined, I think that it is equally conclusive that these works, or works of the same character, would, if established in due time, be exercised to a very beneficial result—the preservation of the harbor for an indefinitely long period.

"There are other evils which, if they affect the salubrity of the city more immediately than they prove detrimental to the harbor, are not, on that account, of the less consequence. The Don annually transports, even at this day, considerable quantities of silt from the interior of the country to the marsh, and during freshets a portion escapes from thence into the harbor through the openings in the beach between the windmill and Privat's, tending, of course, when deposited in the basin, to lessen its depth.

"All the drains and sewers empty into the Bay, making it, in truth, the grand cesspool for a population of probably 30,000 inhabitants, with their horses and cattle. The sewers of necessity bring down no inconsiderable quantity of solid matter, impairing greatly the purity of the water in the harbor, as well as gradually lessening its depth. This evil, increasing in a proportionate ratio to the growth of the city, might be greatly ameliorated, if not almost totally removed, by the construction of a main sewer along the whole city front eastward to the marsh. Into this sewer all the lateral ones from the north and the drainage of gas, chemical and other such works should be made to discharge. The feculent mixtures produced would thus be collected and conveyed to a distant point, where, by simiar operations to those now ripening in Britain, which will strip them not only of their noxious, but even of their offensive characters, might be profitably converted into a market commodity of the highest value to the farmer.

"The prejudicial effect of the Don on the depth of the harbor may be also destroyed by closing its present outlet and forming an opening of sufficient capacity in the beach, separating the main lake from Ashbridge's Bay.

"All proposed works relative to the improvement of the harbor should be carefully considered before any be proceeded with, lest some of them may interfere with preservative measures, or with the general improvement of the whole. It may not be out of place, therefore, to consider another proposition which for many years has engaged public attention, viz., the forming an on eastern entrance."

In 1835 the following notice was gazetted amongst the notices of public improvements:—

"Take Notice.—The inhabitants of the City of Toronto will make application to the next session of the Provincial Parliament to incorporate them into a company for the purpose of opening a ship navigation through the neck of the peninsula between the lake and Bay of Toronto."

It is unnecessary to say that the contemplated improvement was not carried out.

Knowing the nature of the action of the beach at the proposed site of the canal—and I think it is established beyond a doubt—there can be no possible danger of any part of the peninsula being torn away or the basin within being filled up with sand if proper steps be taken to counteract such action. This action is chiefly the progressive motion of the beach, which would effectually be suspended for many years by the piers of the canal themselves, constructed with cribwork in the ordinary manner.

The eastern pier, presenting an obstruction to the motion of the beach westward, would, acting as a groyne, retain it permanently at its eastern side. The sand thus accumulating would strengthen the peninsula at its weakest point.

The entire destruction of the isthmus, although hypothetical, is nevertheless a contingency advisable to guard against. Openings have repeatedly been forced through the ridge bounding Ashbridge's Bay by gales point blank on the beach; these having a destructive action only, might produce a similar result here. If, at the same period, the base of the Scarborough Heights became partially protected from the fury of the waves by the lodgment of an unusual number of trees or from the falling of boulders from the cliffs above, the supply of sand from the east would, for a time, be diminished, the gap would remain open, and liable to be widened at every southerly wind. The peninsula would thus be converted into an island, resembling its kindred formation, "Long Point," on Lake Erie.

The canal, having thus the effect of widening the isthmus and removing all probability of its destruction, would, besides being a great accommodation to sailing craft in adverse winds and to steam vessels at all times, likely enough prove of service in another respect. The purity of the water in the Bay is ever liable to be impaired by the vessels in dock and its close proximity to the city. The canal would provide an additional opening for the ingress and egress of the slight tidal waves formerly referred to, doubtless presenting greater facilities for the renewal of the water in the harbor on its occasional fluctuations in level.

In 1853 a breach was made through the peninsula near Privat's Hotel (at present Eastern Gap), but closed the following year. In 1857 the Gap again formed, and continued open till closed by breakwaters. No works in the meantime were undertaken for the protection of the Island or harbor, and those in charge began to imagine the destruction of the Island and harbor as all but accomplished. Especially was this so in the case of Mr. Hugh Richardson, harbormaster for many years. In his annual report of 1865 he gives information regarding changes in the shore lines as follows:—

"Of the eastern channel little favorable can be said, for there is a bank of sand thrown in for at least 500 yards distant from the old line of beach, with only six feet of water upon it, which makes it of little value."

In 1875 Wm. Kingsford, Government Engineer-in-Charge, made surveys of the harbor with a view of ascertaining where he would be most justified in recommending the parliamentary appropriation in that year of $20,000 to be spent. He presented a very able report to the Public Works Department, in which he states:—

"It is clearly demonstrated by the surveys of 1874, taken in connection with the ancient survey of Bouchette, that the harbor is not filling up, and that it is in no danger of destruction, and that no special steps are required for its preservation.

"The opening of the Eastern Gap is not an injury to the city, and that no work of protection is required to stay the movement of the sand at this point.

"Whatever opinion to be given with regard to this harbor, it must be based on a few facts, and to a large extent be a matter of theory; and a remedy cannot be applied until the cause of injury be discovered."

He recommended the expenditure to be made in dredging operations at the western channel to keep it clear for present needs.

In 1879 the city council, in view of the continued extension of the sandbar into the western channel having narrowed it up to that time to 330 feet, and because of the continued widening of the Eastern Gap, petitioned the Government to have a survey made by competent engineers to ascertain the best means of protecting the harbor.

Acting on this, the Department of Public Works in 1881 engaged James B. Eads, C.E., of St. Louis, to make an examination and report.

This report Mr. Eads submitted in 1882. After referring to previous reports and maps and making comments thereon, he proceeds to analyze the problem of the growth of the western sandbar through a clever argument, and concludes with the following recommendation:—

1. The closure of the Eastern Gap with a dyke of sheet piling, protected on the sea side with brush and stone.

2. The construction of a channel with parallel piers through the western sandbar to connect the deep water of the harbor with the deep water in the lake. He argued in favor of this new work, because he estimated that it would cost far less than a similar work located at the Eastern Gap, owing to a lesser length necessary for both piers and dredging, or than for dredging and improving the existing western channel because of the enormous expense involved in excavating the rock bottom to the desired depth.

3. The closure of the present western channel.

4. The closure of all communication between the harbor and Ashbridge's Bay with a dyke of light sheet piling or one of earth.

In reviewing the reports of investigations and findings of the several gentlemen whose reports and writings are on record one is struck by the unanimity of the following opinions:—

1. That Toronto Island has been formed by materials carried by current and wave action from the eastward, principally from the vicinity of Scarborough Heights.

2. That without continual dredging only one opening in the harbor would exist, and that would be on the west side of the Island, and its cross-section area would depend on the currents through it. Opinion was divided as to whether the Don contributed materialy to such a current or not, but all would seem to agree that if the waters of the Don were first flowed over the marsh so that its sediment would deposit there that its waters would then be beneficial to the harbor.

3. As a natural sequence of the above that a proposed eastern entrance should not be entertained.

4. That if an entrance were to be maintained at the easterly end of the harbor very lengthy piers would have to be built out into the lake. These piers would arrest and collect the drift sand, thus strengthening the weakest part of the sandbar, but that finally the area immediately east of them would fill up, and then the sand would drift around past the south end and a part of it be deposited between the piers, and large sums of money would be required to be spent in dredging to keep the channel deep enough for navigation.

5. That the harbor proper is in no danger of being filled up by sand being washed in, and the only agencies at work to that end are the unfortunate flooding of the Bay with sewage and the sediment from the Don River.

Those in charge of the harbor works at present know that accretion to the Island is continuous. Some twenty-four acres have been added on the lake side at the eastern channel, of which 9½ acres are on the west side. Sand is continually drifting past the south end of the piers, as is evidenced by the dredging operations required there every two or three years. Large quantities are removed in this way. Probably such quantities represent only a moderate percentage of the total drift. Where it goes is not apparent to the writer, and this is one point of much interest which would be important to determine by a survey of the shoals about the lake side of the Island. It evidently is drifting along the bottom out from the shore for the most part. The accretion immediately to the west of the piers is doubtless driven in by the south-west and southerly waves obeying the same laws which sends the sand northerly along the western sandbar. From casual observation I think that a large quantity has been deposited immediately west of Lighthouse Point or Gibraltar Point, as it is now called, and we may very soon see the beginning of another spit or point extending northward from this place, and during the next low water period this will probably be added to and gradually extend and form another bar similar to the present western sandbar.

The present dry land from the south-west point of the Island to the western channel is the creation of about one hundred years. There is no reason why another will not form.

The present eastern channel works, the breakwater from the mouth of the Don to Fisherman's Island and the breakwaters on either side of the channel piers were begun in 1882 and not fully completed till 1900. As you all know, dredging has been constantly necessary to keep the channel in a proper navigable condition. This year (1908) there has been a minimum depth in the channel and approach of about 20 feet.

The wreck of the steamer "Resolute" in 1906, with the accompanying deplorable loss of life, brought such a storm of protest against the insufficiency of the western entrance for deep-draught boats, and the danger in making the eastern entrance in violent weather being so indisputable, the Government decided to undertake the construction of a new western entrance. It was decided to make an entirely new entrance, as it was found after careful estimating by Government Engineer-in-Charge, Mr. J. G. Sing, that the cost of improving the existing channel past Queen's Wharf to make the required depth would be at least $150,000 greater.

The advantages of the new channel will be manifold. It will be 400 feet wide—50 feet wider than the old one. The entrance will be perfectly straight in from the open. A boat, in fact, on her course from Hamilton would run straight through the channel into the Bay; the range lights on the piers will be far removed from conflicting city lights and will reduce danger from that source, and there will be no rock to damage a ship's bottom if she gets a little off her course.

The piers are to be of wood cribwork substructure, capped by concrete, and will rest on bed rock throughout.

They will extend from the Bay side of the bar outward a distance of 2,500 feet, and the available depth by dredging sand alone will be 22 feet at ordinary stages of water level. The cost of this work will be about half a million dollars.

Incidentally, the hydraulic dredge is required to make about twenty-five acres of new land, four to five feet above water-level.

The present year's almost unprcedented high water levels caused a great panic among the owners of cottages on the Island, especially along the lake front from Centre Island easterly; and, indeed, the situation was very serious looking for a time. During two or three violent storms in May and June some few waves topped the crest of the Island and flowed over into the lagoon behind the Yacht Club. Fortunately these storms were not of long duration or much serious damage would have been done. During this summer the Government has added several thousand yards of large stone, weighing from one to five tons each, to the face of the lake shore breakwater, and an extension of the breakwater 1,500 feet westerly is now under construction by contract at a cost of $40,000, and will be possibly completed this fall, which will effectually prevent a recurrence of the recent danger. All of these works have been undertaken by the Government with a view of preserving and improving Toronto Harbor. Incidentally, they have directly protected and preserved the immensely valuable city property on the Island.

In concluding this paper it might be in order to suggest that probably by the time the new channel is completed the popular project of a 22-foot Welland Canal will have had a beginning. That work is so necessary a link in the giant transportation scheme of the country that it is bound to be undertaken at an early date. Then how will Toronto find accommodation for her immensely increased shipping? Is it not time for the city to lay out a generously dimensioned plan of a main channel, with numerous slips leading therefrom, covering the whole of Ashbridge's Bay? Toronto's present waterfront will not by any means accommodate the future demand for dockage space.

All boats bound down from Fort William and upper lake ports will be looking for a return cargo. Such cargoes must be either coal or manufactured articles. The latter, one would suppose, must be had from imports landed at Montreal and from merchandise of Canadian manufacture collected mainly from Montreal and Toronto.

Toronto's harbor of the future must extend behind the full length of its natural breakwater; that is, from Queen's Wharf to the utmost end of Ashbridge's Bay.

The breakwater at Buffalo of much less length cost over $4,000,000. It is a bold, unattractive structure of wood and concrete and stone.

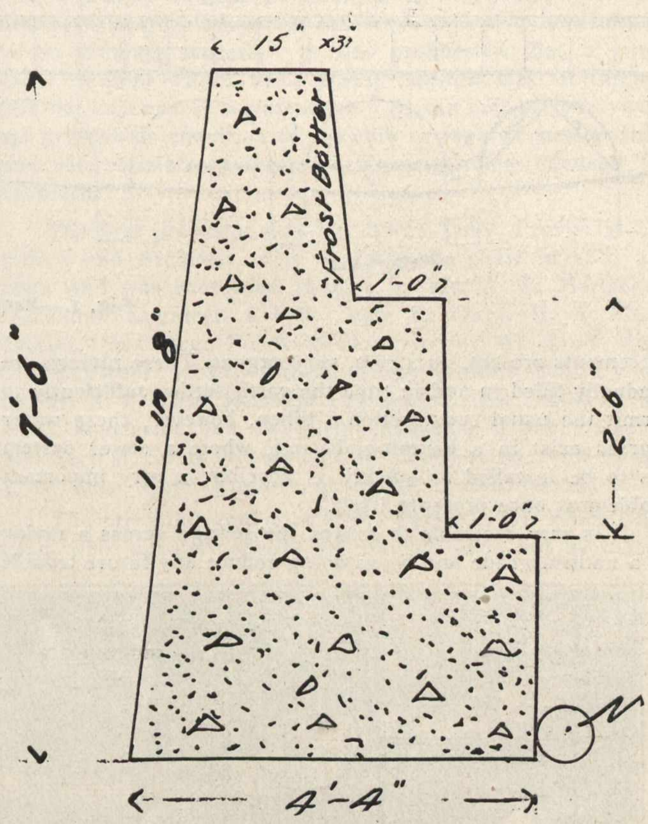
Toronto's breakwater costs nothing, and is for the most part capable of being made into clean, beautiful parks, with ideal bathing beaches, and always the pure air from the magnificent expanse of Lake Ontario to fill the tired lungs of the crowded city dwellers. No other city on the Great Lakes has such a perfect natural harbor, much less such a wonderful island park immediately at her door.

The harbor and Island should by all means be preserved from the filth of the sewers and garbage waste. The city is to be congratulated that at last it has made a step to this end by undertaking the construction of a sewage disposal plant, and it is to be hoped that this plant or plants will be satisfactory and capable of extension to handle the total sewage of the city, present and future.

At a meeting of the Council of the Royal Institute of British Architects, held in the rooms of the Institute, No. 2 Conduit Street, London (England), on 10th January, it was resolved unanimously that the request of the Architectural Institute of Canada to become an allied society of the Royal Institute be approved, and that the necessary arrangements be made.

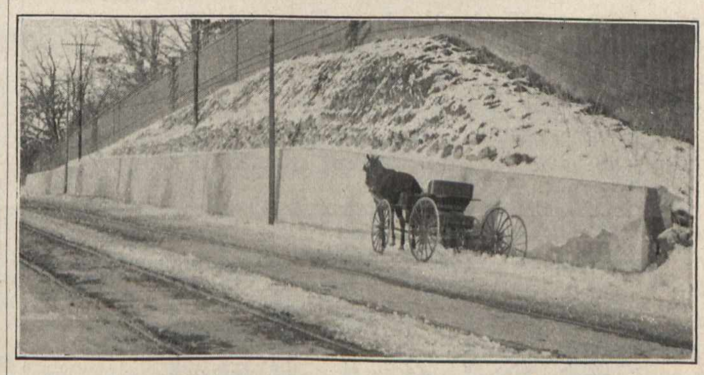
CONCRETE RETAINING WALL.

That concrete is admirably adapted for construction work where economy and permanency are desired is particularly noticeable in the case of concrete retaining walls. This type of construction may be found everywhere. The artistic and finished appearance of concrete has also been instrumental in bringing it into such universal use for this work. The city of Toronto



End Sections of Wall.

has recently completed a concrete retaining wall on the east side of Avenue Road Hill, extending for a distance of 250 feet, protecting the property of the McCormick Estate. The work was commenced by the city during April, 1908, and completed during July. The excavations at wall ends were made to comply with the form of wall as shown in the accompanying view. The wall throughout was constructed of concrete of the following pro-



Concrete Retaining Wall, Avenue Road Hill, Toronto.

portions: One part Portland cement, three parts clean, coarse, sharp sand, and five parts broken stone. The facing, which was 3½ inches in thickness, consisted of one part cement and two parts clean, sharp sand. The foundations were built on hard pan. The entire work cost $3,000. The accompanying view shows the completed wall, a model of neatness and durability, that could not be obtained from any other material.

CONCRETE VIADUCT FOR A SEWER.

W. R. Worthington, B.A.Sc.

In Municipal Engineering little obstructions are continually cropping up. Among the most frequent are the natural water courses, which break the continuity of the existing roadways. The magnitude of this particular kind of obstruction is governed by the locality and circumstances.

There is practically no difficulty experienced with these water courses in the outlying districts where permanent improvements are not, as a rule, very urgent. These ravines are gradually filled in and in time the earth settles sufficiently to permit the usual construction. When, however, these water courses exist in a booming district, where a sewer system has to be installed as quickly as possible, a very important problem at once presents itself.

It is very desirable to convey the sewage across a ravine on a natural grade and by so doing reduce any future trouble to a minimum. To do this, it is essential to construct a well designed and economical structure to carry the sewer with any necessary filling. One is apt to think an inverted syphon would do equally as well and properly so, if you had the assurance that no future trouble would occur. On the contrary, those who have had any practical experience with syphons know there is frequently trouble. Under the very best conditions, inspection and cleansing chambers are absolutely necessary and these in residential districts would create a perpetual nuisance.

In the spring of 1908 the York County Loan applied for a sewer system for their large stretch of residential property in the western part of Toronto. In designing the system, it was found necessary to carry the main sewer down Sunnyside Avenue. This sewer had to cross a ravine 25-feet deep and 10-feet below the invert of our proposed sewer. On taking into consideration all the conditions a concrete viaduct was thought most advisable. The general design, as in Fig. 1, and a brief description is given below.

The size of the sewer required on Sunnyside Avenue was a 24-inch tile pipe, the construction of which was very simple until we arrived at the ravine. The viaduct was to commence here so that the sewage could be conveyed across at a natural grade.

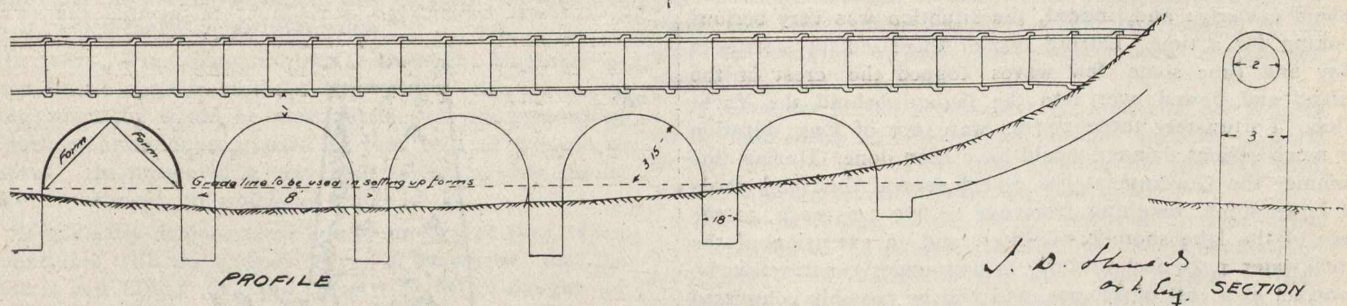
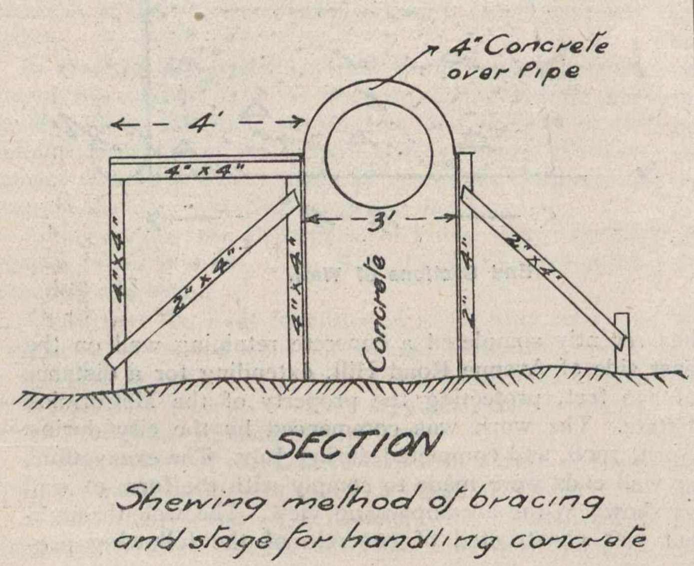
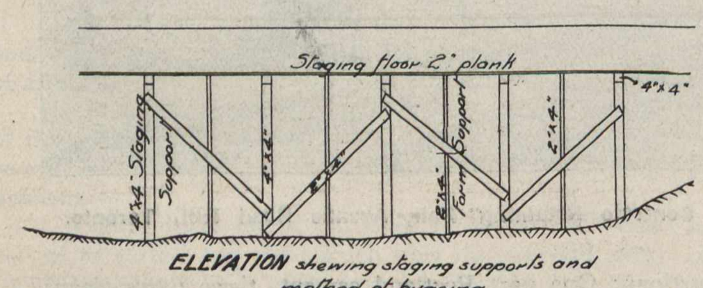


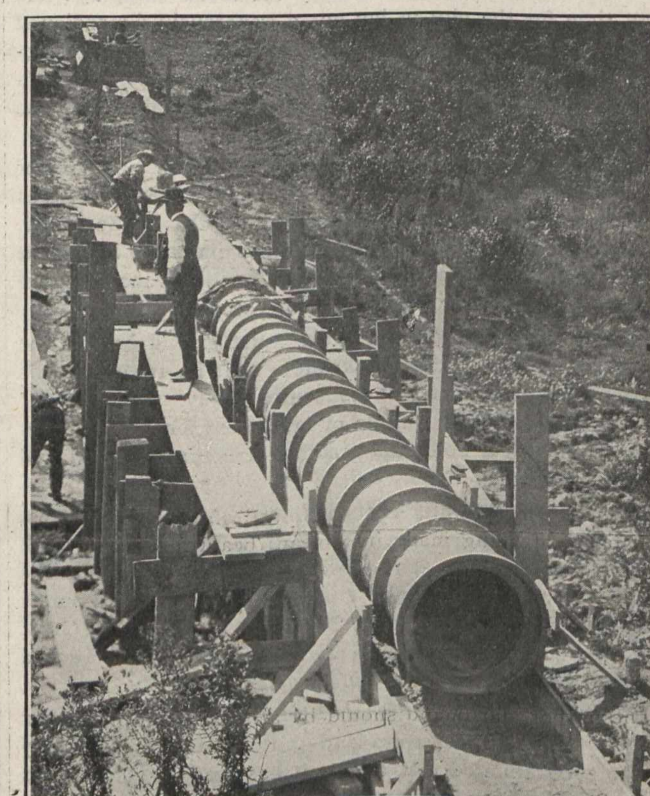
Fig. 1.—Profile and Section.

In constructing this viaduct, the footings were built one day and the abutment the next, just leaving the series of arches to be constructed as expeditiously as possible.

Considerable excavation was necessary to secure good foundation for the footings which were 5 feet by 3 feet 6 inches, and 1 foot 6 inches thick, with pieces of 1½-inch gas pipe left protruding to prevent any movement of the abutments. The abutments were 3 feet by 1 foot 6 inches, and built upon the footings to a height of 4 feet 4 inches below the grade line of the invert of the sewer. Here also two pieces of gas pipe were left projecting to make a bond for the superstructure.







Placing Pipe.

A foot of concrete at the centre of the arches which had a radius of 3 feet 2 inches, (Fig. 1), was found sufficiently strong to support the sewer along with the required filling to bring the depression up to the roadway grade.

After the forms were set for the superstructure, the concrete was filled in to within two inches of the invert of the sewer, leaving slight depressions every two feet to receive the collars of each pipe. Toward the end of the day great care was taken to have the concrete finished directly over the abutments.

As the concrete set fairly hard, the pipe layers followed up and the pipes were surrounded by four inches of concrete, the top being finished off in a semi-circular form.

The concrete used for the entire structure was one of cement, two of good sharp sand and five of 1-inch broken lime stone.

When the work was completed and had set for about ten days the forms were removed and the whole structure presented an appearance as shown in Fig. 3.

The construction, exclusive of pipe, cost about $3 per lineal foot.

This work was carried out under the supervision of Mr. J. D. Shields, B.A.Sc., Sewer Engineer, Toronto.

THE ENGINEERS' CLUB OF TORONTO.

A. B. Barry.*

The early days of the club are best described in the introduction to "Bulletin list," issued in 1903, of which the following is extracted:—

"Early in the year 1899, as the result of several conferences between the conveners, it was decided to call a meeting of the Engineers, Architects and Land Surveyors resident in Toronto, to obtain their views as to the desirability of forming a society or club. The notice calling the meeting, dated February 16th, was signed by W. T. Jennings, John Galbraith, E. H. Keating, E. B. Temple, Robert McCallum, C. H. Rust, and Willis Chipman.

"The first meeting was held at the School of Practical Science, on the evening of February 23rd, and after some discussion it was resolved to organize a club, to consist of members of the Engineering, Architectural and Surveying professions resident in Toronto and vicinity. A committee was appointed to draft a Constitution and By-laws and to report at an adjourned meeting to be held on March 9th.

"At the next meeting a draft constitution was presented, and with some slight amendments adopted. The committee was instructed to ascertain the cost of a suitable club-room, and to send out a circular submitting a number of questions relating to club-room fees, etc. An adjournment was made till April 11th.

"At this adjourned meeting, as a result of the replies to the printed circular dated April 6th, it was decided to defer the renting of a club-room, but to organize the club and elect officers at a meeting to be held in May. Of the fifty ballots received, thirty-five favoured a down-town club-room, and expressed themselves as willing to contribute $5 annually.

"The fourth preliminary, which may be called the first annual meeting, was held at the Rossin House, on May 5th. About twenty-five engineers and surveyors attended. The club was fully organized, under the name of the 'Engineers' Club of Toronto,' and the membership fee was fixed at $1 for the current year. The constitution was adopted, and officers elected.

"The constitution was printed, with a list of officers, and a copy sent to every engineer, surveyor and architect resident in the city, with an invitation to attend the first regular monthly meeting on June 6th.

"The club was now fairly launched. Many engineers who expressed themselves as in favor of forming the club, and as willing to support it in every way, were in doubt as to its ultimate success. It was prophesied that it would cease to exist within three years, through lack of interest and the expense of maintenance. At the end of four years, the prosperous condition of the club as regards membership, and the satisfactory financial showing, have silenced the doubters."

The first president was Mr. Kivas Tully, Provincial Engineer and Architect, who occupied the chair in 1889 and 1890, and was succeeded in 1901 by Mr. A. L. Hertzberg, Divisional Engineer, C.P.R.; 1902 by Major H. A. Gray, Engineer-in-Charge Public Works; 1903 by Mr. C. H. Rust, City Engineer; 1904 by Captain Killaly Gamble, D.L.S.; 1905 by Mr. R. F. Tate, Resident Engineer, C.N.R.; 1906 by Mr. F. L. Somerville, late Divisional Engineer G.T.R.; 1907 by Mr. Cecil B. Smith, Hydro-Electric Commission; 1908 by Mr. J. G. Sing, Chief Engineer-in-Charge Public Works.

The presiding genius from the start was Mr. Willis Chipman, who, not only originated the club idea, but by his untiring energy and business methods, harmonized conflicting interests and prejudices and, by arrangement with the Ontario Association of Architects was finally enabled to provide the present rooms and place the club on a sound financial basis.

The membership has increased yearly, and at present there is a roll of about 300, including civil, mechanical, electrical, hydraulic, and mining engineers, architects, land surveyors, geologists, mineralogists and college professors, etc.

Some time since it was proposed to elect "associate" members, or those other than "professionals," but by an overwhelming majority the proposal was defeated, and the qualification for membership still restricted to those only who have had at least three years responsible charge in engineering or applied science, graduates in civil engineering from any Canadian, British or foreign universities or the Royal Military College of Canada, Dominion and Ontario Land Surveyors, etc.

Meetings are held every Thursday at 8 p.m., except during summer months, but the rooms are open at all times to members who may wish to consult the technical library or magazines and papers.

At the weekly meetings papers are read and discussed, generally upon engineering topics, but at times scientific matters of general interest are presented, and opportunity is also afforded to bring any matter before the club which

Fig. 3.—Completed Viaduct.

* President of the Engineers' Club, 1909.

might be considered advantageous to the members of the profession generally.

Municipal engineering matters are freely discussed, and recently a very strong petition was presented to the Dominion Government urging that a "Canadian" Engineer be appointed upon the Quebec Bridge Commission, and there appears to be every prospect of success, and the steps already taken by the executive have met with universal approval all over the country.

The social side of the club must not be overlooked, especially in its influence upon the younger members, many of whom are thereby enabled to seek advice from, and consult with older members of the profession upon technical experiences, ethics, and practice, and the members being constantly thrown together in lecture, reading or smoking rooms, must acquire a friendly feeling towards each other, and the reserve of "strangers" is broken down and replaced by a willingness to give and take, this has been observed where engineers representing diverse interests, have in a friendly manner so brought their principals together that satisfactory settlements have been made without recourse to litigation.

It is hoped in the near future to either enlarge our present rooms or acquire new quarters so as to provide for our increasing wants, and as soon as possible steps will be taken in this direction.

THE SCHOOL OF PRACTICAL SCIENCE.

C. H. C. Wright, B.A.Sc.

Early in 1871, the Government of Ontario appointed a commission consisting of Drs. Hodgetts and Machattie, to visit the United States to inquire into and report on the working of those schools devoted to the study of Practical Science. As a result of this investigation, the Premier, Hon. John Sandfield Macdonald, proposed to the Legislature to establish a College of Technology in Toronto for the purpose of giving instruction in Applied Science. In order to develop the industrial resources it was proposed to hold night classes for the artisan who could not attend during the day as well as day classes for those who could devote their whole time to study. In order to carry out this proposal the building now occupied by the Public Library on Church Street was bought from the Mechanics' Institute and equipped for the purpose. Before the college was ready to begin work a change of government took place, and the new Prime Minister, Hon. Alexander Mackenzie, and his chief advisers, who were not in sympathy with the proposed method, established the evening classes for workmen and left the balance of the scheme for further consideration. These evening classes were conducted for a number of years by the following instructors:—James Loudon, Instructor in Mechanics; W. Armstrong, Instructor in Drawing; and W. H. Ellis, Instructor in Chemistry.

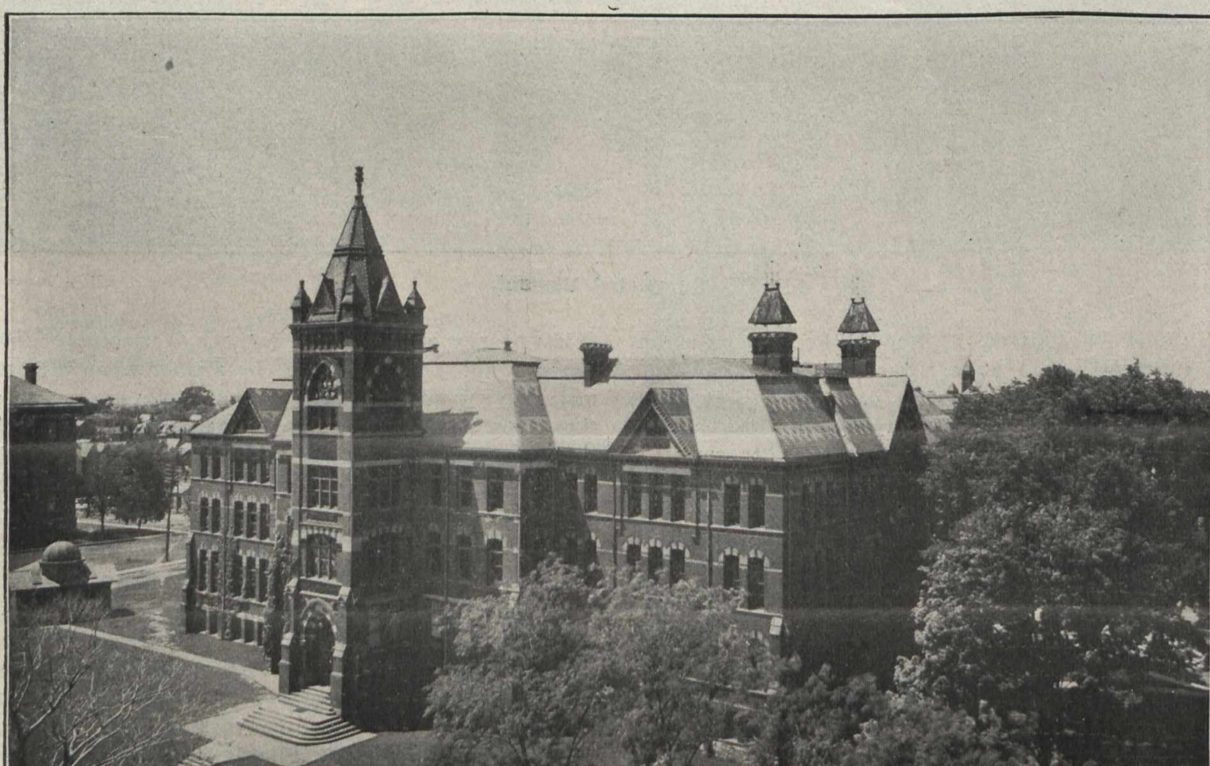
A comprehensive report on the question of technical education was made by Professor James Loudon in 1875 to the Legislature, and in 1877 the Minister of Education, Hon. Adam Crooks, proposed to establish a School of Practical Science along the lines suggested in this report. In accordance with this minute of the Minister of Education, a building was erected near the Provincial University, and the teaching staff of University College was utilized as far as possible.

The first session of the school began in 1878, with six students and the following staff:—H. H. Croft, D.C.L., Professor of Chemistry and Chairman of the Board; E. J. Chapman, Ph.D., LL.D., Professor of Mineralogy and Geology; James Loudon, M.A., Professor of Mathematics and Natural Philosophy; R. Ramsay Wright, M.A., B.Sc., Professor of Biology; John Galbraith, M.A., Professor Engineering; W. H. Ellis, M.A., M.B., assistant to the Professor in Chemistry.

In this connection the following quotation from the first calendar of the school is interesting:—

"The position which it is intended the School of Practical Science shall satisfactorily occupy in our educational system may be indicated as follows:—Firstly, students who have passed through the regular courses of the school will be enabled to prosecute professionally, (1) Engineering; (2) Assaying and Mining Geology, or (3) Analytical and Applied Chemistry. With this view the diploma admitting to the standing of "Associate of the School" will be granted in each of these branches after due examination."

In 1884 the degree of C.E. was established by the University of Toronto, the statute of the Senate providing that the candidate shall hold the diploma of the School in Civil Engineering, shall have spent 3 years in the actual practice of the profession, and submit a suitable thesis on an engineering subject accompanied with drawings, specifications and estimates, etc. The degree was first conferred in 1885 on Mr. J. L. Morris, of Pembroke, Ontario, a graduate of 1881.



Engineering Building—Toronto University.

The University Federation Act of 1887 transferred the instructors of University College, who were assisting in the school to the staff of the University of Toronto, thus severing the connection between University College and the S.P.S. In order that the students of the School might continue to enjoy the advantage of the instruction from the University teaching staff, the Senate passed a statute in October, 1889, affiliating the School to the University. As the result of a visit of the Hon. G. W. Ross, Minister of Education, and J. Galbraith, Professor of Engineering, to the Universities of the United States in 1888 it was decided to establish engineering laboratories in the School. By an Order-in-Council, dated November 6th, 1889, another change was made, and the management of the School was entrusted to a council composed of the Principal as Chairman, and the professors, lecturers, and demonstrators appointed on the teaching staff of the School. The old board was superseded by the new council in October 1890, at the beginning of the 13th session of the School. The first council was composed as follows:—John Galbraith, Professor of Engineering, Principal and Chairman; W. H. Ellis, Professor of Applied Chemistry; L. B. Stewart, Lecturer in Surveying; T. R. Rosebrugh, Demonstrator in Engineering Laboratory; C. H. C. Wright, Lecturer in Architecture.

The building erected in 1877-78, i.e., the north wing of the present Engineering Building, accommodated in addition to the School of Practical Science, the Departments of

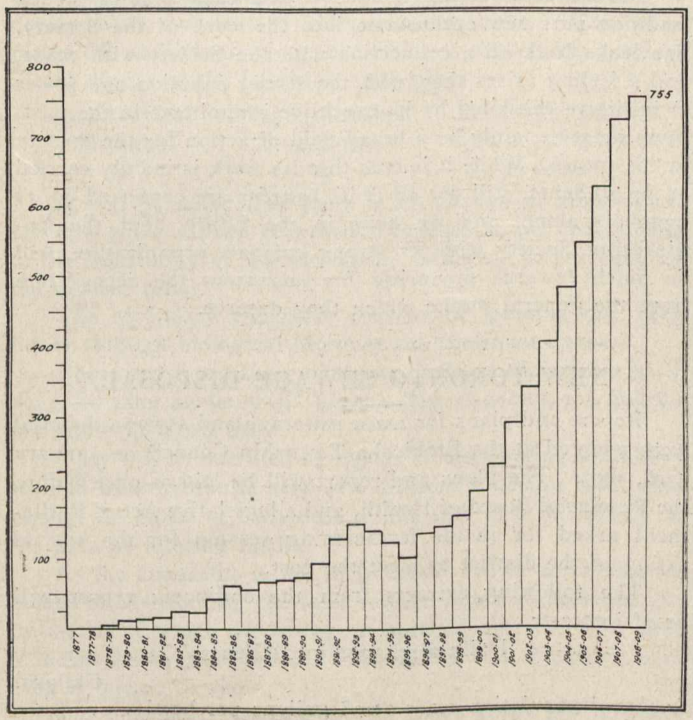


Diagram Showing Increase in Attendance.

Biology, Chemistry and Mineralogy, and Geology of the University. Ten years later the Biological Building was erected, and again enlarged in 1890, thus providing accommodation for the departments of Biology and Mineralogy and Geology. In 1889-90 the S.P.S. was enlarged by the erection of the central portion and of the south wing. For three years after the University fire in 1890 the Library of the University occupied rooms on the top floor of the School, and an extra story was added to the eastern and western portions of the north wing as reading rooms. In 1894, the University department of Chemistry was transferred to its new quarters and the Engineering Building completely devoted to the work of the School. During 1901 plans were drawn for the Chemistry and Mining Building, facing College Street. This building was completed in 1905, and provides accommodation for Applied Chemistry, Mining, Mineralogy and Geology.

The Senate of the University in 1892 passed a statute establishing the degree of B.A.Sc. By this statute the candidate was required to hold the diploma of the School, to have fulfilled the conditions respecting the fourth or post-graduate year, to present a thesis based on the result of this year, and to pass a satisfactory examination. In 1896, the University Senate passed a statute amending the requirements for the degree of Civil Engineer (C.E.), and establishing the other professional degrees of Mining Engineer (M.E.), Mechanical Engineer (M.E.), and Electrical Engineer (E.E.).

In 1905 the Government, of which Sir James P. Whitney was Premier, appointed a Commission, consisting of Goldwin Smith, Esq., D.C.L.; Sir William R. Meredith; J. W. Flavelle, Esq.; Byron E. Walker, LL.D.; A. H. U. Colquhoun, B.A.; Rev. H. J. Cody, M.A.; Rev. D. Bruce Macdonald, M.A.; to inquire into and report upon a scheme of organization, management and government of the University of Toronto. In their report on the School of Practical Science, the Commission say:—

"The nature of the tie between the S.P.S. and the University has long been one of the anomalies of the administrative system. The form in which their relations were cast by successive Acts of the Legislature and by Orders-in-Council, has been, we are convinced, injurious to both institutions.

"In recommending the union of the S.P.S. with the Provincial University, the belief of the Commission is that closer relations will be an advantage to both. In a new country like Canada, with an era of constructive undertakings before it, with undeveloped wealth in farm, forest, mine and water power, the practical part of the University course is of importance. The Provincial system of education must take into account the educational requirements of the country. The development of the natural riches of our northern region creates many openings for engineering and industrial work."

As a result of the labors of the Commissioners, the University Act of 1906 was passed, and by it the School of Practical Science became the Faculty of Applied Science and Engineering of the University. As has been previously stated, there were 6 students in 1878-79, while to-day the number totals 755, and the accompanying diagram will give an idea of this rapid growth.

In the earlier years the standard of admission was the intermediate High School examination, while to-day Junior Matriculation is required. The average age of the candidates for admission was 21 in 1893 and 20 in 1908. The total number of graduates is 858, and of these 78 per cent. are in Canada to-day. Many of them are to be found among the leading engineers of the time and most of them taking a prominent part in the development of the country and its industries.

In closing, it is only fair to say, what is apparent to every undergraduate and graduate, that they, the University and the Province owe a debt of gratitude to Dean Galbraith for the organization of the School as well as for the careful and self-sacrificing interest he has at all times taken in its administration. To mention the School to any one acquainted with it, is to name Galbraith, for he has given his best to the institution. His policy, mapped out when there was little experience to guide, has remained constant through thirty years of trial, and to-day, with 755 students, 858 graduates and a name that is known wherever there is engineering work of any consequence in progress to-day in Canada, from coast to coast and from the border to the frozen north, the School stands as a monument of which he may well feel proud.

THE ENGINEERING SOCIETY OF THE UNIVERSITY OF TORONTO.

T. H. Hogg, B.A.Sc.

The Engineering Society of the Faculty of Applied Science and Engineering of the University of Toronto was founded in 1885, being known at that time as the Engineering Society of the School of Practical Science. The names most intimately connected with its beginning are Messrs. Herbert Bowman and T. Kennard Thomson who were undergraduates at that time. It is essentially a student's Society and only undergraduates and graduates in Engineering of the University are admitted as ordinary members.

The objects of the Society according to the Constitution are:—

1. The encouraging of original research in the Science of Engineering.

2. The preservation of the results of such research.

3. The dissemination of these results among its members.

4. The cultivation of a spirit of mutual assistance among the members in the practice of the profession of Engineering.

The membership of the Society has risen steadily in point of numbers since its inception. It began with a total membership of about thirty. At the present time of ordinary members there are 750 with a life membership of about the same, making a total of nearly 1,500.

For the first few years of its existence, membership for the undergraduates was optional, but recently through the cooperation of Dean Galbraith, it has been made compulsory for all in attendance in the Faculty, a fee of $1 per year being imposed and collected with the regular tuition fees.

Until the fall of 1908 meetings were held each alternate week of the academic year: that is from October until April. The Executive Committee then decided that the time had come for a division of the Society, as the meetings were becoming too large and unwieldly, for good discussions of the papers presented. The Constitution, too, had become inadequate, not having been revised since the founding of the Society. A new Constitution was therefore drafted and in this provision was made for sectional meetings, the members being grouped according to the courses taken, the Civils and Architects, Mechanicals and Electricals, and Miners and Chemists forming three divisions. These smaller meetings are held alternate to the general meetings, and at them papers of more specialized interest are read. By this means a much freer discussion is obtained and many more of the undergraduates are enabled to prepare papers and deliver them. These smaller meetings are persided over by the vice-presidents of the respective sections, and no business of a nature affecting the Society as a whole is transacted. The general meetings are reserved for business and for topics of general interest to the student body. As a natural outcome the papers given at the sectional meetings are nearly all by undergraduates while those given at the general meetings are by graduates and men prominent in the outside world.

The officers of the Society are a president, three vice-presidents, a corresponding secretary, a recording secretary, a treasurer, a paid secretary, an assistant to paid secretary, and five representatives, one from each of the four years of the Faculty, and one representative of the graduates, all of whom, with the exception of the paid secretary, constitute the Executive Committee.

The appointment of a permanent secretary in the fall of 1908 marks a turning point in the affairs of the Society. For a number of years, certain supplies had been handled for the students, the revenue accruing from the sale of these being used for the expenses of carrying the Society along. This branch became so large that it was found necessary to appoint a secretary who would devote his time to the ordering and sale of supplies, and the other work incidental to the organization. The Society now handles, at a slight increase in cost, all draughting supplies, etc., used in the Faculty, thus affording a great reduction over the old prices.

In its infancy the question of funds was a serious one with the Society, but happily that worry is now over. Each undergraduate in the Faculty pays an annual fee of $1. This, with the income from the sale of supplies makes a sum which allows of the handling of many departments of advantage to the students and to the Faculty in general. Probably the most important of these departments is the publication of the Society monthly, "Applied Science." Before saying more of this, we must trace its development. In the early days of the Society the transactions, containing the papers read at the meetings, were issued yearly. The first volume of the Transactions was published in 1886, and was a pamphlet of 43 pages. In the then financial condition of the body this was a serious undertaking, as about 500 copies were issued. A gradual increase in membership together with a great development in enthusiasm caused the sending out in 1895, of advance proofs of the papers read, for discussion. This was too much of a forward step and in consequence the Society was nearly swamped. Eventually it recovered its lost ground and from that time until 1906 there was a continuous development in the size of the pamphlet. The No. 20 issued in 1906-1907 had about 250 pages and was very fully illustrated.

With the division of the Society into sections and the increased number of papers forthcoming on that account, it was decided to change the publication to a monthly. This was done in 1907, and the monthly, "Applied Science," was enthusiastically received by all the graduates.

At the present time "Applies Science" is a thoroughly progressive and up-to-date periodical, not of interest merely to graduates of the Faculty nor courting inspection as an academic journal, but resting on its merits as an engineering magazine. It has to-day a circulation of 1,700 copies. There are exchanges with all engineering societies and periodicals in the United States and Canada. The articles appearing in it have been copied in nearly all the leading engineering publications. "Applied Science" in its short life has done much towards cementing together the graduate feeling, and according the Faculty, the recognition among engineers and the general public, which it deserves.

As the organ of the Engineering Society, and as an outward manifestation of what the Society is, the monthly has well justified its existence.

As the membership increases and each year of added tradition puts new enthusiasm into the work of the Society, one looks back on a connection with the Society with pride, and a feeling arises that, with the strong cohesion and power of initiative exhibited by its executive committees in the past, there must certainly be a broad field of action for the Society in the future. While it is true that its work is mainly carried on by students, still not all of its benefits are conferred on its members alone, and we hope in the future, that the Engineering Society with its strong compact organization, will do much towards procuring for engineers the recognition from the general public which they deserve.

NEW TORONTO SEWAGE DISPOSAL.

Report and plans for main sewerage and sewage disposal were adopted at the Etobicoke Township Council on January 23rd, 1909. The plans and report will be laid at once before the Provincial Board of Health, and a legislative Act of Parliament asked for in the forthcoming session for the special rating of the district to meet the cost.

The following extracts from the engineers report will be of interest:

Daily discharge in 24 hours.

	Gallons.
Assumed population 1,000 at 38 gallons per head	38,000
Industrial School	15,000
Factory operatives	5,200
Total domestic discharge	58,200
Grand Trunk round house	50,000
Leather works	25,000
Coated paper factory	24,000
Wall paper factory	15,000
Total trade discharge	114,000
Total discharge from all sources	172,200

The analysis of the principal trade discharge is as follows:—

Parts in 100,000.

Source.	Insoluble matter.	Soluble matter.	Ammoniacal nitrogen.	Oxygen consumed in 4 hrs.
Coated paper factory	174.2	85.0	4.7	17.8
Wall paper factory	8,730.0	317.0	10.9	83.0
Leather factory	56.5	46.0	3.2	6.5

The waste from the Grand Trunk represents water only slightly adulterated with oil and mineral water.

The three factories named above are advised to install sedimentation tanks, in duplicate, to deal with 24 hours' flow discharge, with scum boards, to retain a proportion of the suspended solids, and floating matter, before, discharging into the sewers. It is expected that the total bulk of sewage including trade effluents will present the following approximate analysis.

Ammoniacal nitrogen.	Oxygen absorbed in 4 hours.	Suspended solids.
6.0	20.	40.0

The objects aimed at, in the outfall works, are, 1st, reduction of suspended solids; 2nd, the discharge of an effluent practically free from organic matter which will be non-putrescible and create no nuisance in the lake.

The works are laid out to take three times the dry weather flow of 180,000 gallons per day.

For this purpose a plot of land is utilized of .83 of an acre in area.

The sewage first enters a ditritus or straining chamber 10' x 8' x 8' deep; and then flows by means of a thin film over a weir into duplicate sedimentation tanks each 60' x 30' x 8' deep, in which most of the suspended solids will settle. These tanks are fitted with scum boards at inlet and outlet ends.

The sludge from these beds will be conveyed, periodically as required, from the tanks by syphonic arrangements to drying beds, constructed alongside the tanks. This completes the preliminary treatment which is expected to produce a tank liquor of the following analysis:—

Ammoniacal nitrogen.	Oxygen absorbed in 4 hours.	Suspended solids in fine particles.
6.	12	15 to 20

It will be noted that there is no change in ammoniacal nitrogen while oxygen absorbed is reduced 40 per cent. owing to the weakening of the sewage by retaining 50 per cent. of the grosser solids.

The secondary treatment consists of passing the tank liquor through biological filters of the continuous type.

There are to be three of these, each 40' diameter with 5' deep, filtering media of ¾" broken slag, capacity, 170 gallons per cubic yard per day.

They will be operated by means of distributing sprinklers worked by a hydraulic head of 1' 6" from a dosing tank, supplying the liquid at each dose at the rate of a ½" supply to the area of filtering media.

As the apparatus is apt to freeze in winter an alternative means of distributing the tank sewage liquor is provided for, by means of which the sewage is sprayed over the filter area 6 inches below the surface. The filters will therefore work even if buried in snow.

The total head required for the above works is 8' 0" above the highest lake level or 12' 0" above the lake zero.

The effect of the filters is not only that of straining, but also of nitrification.

Nitrogenous matter will be broken up by means of organisms in the slow percolation through the filtering media, and the liquid rendered non-putrescible.

The total cost of the works along with the main sewerage of the district is estimated at about $14,000.

The engineers responsible for the design of the proposed works are Messrs. Andrew F. Macallum and Mr. T. Aird Murray, Continental Life Building, Toronto, who have been retained to supervise the work to the finish.

OTTAWA STREET RAILWAY.

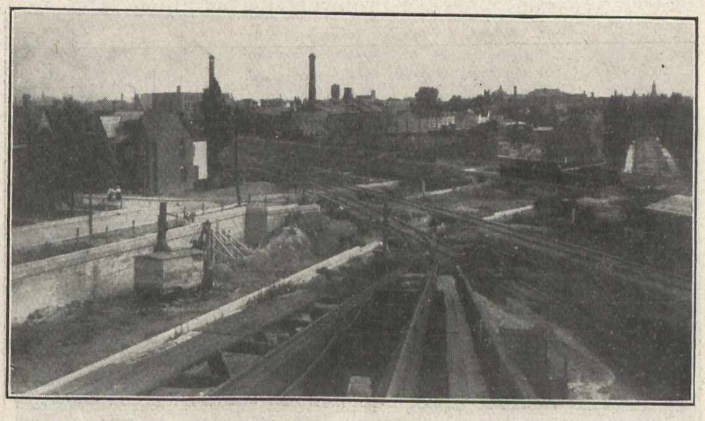
In a recent item regarding the earnings of Winnipeg Electric it was stated that the increase in the company's earnings of nearly $38,000 over last year was the largest proportionate increase of any city in Canada. Ottawa Street Railway's increase was larger, proportionately, viz.:—Gross receipts for 1908, $616,229; increase over previous year, $41,950; dividends paid, 10 per cent. and 2 per cent. bonus.

LANDSDOWNE AVENUE SUBWAY BRIDGES.

Toronto's steam railway crossing problem is one of long standing and costly solution. The trunk lines cross the main thoroughfares and quicker transportation and increased traffic at these crossings has made necessary certain safeguards. First flagmen were employed, later gates installed, and more recently subways were constructed. King and Queen Streets West now pass under the railway tracks and very shortly a third, Landsdowne Avenue will, by way of a subway, pass under the five tracks of the G.T.R. and C.P.R. running north-west out of the city.

It was a bitter fight, the securing of the order to build the subway and the proportioning of costs.

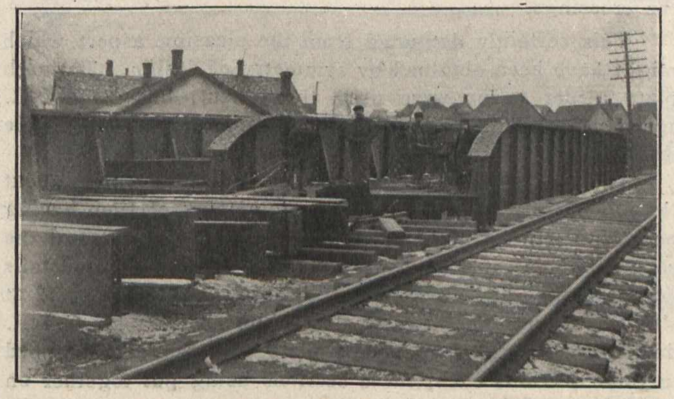
When the much discussed project of a subway to carry street traffic under the many lines of railway tracks at this point at last took shape, the first work was the excavation for concrete walls, it being decided that the most feasible method



View Showing one Bridge in Place and Steam Shovel Excavating.

of building this subway and keep the existing railway tracks open for traffic continuously, was to merely excavate a trench in which each retaining wall would be built—then each of the several railway bridges to carry the tracks over the subway would be erected alongside its intended site, and when ready, jacked over into place, this breaking track for only three or four hours, after this the entire excavating being proceeded with. On May 18th, 1907, tenders were called for steel railway bridges and handrailing for this subway, these tenders to be in not later than July 16th following.

The contract was secured by the Cleveland Bridge and Engineering Company, of Darlington, England, their price for steel erected and complete in all details being four and



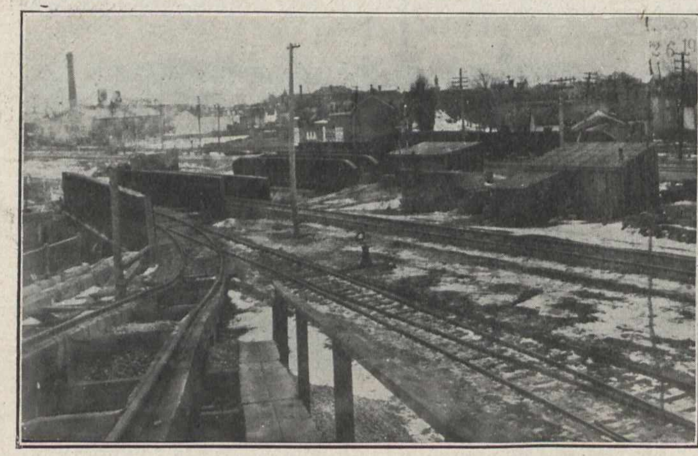
Bridge Set Up Ready to "Cut in."

one half cents per pound, this covering all incidental charges, such as freight, insurance, duty, etc. The inspection was done by the Canadian Inspection Company in Toronto, and by their agents The British and Continental Inspection Company in Great Britain.

This steel-work, supplied to the designs and specifications of Mr. C. H. Rust, the city engineer, consists of two double-track spans for the Grand Trunk lines, and one three-track span and a single-track span for the Canadian Pacific lines.

The spans for the Grand Trunk consist of three girders, 71 ft. 6 ins. long x 9 ft. deep for the double-track span; two girders 74 ft. 6 ins. long and one 7 ft. deep and the other 9 ft. deep, together with a girder 101 ft. 6 ins. long x 10 ft. deep for the remaining double-track span. The work consists of ordinary plate girders, and cross girders 11 ft. centres and 2 ft. deep. The intermediate stringers between the cross girders consist of 15 ins. x 5 ins. and 9 ins. x 4 ins. joists. There are no floor plates. The three-track span for the Canadian Pacific lines consists of four girders, each 70 ft. 6 ins. long x 7 ft. deep and the single track span consists of two girders 72 ft. 6 ins. long x 7 ft. deep. These spans consist of ordinary plate girders, the ends of the top flanges at the abutments being curved.

The flooring consists of 18-in. rolled steel joists, 18-in. centres, covered with 5-16th flat floor plates. The steel-work for the Grand Trunk spans has a weight of 216 tons and that for the Canadian Pacific spans 220 tons. In addition, there is about 1,300 lineal feet of ornamental handrailing, 3 ft. 10



View Showing Completed Bridges.

in. high, and cast iron intermediate and end pillars, and there is also ornamental handrailing on the staircase leading down into the Lansdowne Avenue subway.

The Canadian Inspection Company were awarded the mill, shop and field inspection of this steelwork, their European agents, the British and Continental Inspection Company handling the Great Britain end of the work.

Unfortunately owing to the bridges having to be built for both the Grand Trunk Railway and the Canadian Pacific Railway, each of these roads having tracks crossing the proposed subway, one design could not be adopted for all the crossings.

This certainly detracted from the pleasing aspect which might have been obtained by symmetry of design. Through plate girder spans were used throughout, but the C.P.R. specifications and design called for round end girders, while the Grand Trunk Ry. specified square ends.

The first shipment of steel left Darlington, Eng., about the 9th of July, 1908, a considerable amount of time having been lost between the date of awarding the contract and the commencement of shop work owing to adjustment of details pertaining to shop drawings. This first shipment arrived at site July 29th. The steel on this shipment was for G.T.R. double-track parallel span, the plate girders being shipped in three sections each, these sections being put together on the field and field riveted.

Since then erection work has been proceeding practically steadily, though frequent delays have been occasioned by reason of slowness of arrival of shipments of steel. Erection gang consists at present of about 18 men, under Superintendent Cox, and an electrically operated compressor plant supplies the compressed air for the riveting guns.

The main switchboard, distributing boards and cabinets for the new drill hall at Sherbrooke, Que., are being supplied by the Hill Electric Manufacturing Company, Montreal.

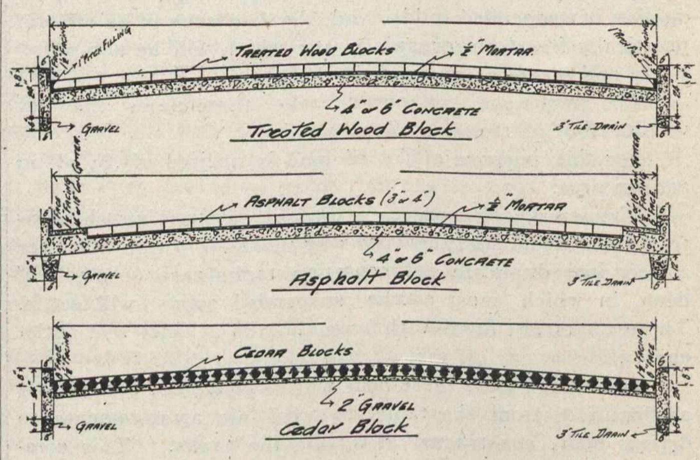
STREET PAVEMENTS.

Geo. G. Powell, B.A.Sc.*

The subject of Street Pavements it always of more or less interest even to those not specially connected with their construction. It will, therefore, be the aim of this article to give a few details regarding those pavements which have been found to be most suitable for the traffic to be met with in a large city.

Asphalt.

The asphalt pavement is probably the most popular and at the same time the most economical pavement to be had for



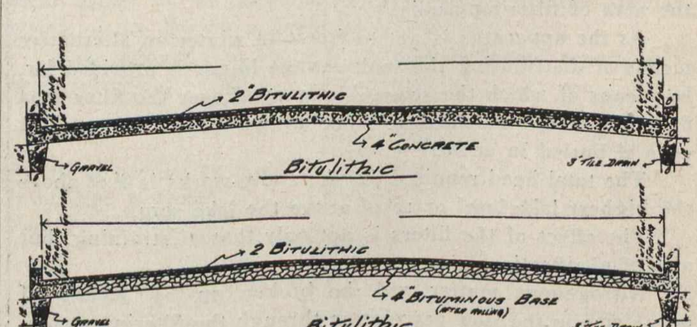
general city traffic where grades are not too steep (say up to 3 per cent.), and where traffic is not too congested.

In Toronto there are two kinds, viz., heavy and light.

Heavy asphalt pavement consists of a Portland Cement concrete foundation 6 inches in depth composed of 1 cement, 3 sand and 7 stone, an inch of binder and two inch of surface. The above dimensions have proved suitable for the heaviest traffic in this city for a period of from 8 to 10 years. Of course repairs are necessary from time to time to keep these pavements in shape for the guarantee period, which up to the present time has been ten years.

The light asphalt pavement is composed of a 4-inch Portland cement concrete and a 2-inch asphalt wearing surface. This pavement is laid on light traffic or residential streets, and is guaranteed for 10 years.

It is proposed, however, to replace this light asphalt pavement with a heavier construction of 5-inch concrete,



1-inch binder, and 1½ or 2-inch. surface, as it has been found that the traffic conditions on a street, once it is paved, increases so materially, that the surface has a tendency to creep, and it is thought that the binder will prevent this.

A granolithic gutter composed of 1 cement, 1 sand and 3 granite chippings is laid next to the curb on the green concrete foundation, so as to insure a thorough bond. The depth of the gutter is the same as the thickness of the pavement surface, and from 14 inches to 16 inches wide. The price of this surface including foundation is 25c. a lineal foot.

Originally the asphalt was laid right up to the curb, but was found to rot and disintegrate under the action of water, so the granolithic gutter was substituted. However, the

*Assistant Engineer, charge of Roadways' Department, Toronto, Ont.

granolithic surface is so hard and brittle that it becomes cracked and broken, and in the near future some other substitute will have to be found.

Concrete curb is now used altogether and is found to be very satisfactory, there being no tedious delays as often occurred in the days when stone curb was so extensively used. The materials for concrete curbing are almost always on hand or easily procured, while the same cannot be said in regard to stone curbing.

The concrete curbing is usually constructed in conjunction with the foundation, so that a thorough bond is secured.

The concrete curbing is 6 inches thick and varying in depth according to the class of roadway to be constructed. The face and top of curb to a depth of 1½ inches are composed of same mixture used in gutters, while the core is composed of a 1 : 2 : 5 mixture. The cost of this curb is about 30c. per lineal foot.

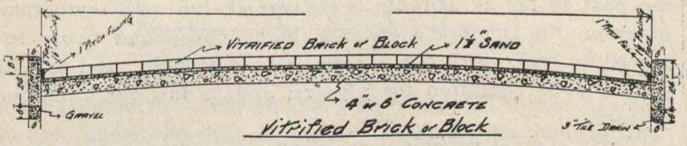
The cost of a heavy asphalt pavement will average $2.25 per square yard, and of a light asphalt $1.55.

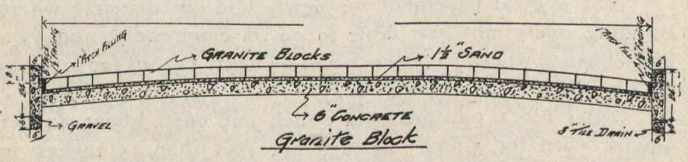
For details of these pavements see cross section 1, 2 and 3.

Bitulithic.

The bitulithic pavement is a patent pavement controlled in Toronto by the Warren Bituminous Company. It has proved fairly satisfactory, and costs about $2.25 per square yard.

The foundation is either broken stone thoroughly rolled to a thickness of 4 inches and then sprinkled heavily with a bituminous cement so as to insure the particles of stone being well cemented together, or a 4-inch Portland cement concrete composed of 1 cement, 3 sand and 7 stone. On





the foundation is spread the surface mixture to a depth sufficient to roll down to 2 inches after thorough rolling.

The surface mixture is composed of graded stone varying in size from 1 inch to an impalpable powder, proportioned in such a manner as to reduce the voids to a minimum.

The cementing material is a patent bituminous preparation added in such quantities to thoroughly coat all particles and fill all voids.

The surface when rolled is flushed with a special bituminous cement called a flush coat composition, and then stone chippings are rolled in so as to fill all surface voids, thus roughening the surface and making it less slippery.

The bitulithic pavement can be laid on steeper grades than asphalt, but our experience in Toronto shows that a 5 per cent. grade is about a maximum for this class of pavement for satisfactory results.

Details of curb and gutter are same for this pavement as for asphalt. See section 4 and 5.

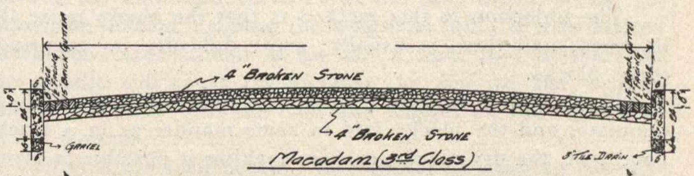
Vitrified Brick or Block.

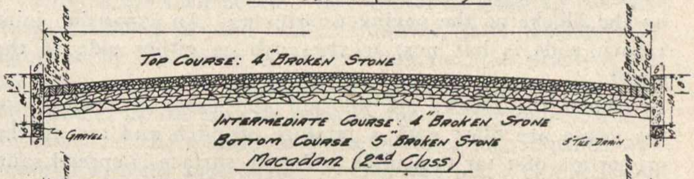
The vitrified brick or block pavement is probably one of the most serviceable pavements in existence to-day, provided due care is taken in the selection of the paving blocks. It is a trifle more costly than asphalt or bitulithic, being worth about $2.55 on 6-inch. concrete and $2.25 on 4-inch. concrete. The main objection to this class of pavement is the noise, and up to the present time nothing has been discovered that will do away with this objection.

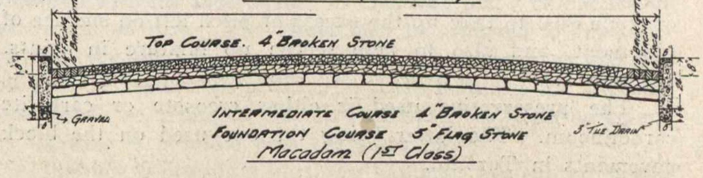
Fillers of various kinds to be used instead of grout have been experimented with, but with only partial success.

The foundation as in the other permanent pavements is of concrete either 4 inches or 6 inches thick, according to the traffic, and of the proportions mentioned previously. On this foundation is spread a layer of sand from 1½ inches to 2 inches in thickness, and upon this bed the blocks are laid in parallel rows at right angles to the curb, breaking joint so as to give about 1/3 bond.

The blocks are then watered and carefully gone over in order to discover any defective ones either for quality or conformation. When the blocks are culled to the satisfaction of the engineer and properly rolled with a heavy surface roller, the joints are carefully filled with grout run in in two to three operations. The bottom half of the joint is filled with grout







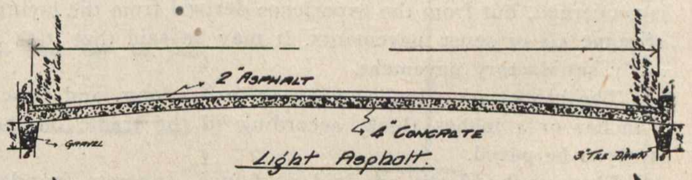
in the proportion of 1 of cement to 2 of sand; the top half with grout in the proportion of 2 cement to 1 of sand.

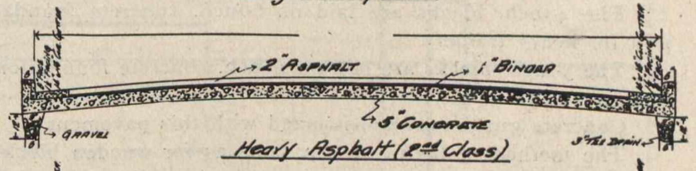
An expansion joint from ½ inch to 1 inch wide is left on either side of the pavement next to the curb. This joint is then filled with pitch. (Section 6).

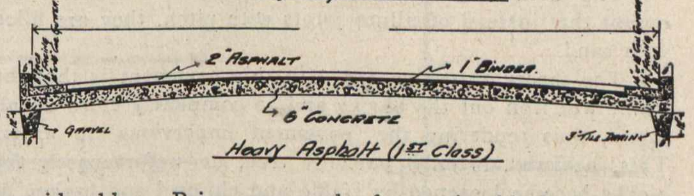
The curb usually constructed with vitrified block pavements is 24 inches deep and 6 inches wide with an 1½ inch granolithic wearing surface on the top and on the face for a distance of 8 inches from the top. The price per lineal foot for this class of curb is 42c.

Granite Setts.

Granite sett pavement is laid in much the same manner as a vitrified block pavement, except that on account of the large size and irregularity of granite setts they have to be paved, i.e., properly beded in sand cushion and leveled one by one. This method of laying the blocks increases the cost







considerably. Price per yard of granite block pavement being $3.50. (Section 7).

Wooden Block.

Wooden block pavement is in the experimental stage in Toronto, and no very definite estimate of its wearing qualities can as yet be made, owing to the fact that it has only been down for 3 years. However, indications are that it will prove very satisfactory as a street pavement.

Some years ago round cedar blocks or tamarac blocks were laid on a concrete foundation, and the joints filled with pitch and gravel, this pavement being very satisfactory, so that there is every expectation that the oblong wooden block, treated with a preservative and laid very close together, will give much better results.

The method of construction of a wooden block pavement is similar to that of a brick pavement, except that instead of a sand cushion 1½ inches in thickness, there is a mortar cushion ½ inch in thickness. This cushion is put in in two ways, either quite wet or very dry. If the former method is used the surface is troweled to conform to the shape of the roadway and allowed to harden, the blocks then are placed on this hard smooth surface.

The objection to this method is that the blocks must all be sized, and there is usually great difficulty in securing these blocks.

If the latter method is used the bed is struck with a template, and the blocks laid in same manner as in a brick pavement, the dry mortar cushion making it possible to level up the blocks as the paving progresses. An expansion joint 1 inch wide is left next to the curb on either side of the street.

When the blocks are all laid and properly leveled up, the joints are filled with a mixture of pitch and tar, in the proportion of 1 tar to 3 pitch. On the surface is spread sand or stone dust to take up the excess of pitch left on surface of pavement, and also to help stiffen up mixture in joints. (Section 11).

The preservative used is either creosote or carbolite carbolineum. The latter being the one used on the block pavements in Toronto.

The wooden blocks are impregnated with preservatives under pressure and will absorb about 15 pounds of the liquid per cubic foot. However, in the case of carbolite carbolineum preservative the blocks are only dipped, and on that account only absorb from 3 to 5 pounds.

The is probably the great objection to the use of blocks treated with this preservative, as the tendency is for the blocks to absorb moisture, expand, and as a result heave up a section of pavement.

Our experience of these blocks in track allowance work has not been satisfactory for this reason:

The blocks are usually 3 inches or 4 inches deep and 3 inches wide; the length varying according to the width of plank the blocks are made from. The price per cubic yard for this pavement is $3.50. (See section 11).

Asphalt Block Pavement.

This pavement is also experimental in so far as Toronto is concerned, but from the experience derived from the laying of some six or seven pavements, it may be said that it is a fairly satisfactory pavement.

The blocks are 5 inches wide, 12 inches long, and either 3 inches or 4 inches thick, according to the traffic on the street to be paved.

The 4-inch. blocks are laid on 6-inch. concrete foundation for heavy traffic.

The 3-inch. blocks are laid on 4-inch. concrete foundation for light traffic.

Concrete gutters are constructed with this pavement.

The method of laying is the same as for wooden block, except that instead of filling joints with pitch, they are filled with sand.

The theory in connection with this pavement is that the traffic will iron out the blocks and so completely close up all joints, thus rendering the pavement impervious to water. This, however, is only partially true, as unfortunately the blocks become loosened by traffic and chipped and broken at the edges, thus marring the appearance of the surface, but not doing much harm to the wearing qualities. The trouble apparently is that the blocks have to be made with asphaltic cement of too low penetration in order to be able to handle and ship them.

It is thought that the asphalt block pavement is easier to repair than an ordinary sheet asphalt pavement, but experience has taught us that this is not the case, for it can be readily seen that a good repair can not be made with new blocks when those surrounding it are slightly worn, and again on account of the closeness of the joints it is necessary to remove a lot more blocks than the repair really requires. Notwithstanding these minor objections, the pavement will in all probably give good service.

It is worth about $3.75 per yard for 4-inch. blocks on 6-inch. concrete, and $3 for 3-inch block on 4-inch. concrete. (Section 12).

Macadam Pavements.

Macadam pavements have been extensively laid in Toronto in the past, but of late years they have been rather unpopular, due no doubt, to the mud in wet weather, the dust in dry weather, and the difficulty in keeping them in good repair.

A reference to the cross sections (8, 9, 10) will give details of construction. The top layer of stone in every case is granite, the other layers limestone. The different layers are blinded with clean pit gravel or stone dust, the rolling is done by a heavy steam road roller.

Brick gutters are used on heavy grades to prevent the erosion of the pavement by the rush of water.

The cost of a good macadam pavement is approximately $1.50 per yard.

Efforts are being made to find some preparation which will both bind the surface of a macadam roadway together so that traffic will not cause it to travel and at the same time render the surfce dustless.

These preparations are mostly made from tar or asphalt an' have not been an unqualified success.

Treating the surface with this dust laying composition adds materially to the cost.

Cedar Block Pavement.

This pavement laid on a sand bed has become a thing of the past so far as Toronto is concerned, but as a temporary pavement, it is quite a success, being cheap and easily removed to make way for a permanent pavement, and it will last in good condition for 3 years, and in fair condition for 5 years.

It is a good pavement for newly laid out districts where building operations are liable to go on extensively, and as a consequence where pavements will be badly cut up for services of one kind or another.

Cedar block pavement on 2-inch and costs about $1 per square yard for 5-inch blocks, not less than 5 inches in diameter or more than 8 inches.

SOCIETY NOTES.

McGill Engineering Society.—A meeting of the Undergraduates Society of Applied Science, McGill, was held on Monday evening, 18th inst. The address of the evening was by Professor Tucke, head of the Mechanical Department of Columbia University, who had come to Montreal on purpose to address the students on his favorite subject, "Gas Engine." He dwelt on the subject from a commercial basis, showing that a strictly technical education was of no value unless it could be applied commercially. He outlined the material for power plants and the evolution of the gas engine, comparing the efficiency of the gas engine with that of the steam engine, giving statistics of the very highest worth to students of Applied Science. In all it is highly probable that the Undergraduate Society never listened to a lecture of such real value from a practical point of view. Prof Sexton, Director of the Technical Schools for the Province of Nova Scotia, was present, but owing to the lack of time was unable to give an address of any considerable length, but the Society trust that at some future date they may be fortunate enough to secure a paper from him who has done so much to further technical education in the Province of Nova Scotia.

At the annual examinations to be held for Ontario Land Surveyors commencing February 8th, 1909, there are applications from twenty-two candidates wishing to write on their final examination and twenty-eight for the preliminary.

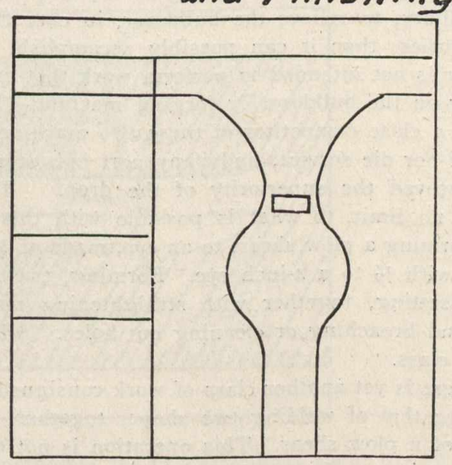
DROP FORGING, II.

A Forge Man.

The term, Drop Forging, is one of the countless coined words of the present epoch of manufacturing. The definition is straight to the point, permitting no misunderstanding of the term, or word. The popularity of the phrase is very evident. If an unusual shape or section is presented, one that defies a student in ascertaining the necessary operations, or methods of its construction, he excuses himself by remarking:—"It is a drop forging."

What is a drop forging? Has the student ever asked himself that question? Drop forging is not entitled to pose

Fig. 1 Plan View Showing Breakdown and Finishing.



as one of the wonders of the age in the sense superstition would confine it. And, on the other hand, all things are not possible under the drop hammer. There are mechanical and financial limits connected with drop forging. It is mechanically impossible to drop forge a locomotive, assembled, with steam up, ready to start from the hammer to duty. As it is likewise financially impossible to drop forge an article that would necessitate the designing of expensive, intricate dies, that would, by the maintenance of the dies, increase cost per unit over other methods.

There are two distinct types of drop hammers familiar to most of the readers. "First,"—The steam drop which is a forced blow, steam enters the cylinder through a steam port, under and over the head of the rod. The steam entering the lower port, raises the ram. The steam, in the upper port of the cylinder, over the head, escaping through the exhaust valve. The valve reversed by the lever, the steam escapes in the lower chamber, and the entering steam, forces the rod and ram home.

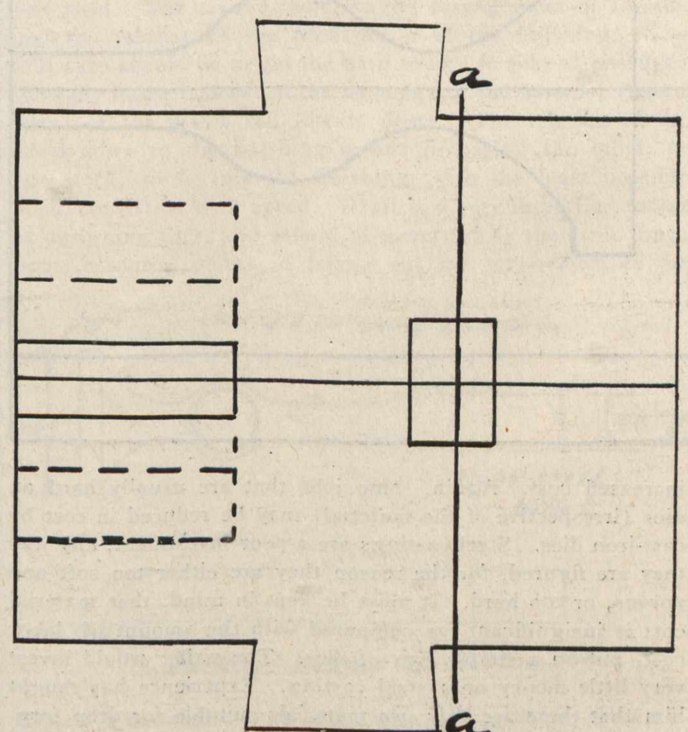
The steam drop hammer is essentially a roughing hammer, for the reason the weight of the blow cannot be gauged to the desired uniform accuracy necessary to accomplish fine, light drop forging. (The writer expects to receive complimentary bouquets from all steam drop hammer manufacturers, for this remark). However, in justice to them, and the steam drop, great efficiency of product, both in quality and quantity, is possible with the steam drop. The steam drop hammer has proved its superiority for heavy work, if the forging permits the dies to be so constructed that the force of the blow will be nearly central with the ram and rod, there is no question of the superiority of the steam over the board drop hammer. There is, however, danger with dies constructed so that the force of the blow strikes extremely to one side of the die, in breaking the piston rod.

Second.—The board drop is constructed along entirely different lines, as its name suggests. The force of the blow is governed by gravity, or the falling weight of the ram. A flat board, free from knots, and with a straight grain, is inserted in a slot in the ram, and held secure by means of a set-screw in the latter. The board passes between two pulleys, one is stationary, and is driven by means of a belt action on a pair of pulleys at either end of the shaft. The second is an idle pulley, and is moved to and fro by means of a cam, connected with a rod to the treadle at the base of the hammer. There is a sleeve located on the rod, secured by a set-screw. In a slot on the right side of the hammer, is a small cam, also holes in the column of the hammer, in which a pin is located. This pin and cam lock each other. A full pressure on the treadle causes the cam on the idle wheel to move in toward the board, binding the same to the live pulley. The hammer is raised by friction, until the sleeve strikes the cam and throws out the idle wheel, which relieves the friction, causing the weight to fall. If it is desired to suspend the hammer in the air, a light foot pressure on the treadle will cause the hammer to rise to the desired height and lock with the cam and trigger on the right side of the hammer.

Drop forge men become very expert in gauging the distance of travel of the ram. However, it is mechanically regulated by the sleeve on the friction rod. In practice, the foot is placer on the treadle with sufficient pressure to raise the hammer up till the cam releases the friction pulley, and is not taken off the treadle until the hammer has returned and engaged with the lock device, or cam and pin. The action of gravity is positive. The sleeve may be adjusted to any location on the rod, so that a uniform light, heavy or medium blow is the result. In addition to these features, the mechanism can be so arranged that an automatic blow can be given, as likewise is possible with the steam drop.

The board drop is a finishing hammer, but similar to the steam drop can perform other duties. The rope drop deserves mention because of its antiquity. The action is obtained from friction. A rope is passed around a moving pulley, a pressure on the rope causes the ram to rise, releasing the ram drops. The rope is efficient on forming, and similar work. However, this same work can be performed, in most cases, with greater speed on the bulldozer. The rope drop is not used very extensively, being superseded by more im-

Fig 2 Front View of Dies



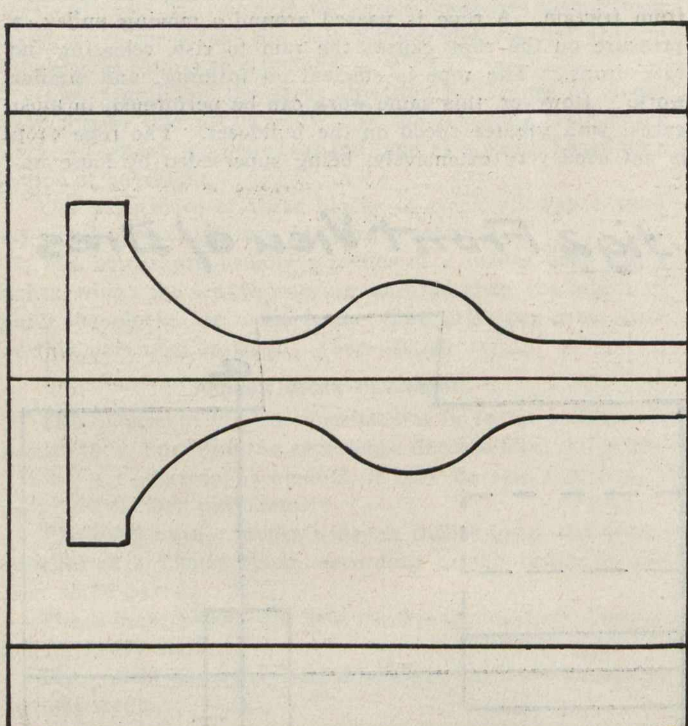
proved methods, but is still in evidence in straightening malleable casting, and work of a kindred nature.

There is still another type of drop hammer, not known to many of the readers, for the reason it is confined to a certain class of work. The principle of this drop consists of a slotted ram working in slides, on housings or columns. A driven shaft is located back of the slotted ram. An "S" shaped cam acts on the slot on the ram, as the cam revolves or turns, the projection of the cam raises the hammer till it passes out of the ram, which drop to the die, to be lifted again by the second projection of the cam. The action is rapid, but is objectional for drop forging, from the fact no provision is made to stop or govern the blows of the hammer. This hammer was designed by the writer's father, some thirty-five years ago. It is extremely efficient in drawing out carriage axles and smaller work. It is economic in both power and maintenance. A system of pegs † is operated in connection with the dies.

All of the described hammers are perfect types of their style, but drop forging is not a question of hammer so much as a question of dies, which is the vital point of the operation or art.

In shape ‡ forging, the billet is manipulated and forged until it is formed into the desired shape. Drop forging, generally speaking, consists of placing the billet or metal under the dies, the latter forming the forging. Drop hammer dies can be divided into four classes, and increase with difficulties and complexity of design. They may be made of cast-iron, semi-steel, steel castings, open hearth steel, and carbon or tool steel, according to the nature of the work and the length of service desirable. Thus it is very often possible to reduce cost by having the dies made of cast-iron, which, under ordinary circumstances, would be made of a good grade of tool steel, if the quantity of the order would justify or permit the

Fig. 3 Showing Breakdown.



increased cost. Again, some jobs that are usually hard on dies (irrespective of the material) may be reduced in cost by cast-iron dies. Steel castings are a poor investment, any way they are figured, for the reason they are either too soft and porous, or too hard. It must be kept in mind, that material cost is insignificant as compared with the amount of labor cost, put on a simple pair of dies. The writer would invest very little money on a steel casting. Experience has taught him that there are only two materials suitable for drop forging dies; namely, a good gray cast-iron, and an open-hearth forged die, within the following analysis:—

Carbon	.60 to .80
Phosphorus	.03 to .04
Manganese	.40 to .50
Sulphur	not over .03
Silicon	.08 to .10

This analysis can be readily annealed, machined, and will take a good strong, tough temper, and holds an edge. These are the requisites of a drop forge die.

The first of the four classes of dies is the simplest, and should be made of cast-iron, namely, the forming type of die. The plow seeder shear is perhaps the best example of this class. The die is simply the impression of the shape. There is no contour of shape that will admit draft or freedom to lift the shape off the die, that cannot be performed on the drop hammer. This contour is divided between the top and bottom dies, projections are left on either side of the die, for the purpose of preventing the top die, going below a certain dimension. Thus, if a dish shape were required, and the depth of the concave was half an inch and the metal three-eighths of an inch thick, if the blow struck full force on the metal with no restrictions, the dish-shape would be formed, but the thickness of the metal would be reduced.

Work of this nature, included in the category of this type of die, may be performed on the bulldozer, and in many cases with greater speed. However, the drop can be used as an auxiliary, to relieve the bulldozer, in case the latter has more duties than it can possibly accomplish. The drop hammer is not intended to perform work that can be formed cheaper on the bulldozer or forging machine. However, the drop is a close competitor of these two machines, within the limit of her die service, and "any port in a storm" has very often proved the superiority of the drop. There is very nearly, no limit, to what is possible with this type of die, from forming a plow shear, to an eye, made of ½ by 2½-inch metal, with ½ to a 4-inch eye. Forming, twisting, bending and offsetting, together with straightening malleable castings, and broaching or cleaning out holes. All are confined to this class.

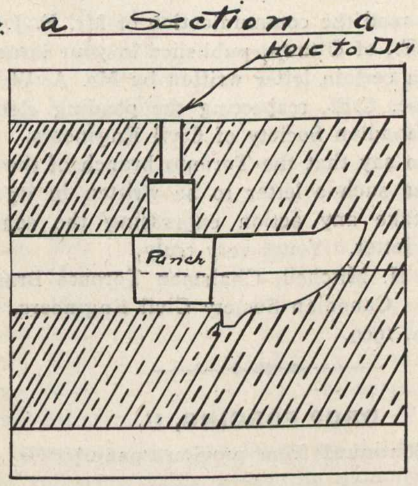
There is yet another class of work consigned to the forming dye; that of welding two shapes together, as in the instance of a plow shear. This operation is not only possible, but there is no other method of equal economic value. The designing of forming dies, requires no explanation. The method of making the cast-iron die does, and is very important from a financial point of view. To say that pattern making is expensive is unnecessary, and that any additional expense placed on the dies would increase the cost per unit of forging is superfluous also. The minimum of expense, machine work and trouble is reached by making a plaster-paris cast. This is accomplished by forming the desired shape by hand, and scraping or filing a smooth surface all over it, so that it will leave a smooth impression in the plaster. The next step is to build a box, having the inside size equal to the bottom die, build a dovetail in the bottom of the box to suit the dovetail of the die (allowing finish). A light frame-work is built in the box, to support the shape, or pattern, which is placed with the concave, or bottom of the dish, or radius, down. The volume of plaster-paris may be economized by building false work in the centre of the box. There should be, however, at least two inches of plaster on all sides. The plaster cast may be strengthened by intersecting wires or small rods, the ends projecting in the plaster, which is now poured into the box, flush with the top of the pattern. It may be necessary to build the sides of the box up higher than required to accomplish this. Before the plaster sets too hard the superfluous plaster should be cut away, smoothing the face of the part that has been cut, by scraping with a piece of glass. A flask is now set on the bottom die, and plaster poured flush with the top die. They are now separated, the pattern removed, the surface scraped smooth, and given a coat of shellac. The plaster-paris casts are now used as patterns in making the castings for the dies. The entire operation requires very little time and is inexpensive.

The second type of drop hammer dies advance with complexity, and it is difficult to find a suitable term, or name, for them, other than swedging dies, or dies where provision is made for the superfluous metal to escape at both ends of the die. This is accomplished by revolving or turning the bar, or section under the hammer, the hammer striking a succession of rapid blows.

The advanced portion, commencing with the third, or drop forging dies without a flash. §In the elementary there are practically only two factors confronting the designer, namely, those of draft, and impression, these would need no associates in many cases, were it not for the commercial factor. It would be possible to drop-forge a six-throw automobile crank shaft by the factors of draft and impression by simply laying out the crank on the die, allowing draft, and placing a billet of sufficient thickness, width and length on the impression. Sufficient force or pressure could be generated to drive the metal to the extreme depth of the dies, but nine-tenths of the metal would escape in the flash. If the finished crank weighed fifty pounds it would require a billet of five hundred pounds to make the crank by this method. Without considering the cost of the additional equipment, heating and labor expense, the practical objection to this

Showing Finishing & Punch

Fig 4. a Section a



extravagant method is the excessive heat spent to the dies by friction and radiation. The necessary sharp corners would become soft and compress, or turn over, leaving an undesirable radius. The application of cold air would not be effective, and water would result in cracking the dies from uneven expansion and contraction.

The service of a drop forge die is of utmost importance. The object of the art is reduced costs, and however ingenious or efficient the die may be, if it is constructed along delicate lines, that would necessitate constant repairs it would defeat the object.

The former and latter design of dies are financially impossible, the former by waste, the latter by maintenance repairs. This important fact leads to the distinction between the elementary and the advanced class of drop forge dies, namely, that of break-down in the advanced type. The break-down, combines the efficiencies of the steam drop, and the board drop, the former performing the difficult, active work, and the latter putting the finishing touches on the product. The break-down, may be direct or indirect in the same die, or separate dies. Confining ourselves to this third class of drop-forging dies, which, in many cases, require broader experience and knowledge to design than any other, it is highly desirable, inasmuch as forging without a flash saves both material and labor. However, it is not applicable to fine work, but can be applied to the rougher class of work, and is a close competitor to the forging machine.

Fig. 5 shows a solid box vice jaw, drop-forged without a flash, and affords a good illustration of the possibilities of drop-forging. The jaws of a 50-lb. vice are 5½ inches and 2-inch wide, across the box, into which fits a malleable cast sleeve. The laymen and possibly others would no doubt express surprise to learn that the jaw can be forged in exactly thirty seconds, and further there is no waste of material, except the punching for the screw and sleeve, equal in area to a fifty-cent piece.

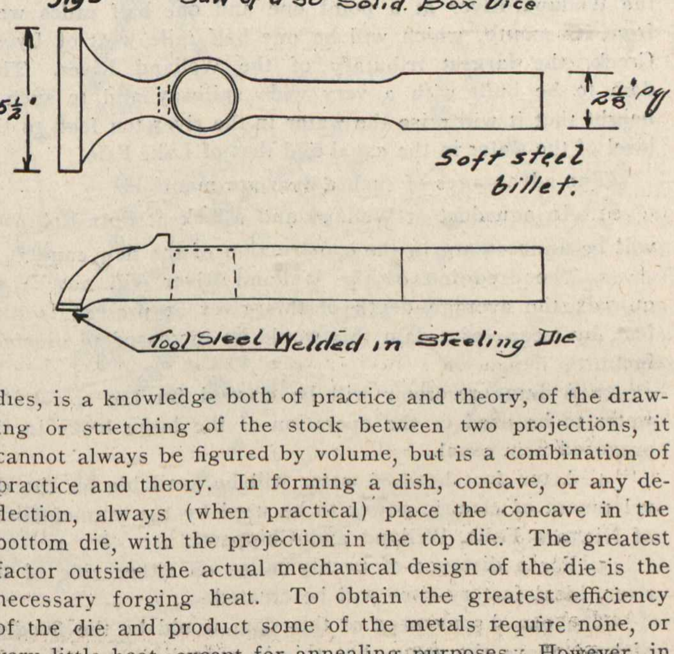
Fig. 1 shows the plan view, the die is divided into two sections—the break-down, and the finishing. The jaw is made of two and an eighth-inch square soft steel, and faced with tool steel. It is evident that the metal must spread more than twice this thickness, and this is accomplished by placing the billet on the break-down, which coincides with the side of the jaw. This narrows the metal on both sides of the box, or boss, and forces the metal towards the jaw, which is prevented from going past the required length by the end of the die. This acts as a fuller on the metal, which stretches the metal, and coming in contact with the end of the die, must upset, adding volume to form the jaw. The break-down is machined out a fraction smaller than the width of the finishing.

Two bodies cannot occupy the same location at the same time, if the billet was not soft, due to the application of heat, the die or punch in the top die could not go below the surface of the metal; if the punch was soft it would upset; as it is, it is hardened, and the billet being softer metal, must spread and seek another location, or follow the line of least resistance. This space is confined to a narrow limit around the punch. The die sinks in the metal, the latter filling the space around the punch, forming the box for the screw. It requires from four to six passes to finish shaping the jaw. The tool steel is welded on the face of the jaw, in the same bottom die, and another top or steeling die, which is the same as the forging die, except an additional space machined off the die to allow for the extra thickness of the tool steel.

The fourth distinct type of drop-forge die is simply an impression of the shape. All that has been said of the forming die, will apply to this type. Of course the object of the latter is to forge the shape, necessitating greater accuracy of workmanship in making the die (which should be of an open-hearth, high carbon, or tool steel, and hardened). It is impossible to lay down exact lines that would enable the inexperienced tool maker to design an economical drop-forge die. For the reason, that which would apply to one shape would not apply to another. Again, the difference of error limit is all the way from .001 to a blacksmith's hair (equal to an inch and a quarter), but a study of the following factors will serve as a guide.

The first, selection of stock for the die. A knowledge of the quantity, and material of the forging is necessary to decide this question, if the operation is that of forming, cast-iron would be suitable, providing the error limit was within one-sixteenth of an inch, and the metal soft, such as iron or soft steel. The second factor is the arrangement of the die and the relation of the break-down to the finishing. The first care should be to get the hard work (as near as possible) centrally located, between the housings of the hammer (board drop) or the piston rod (steam drop). The relation of the break-down to the finishing means preparing the billet, or bar stock, to fit into the finishing, with the least possible flash, consistent with speed. Draft is a very important factor in designing dies, and should be governed by the error limit. Some essential points in laying out the break-down of the

Fig 5. Jaw of a 50# Solid Box Vice



dies, is a knowledge both of practice and theory, of the drawing or stretching of the stock between two projections, it cannot always be figured by volume, but is a combination of practice and theory. In forming a dish, concave, or any deflection, always (when practical) place the concave in the bottom die, with the projection in the top die. The greatest factor outside the actual mechanical design of the die is the necessary forging heat. To obtain the greatest efficiency of the die and product some of the metals require none, or very little heat, except for annealing purposes. However, in

(Continued on next page.)

CORRESPONDENCE

[This department is a meeting-place for ideas. If you have any suggestions as to new methods or successful methods, let us hear from you. You may not be accustomed to write for publication, but do not hesitate. It is ideas we want. Your suggestion will help another. Ed.]

CONCERNING THE ENLARGEMENT OF THE WELLAND CANAL AND DEEPENING OF THE WELLAND RIVER.

Sir,—From a glance at the map it will be seen that the Welland River intersects the Welland Canal at Welland. As is well known to those who take an interest in such matters, the level of the water in the canal is, as far down as the first lock near the town of Thorold, at exactly the same elevation as the water in Lake Erie.

But the water surface of the Welland River is ten feet lower than the water surface in the canal; in order therefore, to take a boat from the canal to the river it is necessary to make use of a lock which is located at Port Robinson. Owing to the difference in elevation of the surfaces of the two bodies of water it is impossible to make any direct hydraulic connection between them, hence they must cross one over the other in such a manner that there will be no uncontrolled entry or exit of water to or from one into the other. This difficulty was overcome at the time of building the canal by means of a heavy stone aqueduct, through which the water of the canal flows and under which the Welland River flows, both waters being thus entirely independent of each other.

The cost of building this stone aqueduct was in round figures one million dollars. To alter the aqueduct so that it will conform with the width and depth of the proposed new canal will cost them from one half to three quarters of a million dollars.

To dredge the Welland River, as has been proposed by Mr. W. M. German, M.P., so that it may be of practical use to shippers will cost, say one half million dollars.

It is therefore proposed by the writer, that in order to save the expenditure of this sum of one million dollars and at the same time create a water-front suitable for the construction of miles of wharfs, that a dam be constructed in the Welland River at a point one and one half miles west from its mouth, which will be one half mile west of Lyons Creek, the largest tributary of the Welland River. This dam to be built with a very wide spillway and to such a height that it will raise the water in the river ten feet, to the level of the water in the canal and that of Lake Erie.

The advantages of such a dam are manifold:—

1. An aqueduct at Welland and a lock at Port Robinson will be unnecessary in the construction of the new canal.

2. The dredging of the Welland River will not be required; the average depth of this river at present is nine feet, by means of a dam this would be increased to nineteen feet.

3. A huge reservoir will be created for the storage of water to be used in the operation of the large locks in the proposed new canal.

4. A ten foot head of water will be available for the development of electric power to be used by the municipalities of Niagara Falls, Welland and Chippewa.

5. For a distance of twenty miles on either side of the river, ideal factory sites will be created.

The one d'sanvantge of this dam would be the flooding of land above the same, but this is a negligible matter, for at no point are the banks of the Welland River lower than Lake Erie level. Moreover, land on either side of the river is at present used solely for farming. Yours truly,

J. C. Gardner, B.A., Sc., Ass. M. Can. Soc. C.E.
Niagara Falls, Jan. 26th, 1909.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

Sir,—I have read the communication of Mr. E. J. Walsh, M. Can. Soc. C.E., of Ottawa, published in your issue of the 22nd regarding a certain letter written by Mr. A. W. Campbell, M. Can. Soc. C.E., respecting the pending election of officers to the Canadian Society of Civil Engineers.

Permit me to say that the Toronto branch of the society did not authorize such a letter to be written in its behalf, neither did it take any action expressing the sentiments contained in the letter. Yours very truly,

C. H. Mitchell, Chairman Toronto Branch
Canadian Society Civil Engineers.
January 26th, 1909.

DROP FORGING, II.

(Continued from previous page.)

reference to soft steel, the most desirable and common metal in use for drop forgings, a high heat is essential to get the best results. The application of heat to steel, causes it to become soft, if sufficient heat is applied, it will change the steel from a solid to a liquid form, or in other words, the greater the heat the softer the metal.

Without going into metallurgy, it will be sufficient to say that there is a limit of heat that can be applied to steel without (in the vernacular of the shop) burning the metal. Steel will impress, emboss, and become more ductile, and elastic, in proportion to the heat. The desired drop forging heat is around 1,950 Fahrenheit, and if it is desired to cause the metal to flow to the extreme, it is necessary to increase this temperature up to about 2,100 Fahrenheit.

The fibres or pours of the metal, are no doubt expanded to the point that is injurious to the metal. However, forging or compressing the metal, regenerates and improves the metal, beyond that of its original state.

Blast is blown on the dies, for two reasons, the first, removing the scale from the dies; and second, to intensify the heat.

†A peg is a block of metal, placed between the hammer dies to prevent the dies from going below a certain size. Thus, if a 3-inch shaft or square is desired, a 3-inch peg is placed under the hammer dies.

‡Shape forgings is applied to all smithing, performed under the steam hammer, not made in dies.

§A flash is that part of the metal that escapes between the dies, leaving a flash, or fin, on the drop-forging, which is sheared off in the trimming press.

The report of the International Waterways' Commission, based on observations made June 14, July 19, and on August 1 last, when the two American plants shut down to permit an inspection, shows that these two plants on the Niagara River, by diverting 8,000 cubic feet a second, lowered the water only two-fifths of an inch. The normal flow over the American falls is about 19 inches. It was also found that the diversion of 8,000 cubic feet diverted by the two plants lowered the level of the river at Grass Island 3¾ inches; near the Ontario intake on the Canadian side about 1¼ inches.

STAR MAP, SHOWING THE PRINCIPAL STARS, VISIBLE AT 10 P.M. FEBRUARY FIRST IN LATITUDE 45° N.

L. B. Stewart, D.T.S.

The table below gives the apparent places of the brightest of these stars for February 1st at transit across the meridian of 5h W. of Greenwich.

Star	Mag.	R. A. h. m. s.	Decl. ° ′ ″
β Cassiop	2.4	0 04 16.6	+ 58 38 58
α Cassiop	2.5	0 35 18.1	+ 56 02 25
γ Cassiop	2.3	0 51 10.3	+ 60 13 35
α Ursæ Min. (Polaris)	2.1	1 25 59.3	+ 88 49 30
α Tauri (Aldebaran) ..	1.1	4 30 41.7	+ 16 19 36
α Aurigæ (Capella) ...	0.2	5 09 58.0	+ 45 54 30
β Orionis (Rigel)	0.3	5 10 10.0	— 8 18 30
α Orionis (Betelgeux).	1.0	5 50 14.9	+ 7 23 24
α Canis Maj. (Sirius).	—1.4	6 41 08.6	— 16 35 33
α Geminorum (Castor)	2.0	7 28 48.4	+ 32 05 22
α Canis Min. (Procyon)	0.5	7 34 32.8	+ 5 27 28
β Geminorum (Pollux)	1.2	7 39 45.6	+ 28 14 48
α Leonis (Regulus) ..	1.3	10 03 32.2	+ 12 24 42
β Ursæ Maj.	2.4	10 56 22.7	+ 56 52 06
α Ursæ Maj.	2.0	10 58 08.9	+ 62 14 25
γ Ursæ Maj.	2.5	11 49 03.9	+ 54 11 52
δ Ursæ Maj.	3.4	12 10 56.7	+ 57 32 06
ε Ursæ Maj.	1.8	12 50 02.4	+ 56 27 00
ζ Ursæ Maj.	2.1	13 20 16.2	+ 55 23 47
η Ursæ Maj.	1.9	13 43 57.4	+ 49 45 47

Determination of Azimuth by the Pole Star.

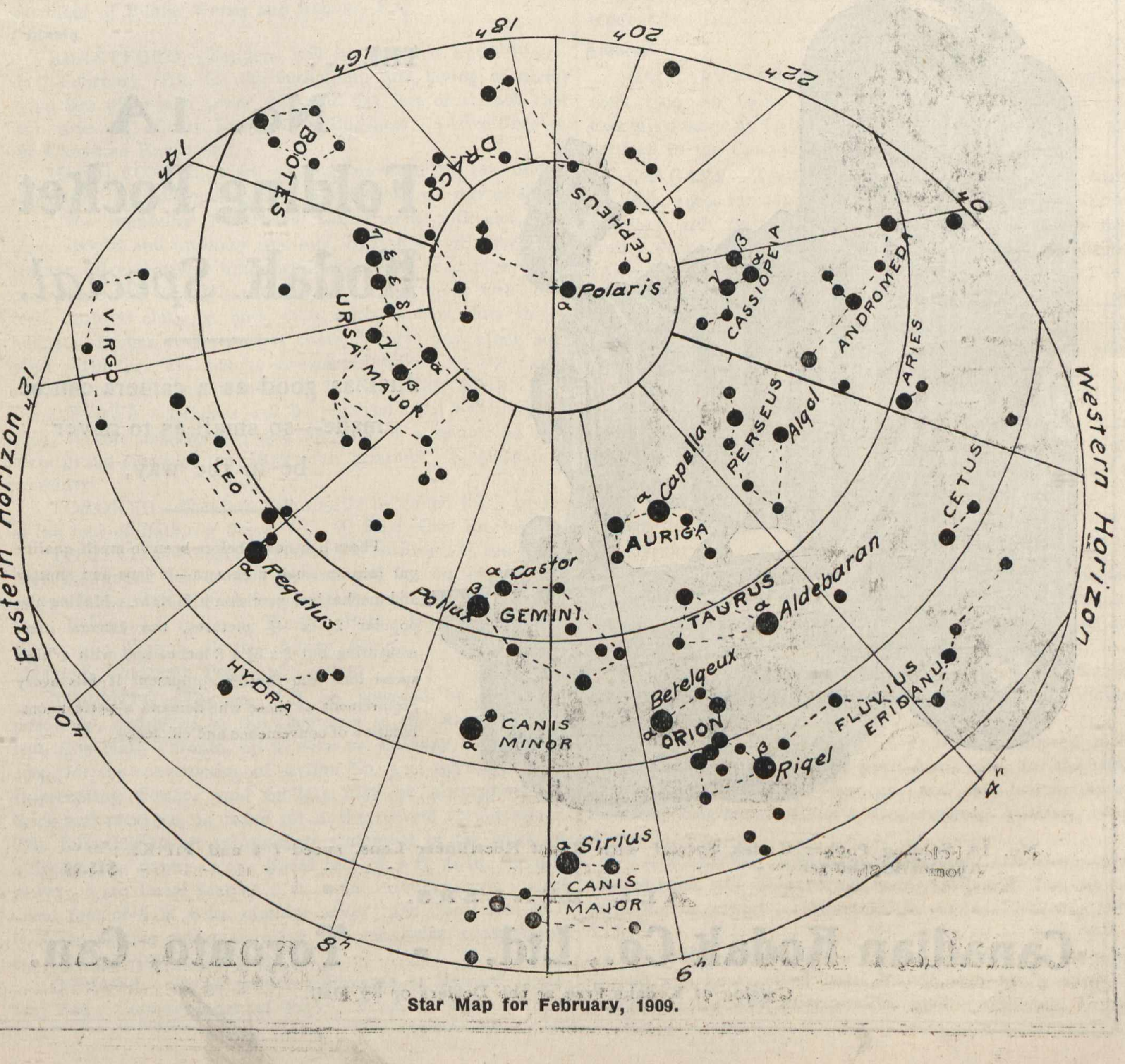
The following table gives the azimuth of Polaris on February 1st, 1909, for places in longitude 5h (= 75°) W. L = the latitude of the place, and T the standard time:—

T	Sid. time	L = 44°		L = 48–		L = 52°	
P.M.		A	a	A	a	A	a
h. m.	h. m. s.	° ′ ″	″	° ′ ″		° ′ ″	
8 00	4 46 20.2	358 43 51	—16	358 38 00	—18	358 30 41	—19
8 30	5 16 25.2	36 22	—14	29 57	—15	21 57	—16
9 00	5 46 30.1	30 20	—11	23 30	—12	14 58	—13
9 30	6 15 35.0	25 54	— 8	18 45	— 8	09 51	— 9
10 00	6 46 40.0	23 07	— 4	15 48	— 5	06 41	— 5
10 30	7 16 44.9	22 00	— 1	14 38	— 1	05 29	— 1
11 00	7 46 49 8	22 35	+ 2	15 18	+ 2	06 15	+ 3
11 30	8 16 54.7	24 49	+ 6	17 45	+ 6	08 58	+ 7
12 00	8 46 59.7	28 41	+ 9	21 56	+ 9	13 33	+10

In this table azimuths are reckoned from the N. in the direction E.S.W. The quantity **a** is the error in the azimuth resulting from an error of 1m. in the time. It will serve to show the best time to observe if the watch correction is not well determined. The azimuth for any other latitude may readily be found by interpolation.

To find the standard time corresponding to any azimuth given in the table, for a place whose longitude differs from 5h, **add** to the time of the table an interval equal to the amount by which its longitude **exceeds** 5h, diminishing that interval by 0.16s for each minute in its amount. For any other date diminish the time given in the table by 3m 55s.9 for each day elapsed since February 1st.

For example, at a place in latitude 49° 20′ N., longitude 80° (= 5h 20m) W. an observer wishes to take an observation for azimuth between 8 and 9 p.m. on February 8th.



Star Map for February, 1909.

Here the interpolated value of the azimuth for 8h 30m is 358° 27′ 29° and the corresponding time for the given longitude and date is

8h 30m 00s
+ 19m 57s (= 20 × 0.16s)
27m 32s (= 3m 56s × 7)
= 8h 22m 25s

If this observation is interfered with by clouds, the next one may be taken half an hour later.

If the direction of the meridian is known approximately, the correction of a watch on standard time may be found by observing the watch time of transit of a star. The star's R.A. is then the sidereal time of transit, and the corresponding standard time may be found as follows: Subtract from the nearest standard time given in above table an interval equal to the corresponding sidereal time minus the R.A. of the star observed, first reducing this interval to the equivalent mean time interval by subtracting 0s.16 for each minute in its amount. The corresponding sidereal time is found by adding to that of the table 3m 56s.555 for each day elapsed since February 1st, and subtracting the amount by which the longitude exceeds 5h, or adding the amount by which it is less.

Thus, if at the place and date of the above example the meridian transit of the star Aldebaran be observed at the watch time 7h 37m 12s p.m., to find its correction on standard time

		h. m. s.
Sidereal time, 8 p.m. (table)	=	4 46 20.2
3m 56s.555 × 7		27 35.9
		5 13 56.1
Correction for longitude	=	20 00
Sideral time at place and date	=	4 53 56.1
R.A. of star	=	4 30 41.7
Difference	=	23 14.4
32.2 × 0s.16	=	3.7
Equivalent mean time interval	=	23 10.7
		8 00 00
Standard time of transit	=	7 36 49.3
Watch	=	7 37 12
Watch fast	=	22.7

For an equatorial star the error in the observed time of transit due to an error of 1′ in azimuth = 2s.8 in latitude 45° N.; for a star whose decl. = 15° N. this is 2s.1, and 15° S. it is 3s.6; therefore the greater the altitude of the star the less the effect of an error in azimuth.

The methods described above do not take account of changes in the star places, but with ordinary field instruments and for short periods of time these are negligible.

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.

New Brunswick.

CENTREVILLE.—Tender for Centreville School Building will be received at the office of the secretary of the School Trustees, Centreville, N.B., until Monday, the 8th day of February, at noon, for the building and completing ready to occupy, a school building in Centreville according to plans and specifications to be seen at the school secretary's office or at the office of the architect, H. H. Mott, St. John, N.B. Address, H. J. Clark.

WOODSTOCK.—The building committee of the municipality of Carleton will receive plans, specifications and cost of plans and estimates for the building of a brick Court House in the town of Woodstock during the summer 1909. Said tenders to be addressed to the undersigned. Tenders to be received up to February 20th, 1909. Henry A. Phillips.

Quebec.

QUEBEC.—Tenders addressed to the Hon. L. A. Taschereau, Minister of Public Works and Labour, P.Q., will be received at the Parliament Buildings, Quebec, on the 5th February next (1909) for the completion of the new Jail of the district of Montreal. Alphonse Gagnon, Secretary Department of Public Works and Labour, P.Q.

Ontario.

BRANTFORD.—Tenders will be received until Thursday, February 11th, for the furnishing and laying of about 2,250 feet of 12-inch sewer pipe and 635 feet of 12-inch cast iron pipe. T. Harry Jones, City Engineer. (Advertised in the Canadian Engineer.)

HAMILTON.—Tenders will be received by the undersigned up to 12 o'clock noon on Wednesday, 3rd day of Feby. next, for supplying Waterwork Department with cast iron pipe, special and ordinary castings, hydrants and valves and leather valves, service brass work, pig lead, lead pipe, stopcock boxes and sundry hardware. Fire Department with horse feed, uniform clothing, hats, caps, mitts, gloves, duty shirts, helmets, rubber coats, rubber boots, badges and other supplies. Tenders will not be considered unless on the forms supplied by the departments. S. H. Kent, City Clerk.

OTTAWA.—Tenders will be received until February 12, 1909, for the construction and erection of a reinforced concrete grand stand on the Ottawa fair grounds. E. McMahon, secretary.

TORONTO.—Tenders will shortly be called for a bridge at the foot of Bathurst Street. C. H. Rust, City Engineer.

TORONTO.—Separate tenders for hardware to the buildings mentioned below will be received by registered post only addressed to the undersigned up to noon on Tuesday, 2nd February, 1909. 1. Public Bath House—Stephanie Place. 2. Wagon House—Agnes Street. Joseph Oliver (Mayor), Chairman Board of Control.

TORONTO.—Tenders will be received by registered post only, addressed to the Chairman of the Board of Control, City Hall, Toronto, up to noon on Tuesday, February 2, 1909, for the construction of section No. 3 of the High Level Intercepting Sewer; said tenders may be alternative, for brick and concrete, as called for in the revised specifications. The following is an approximate statement of the work required to be done:—1,972 lineal feet of 7 ft. 6 in. circular sewer; 2,419 lineal feet of 7 ft. 9 in. circular sewer; 1,556 lineal feet of 8 ft. 0 in. circular sewer; 439 lineal feet of 8 ft. 6 in. circular sewer, together with manholes, connections, etc. Joseph Oliver (Mayor).

OTTAWA.—Sealed tenders addressed to Howard Douglas, Esq., Commissioner of Parks, Banff, Alberta, will be received up to 12 o'clock noon on the 5th February, 1909, for the following sewer pipe and fittings required for extensions to the Banff sewerage system: 282 feet of 8-inch sewer pipe; 1,810 feet of 9-inch sewer pipe; 600 feet of 15-inch sewer pipe; 30 6-inch off 15-inch sewer junctions; 60 6-inch off 9-inch sewer junctions. The whole of the material to be delivered f.o.b. cars at Banff, Alta., on or before the 1st April, 1909. P. G. Keyes, secretary, Department of the Interior.

Manitoba.

WINNIPEG.—Sealed tenders addressed to the Chairman of the Board of Control, for supply of 120 feet of 26-in. 8-ply rubber elevator belting delivered to the City Quarry, Stony Mountain, will be received at the office of the undersigned up to 11 a.m. on Thursday, February 11, 1909. M. Peterson, secretary.

Saskatchewan.

SASKATOON.—Sealed tenders, addressed to the City Clerk, for 500 horse-power boilers in 2 or 3 units, will be received at the office of the undersigned city clerk up to 6 o'clock p.m. on Wednesday, the 3rd day of February, 1909. J. H. Trusdale, City Clerk; E. L. White, Electrical Superintendent.

Alberta.

CALGARY.—Tenders will be received until February 18th, 1909, for boiler and generators to be supplied to the Commissioners at Calgary. H. E. Gillis, City Clerk. (Advertised in the Canadian Engineer.)

CALGARY.—Tenders will be received until February the 18th, 1909, for supplying 1,143 tons (approx.) steel rails, together with fasteners; also steel span wire, cedar poles, trolley wire, etc., for street railway. H. E. Gillis, City Clerk, (Advertised in the Canadian Engineer.)

CALGARY.—Tenders are being asked for the installation of the street railway system complete, also for an addition to the civic power plant which will supply the power. It is expected that the system will be in running order by July.

LETHBRIDGE.—Tenders will be received until March 1st, 1909, for a Municipal Power Plant at Lethbridge. Fuller particulars will be found in the advertisement in The Canadian Engineer. George W. Robinson, Secretary.

British Columbia.

VICTORIA.—Sealed tenders superscribed Tender for Sewerage Works, Prince Rupert, will be received by the Hon. the Minister of Public Works up to and including Monday, the first day of February, 1909, for the construction and completion of certain sewerage works at Prince Rupert, to be completed by the first day of May, 1909. F. C. Gamble, Public Works Engineer, Public Works Department, Victoria.

Foreign.

ADELAIDE, AUSTRALIA.—Tenders addressed to the undersigned will be received until April 28th, for the supply of one bucket dredger, one tug, and two hopper barges. Address, Engineer-in-Chief's Department, Adelaide, South Australia.

LA PALOMA, URUGUAY.—Tenders addressed to the undersigned will be received until April 2nd, for the construction of a port. Ministerio de Obras Publicas, Monte Video.

LEIPZIG, GERMANY.—Tenders addressed to the undersigned will be received until March 15th for a supply of pumps for the New Waterworks. Stadtverorducten, Leipzig.

CONTRACTS AWARDED.

Nova Scotia.

SYDNEY.—The contract has been let to Joseph McGill, Shelburne, for a new boat 130 feet long and 35 foot beam. The contract for placing the machinery has been awarded to Burrel Johnson & Company, of Yarmouth, N.S. The new steamer will have a guaranteed speed of 12 knots, but will be capable of developing greater speed when necessary.

Ontario.

HAMILTON.—The Hamilton Steel and Iron Company has received an order for about twenty carloads of steel for one of the Hill railway enterprises that is being conducted in the North-West. The order comprises about 300 tons of steel angle irons for connecting rails, and about 160 tons of spikes for spiking rails to the ties.

Alberta.

EDMONTON.—The contract for an 1,800 horse-power steam engine at a cost of $27,800 f.o.b. Edmonton has been awarded to Goldie & McCulloch, Galt. The new engine is designed to operate a 1,000 kilowatt alternator which was purchased from the Canadian General Electric Company for $14,300. Tenders were submitted for both gas engines and steam engines, but acting upon Commissioner McNaughton's report the Council unanimously decided in favor of the steam plant. According to the Commissioner's report the cost of a steam plant, together with all auxiliaries, would be $74,350, while a gas producer plant of the same capacity would cost over twice that amount. Owing to the low price of coal, the saving of a gas engine over a steam engine was not compatible with the increased expenditure necessary, and as a result the Council authorized the purchase of the steam engine.

Foreign.

SCRANTON, PA.—The Rockwell Furnace Company has been awarded the contract covering the complete furnace equipment for the new Locomotive Shops of the D.L. & W.R.R. at Scranton, Pa. The furnace equipment consists of thirty-five of the latest type furnaces operated with 300 B.T.U. water gas, which is made in Loomis Pettibone producers. These shops will be capable of turning out complete locomotives, and are to be in operation in three months. No pains or expense has been spared to make them up-to-date, as they embody the latest and most improved machinery and equipment, selected after thoroughly inspecting a large number of modern railway and industrial plants throughout the country.

RAILWAYS—STEAM AND ELECTRIC.

Quebec.

MONTREAL.—William Whyte, second vice-president of the C.P.R. announced that all important proposals in the C.P.R. western programme had been settled by the executive. One of the most important new lines to be built will be from Weyburn to Lethbridge, 400 miles, running about midway between the main line of the C.P.R. and the international boundary. Starting at Weyburn, a distance of 25 miles, it is expected to be completed this year. The filling in of the gap of 130 miles in the centre of the line from Edmonton to Saskatoon is to be completed in the spring. There is to be another line from Lethbridge joining the Macleod to Calgary line a little north of High River Station, a total distance of 80 miles, of which 30 will be built this year, taking the line to Little Bow River. A branch north from Cheadale to connect with the line from Lacombe at Alix will be carried as far as the Ghost Pine Creek this year.

MONTREAL.—It is officially announced that the Mackenzie & Mann's new route to Quebec along the north shore of the St. Lawrence, 175 miles, will be opened for traffic by the first of May.

Ontario.

The City of Chatham will apply to the Ontario Legislature for authority to loan the Chatham, Wallaceburg and Lake Erie Railway Company $50,000 and to provide for the issue of debentures to that amount. The proposed rate of interest is 5 per cent., and the term of the issue will be 30 years.

COBOURG.—Application will be made to the Legislature of Ontario at the next session for an act to incorporate the Cobourg, Port Hope and Havelock Electric Railway Company by Colonel H. A. Ward, K.C., Port Hope. The chief provisional directors are Wm. J. Crossen, Cobourg; Col. Ward, ex-M.P. for Durham County; Bernard McAllister, Cobourg, and Joseph Knox, Havelock. The main line will run from Port Hope to Cobourg, thence across country to Warkworth, to Campbellford and on to Havelock. A branch line is to run from Cobourg to Gore's Landing.

WINDSOR.—The case of Newman and Nelles versus the Windsor Electric and Lake Shore Railway is now being heard at Windsor before His Honor Judge Clay. The plaintiffs claim that they have been unfairly treated in the values of stock and bonds, which they hold with reference to the value of the charter and franchise. Whilst the Railway Company claim that the plaintiffs have received full satisfaction and compensation in this particular. The following engineers are retained to give evidence. For the plaintiffs, E. H. Wingate, of Hamilton, and Keating and Breithaupt, of Toronto. For the defendant's Railway Company, Andrew F. Macallum, of Toronto. The case occupied the greater part of last week hearing the plaintiff case, and stands adjourned till 1st February to take evidence from the defendants.

Manitoba.

WINNIPEG.—Application will be made on behalf of the Midland Railway Company of Manitoba, at the next session of Parliament for an act empowering it, in connection with its authorized line of railway between Winnipeg and the international boundary, to construct and operate a branch line from a point on said authorized line on the east side of the Red River, in township one, range two or range three east, to a point on the international boundary on the west side of the river in range two east, and also authorizing it to sell and convey to another company its existing lines of railway in the province, namely, its lines from Gretna to Portage la Prairie and from Morden to the international boundary.

LIGHT, HEAT, AND POWER.

Ontario.

TORONTO.—A deputation from the Ottawa district waited upon the Hydro-Electric Commission to urge the erection of storage dams on the Mississippi River. It was pointed out that the generation of electrical energy by this means would be very cheap and beneficial to Carleton Place, Almonte, Blakeney, Pakenham, Appleby, and Galeta, as well as to private industries. Consideration was promised.

FINANCING OF PUBLIC WORKS

Quebec.

AYLMER.—On Jan. 19th the ratepayers carried a by-law to spend $50,000 on a waterworks system.

British Columbia.

VICTORIA.—The city of Victoria are voting on a money by-law (January 14th) to raise $50,000 for sewer extension, and on the same date a second by-law to raise $35,00 for the purpose of defraying the cost of alterations in the city hall building.

FERNIE.—Tenders will be received by the undersigned up till the 22nd day of January, 1909, for the purchase of $50,000, 5 per cent. 20-year electrical light debentures. G. H. Boulton, City Treasurer.

Foreign.

LONDON, ENG.—A public issue will shortly be made of £1,000,000 sterling 4 per cent Grand Trunk Pacific debentures, guaranteed by the Grand Trunk Railway. It is understood that the issue will be at 90 or less. Arrangements are now in progress with the underwriters.

ALBANY, N. Y.—The New York & Ontario Power Company were authorized by the Public Service Commission, to issue its capital stock of $600,000 and $1,850,000 in thirty-year 5 per cent gold bonds. The company is developing a water power on the St. Lawrence River at Waddington, St. Lawrence county. The company believes that the water power is capable of developing at a moderate expense upwards of 30,000 horse power, 24-hour service, every day in the year. It is proposed at first to develop and equip approximately half of the power, 17,000 horse power in water wheel electricity.

TELEPHONY.

Ontario.

BELHAVEN.—Dr. Greenwood, of Sutton, has secured permission to build a telephone line from Sutton to Ravenshoe.

MARKET CONDITIONS.

Montreal, January 27th, 1909.

The metal markets of the United States are disappointing in that the improvement looked for after the turn of the year has not developed. Numerous sales are being put through, however, but the quantities changing hands are very limited in volume. Producers are apparently not altering their determination to hold on to their product, as they are not pushing sales nor are they making any reduction in prices. The west and central west anticipate better conditions in the near future, but it is impossible to say, in the meantime, whether their anticipations will be realized. The tariff investigation is having the effect of delaying everything in the metal markets for the time being.

The English market is quiet and steady, and prices are nominally unchanged. Speculatively, the market is fluctuating up and down at a range of about one shilling to one shilling and a half per ton. Stocks continue to show a fair increase but producers are apparently satisfied that conditions will improve later on as they are asking higher prices for future deliveries. The Scotch market is in somewhat better position, owing to the fact that production is absorbed rapidly, leaving stocks comparatively light. There is a somewhat improved feeling in Germany and this is having its effect on the English market, the result being a generally firmer tone than had been looked for at this season of the year. The volume of business is small and quotations are about steady.

In the local market, there is a better enquiry for delivery extending over the first half of the year, several large lots being now under consideration and the likelihood being that business will result very shortly. Canadian furnaces are holding firm at an advance in price over the recent low point which the fierce competition between rival furnaces had driven the market to. Apparently this policy has been altered, and there is every reason to believe that, at the somewhat better prices now prevailing, the Canadian furnaces will still secure the bulk of the orders.

Rolling mills and dealers in different finished or partly finished products are a trifle pessimistic regarding the future, and they generally report business very dull at the moment. Prices are almost unchanged as will be seen from the following list:—

Antimony.—The market is steady at 9 to 9½.

Bar Iron and Steel.—Prices are steady all round, and trade is dull. Bar iron, $1.90 per 100 pounds; best refined horseshoe, $2.15; forged iron, $2.05; mild steel, $2.00; sleigh shoe steel, $1.90 for 1 x ⅜-base; tire steel, $1.95 for 1 x ⅜-base; toe calk steel, $2.40; machine steel, iron finish, $2.10; smooth finish, $2.75.

Boiler Tubes.—The market is steady, quotations being as follows:—2-inch tubes, 8¼c.; 2½-inch, 10c.; 3-inch, 11¼c.; 3½-inch, 14¼c.; 4-inch, 10c.

Building Paper.—Tar paper, 7, 10, or 16 ounce, $1.60 per 100 pounds; felt paper, $2.40 per 100 pounds; tar sheathing, No. 1, 55c. 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).

Cement.—Quotations are for car lots, f.o.b., Montreal. Canadian cement is $1.55 to $1.65 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. English cement is $1.65 to $1.85 per 350-lb. bbl. in 4 jute sacks (for which add 8c. each) and $2.20 to $2.40 in wood. Begian cement is $1.60 to $1.65 in bags—bags extra—and $2.10 in wood.

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.—The market is steady at 15 to 15¾c. per lb. Demand continues limited.

Explosives and Accessories.—Dynamite, 50-lb. cases, 40 per cent. proof, 18c. 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 strength, per 100 fuses:—4-ft. wires, $3.50; 6-ft. wires, $4; 8-ft. wires, $4.50; 10-ft. wires, $5. Double strength fuses, 1$ extra, per 100 fuses. Fuses, time, double-tape, $6 per 1,000 feet.

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.—Prices are rather higher, and the outlook is steady. The following prices are ex-store: Canadian pig, $18.50 to $19.50 per ton; No. 1 Summerlee, $21 to $22; No. 2 selected Summerlee, $20.50 to $21.50; Carron soft, $20.25 to $20.75; No. 3 Clarence, $19 to $20 per ton.

Laths.—See Lumber, etc.

Lead.—Trail lead is unchanged and steady, at $3.70 to $3.80 per 100 pounds, ex-store.

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

Lumber, Etc.—Prices on lumber are for car lots, to contractors, at mill points, carrying a freight rate of $1.50. At the moment, the market is exceptionally irregular and prices are uncertain. 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 moderate, but prices are steady at $2.30 per keg for cut, and $2.25 for wire, base prices

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: 1-4-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. The discount on the following is 69 per cent. off for black and 59 per cent. off for galvanized; ½-inch, $8.50; ¾-inch, $11.50; 1-inch, $16.50; 1¼-inch, $22.50; 1½-inch, $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 $31.50 to $32.50 is given for 60-lb., 70-lb., 80-lb., 85-lb., 90-lb., and 100-lb. 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, 64c. per roll; three-ply, 86c. per roll of 100 square feet. (See Building Paper; also Tar and Pitch.)

Rope.—Prices are steady, at 9 1-2c. per lb. for sisal, and 12c. 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.

Shingles.—See lumber, etc.

Spikes.—Railway spikes are in dull demand and prices are steady at $2.40 per 100 pounds, base of 5½ x 9-16. Ship spikes are also dull and steady at $3 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 and thicker; 12-gauge being $2.30; 14-gauge, $2.05; and 16-gauge, $2.10.

Tar and Pitch.—Coal tar, $4 per barrel of 40 gallons, weighing about 500 pounds, roofing tar, $3.15 per barrel; roofing pitch, No. 1, $1 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.)

Telegraph Poles.—See lumber, etc.

* * * *

Toronto, January 28th, 1909.

Movement in any building materials may be described as limited. Enquiries are fairly numerous, especially for metals, but they have reference more to prices at 1st April or 1st May than to the present. Pig-iron is quiet at unchanged prices. Little doing in structural steel. Builders' hardware shows some little activity. Roofing felt and building paper very quiet. Cement dull. Bricks moving slowly, with a promise of activity for spring. Lumber quiet.

In the United States, to use the words of an observant New York firm, past weeks have been disappointing to those who have been "so confident that the New Year would open with a distinct revival in trade, increased demand and higher prices." It will take time—longer time than has yet elapsed—before the normal prosperity of two years ago, with busy factories, large consumption and higher prices, can come to the United States. The steel industry and the labor unions, by their refusal to adjust prices and wages, have retarded improvement in the metal trades. The expected tariff reductions, however, will probably impress the steel men. How the labor unions are to be made reasonable is a more puzzling problem.

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

Antimony.—Slightly more active at 9¾c. per lb., and a better feeling in the market.

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

Boiler Plates.— 1-4 inch and heavier, $2.40. Boiler heads 25c. per 100 pounds advance on plate.

Boiler Tubes.—Orders continue active. Lap-welded, steel, 1 1-4-inch, 10c.; 1 1-2-inch, 9c. per foot; 2-inch, $8.75; 2 1-4-inch, $10; 2 1-2-inch, $10.60; 3-inch, $11.75 to $12; 3½-inch, $15; 4-inch, $18.50 to $19 per 100 feet.

Building Paper.—Plain, 30c per roll; tarred, 40c. per roll. Business seasonably quiet.

Bricks.—Common structural, $9 per thousand, wholesale, and the demand moderately active. Red and buff pressed are worth, delivered, $18; at works, $17.

Cement.— Market still weak: cement can be had in 1,000 barrel lots at $1.70 per bbl., including the bags, which is equal to $1.30 without bags. At this time of year building operations are closing down, demand is therefore naturally limited.

Coal Tar.—Season about over, price still $3.50 per barrel.

Copper Ingot.—Irregular outside; there is a heavy stock in London, and production still goes actively on. There is no activity here; price 15 to 15½c.

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. Very limited request. Price $1.80 per 100 pounds.

Fire Bricks.—English and Scotch, $30 to $35; American, $27.50 to $35 per 1,000. Moderate demand and fair supply.

TENDERS CALLED FOR

CITY OF CALGARY

TENDERS will be received by the Commissioners of the City of Calgary and addressed to the undersigned marked "Tender for St. Railway material," until the 18th day of February next, 12 o'clock noon, for supplying to the City the following:

Covering approximately:—
397 Long tons 80-pound A. S. C. E. Steel rails.
746 Long tons 60-pound A. S. C. E. Steel rails.
Together with certain special work, also spikes, bonds,
Tie plates.
Angle irons, track bolts, ties etc.
12 standard street railway cars.
One street railway sprinkler.
One street railway sweeper.

Overhead Construction.

Steel span wire poles 30 ft. and 35 ft., three sections.
Cedar poles.
12.5 miles of 2.0 trolley wire.
10.2 miles of 3.0 feed wire.
Span wire.
Hangers, Insulators and Conical strain insulators.
Ears.
Cross-overs and trolley frogs.

Bids will be received upon the entire schedule or any item of the same. A marked cheque covering 5 per cent up to $10,000 and 2½ per cent over and above this sum of the amount bid will be required to accompany each and every tender.

Full particulars and specifications will be supplied at the City Engineer's Office.

The lowest or any tender not necessarily accepted.

H. E. Gillis,,
Dated at Calgary, Jan. 20th, 1909. CityClerk.

CITY OF OTTAWA

CONSTRUCTION OF RE-INFORCED CONCRETE GRAND STAND.

NOTICE TO CONTRACTORS.

Sealed tenders addressed to the Secretary of the Central Canada Exhibition Association, 26 Sparks St., Ottawa, will be received by registered post only up to 12 o'clock noon, Friday, February 12th, 1909, endorsed "Tender for Grand Stand," for the construction complete of a re-inforced concrete Grand Stand to be erected on the grounds of the Central Canada Exhibition Association, Ottawa.

For terms of tender and all information, apply to the undersigned.

E. McMahon,
Secretary C. C. E. A.,
26 Sparks Street, Ottawa,

Ottawa, Jan. 21st, 1909.

CITY OF BRANTFORD

SEWER EXTENSION.

Sealed tenders addressed to John Moffat, Chairman of the Board of Works, in care of the City Clerk, Brantford, Ont., will be received till 12 o'clock Noon on

THURSDAY, FEBRUARY 11TH, 1909,

for the furnishing and laying of about 2,250 feet of 12-inch extra strength sewer pipe and 635 feet of 12-inch cast iron pipe, together with 11 manholes—greatest cut 32 feet—average cut 17½ feet.

Plans and specifications may be seen and instructions to biders and forms of tender obtained at the City Engineer's Office.

Each tender must be accompanied by a marked cheque for five per cent. of the amount of the tender.

The lowest or any tender not necessarily accepted.

T. HARRY JONES,
City Engineer's Office, City Engineer.
Brantford, January 18th, 1909.

CITY OF CALGARY

TENDERS will be received by the Commissioners of the City of Calgary and addressed to the undersigned, marked "Tender for Boiler and Generator," until the 18th day of February next at 12 o'clock noon, for supplying to the City the following:

3 Water Tube Boilers equivalent to 1,000 H. P., with piping and induced draft system for 2,500 H. P.

Also

1 500 K.W. Generator connected to a 750 H. P. High Speed Engine for Railway System, with condenser, switch board, etc.

A certified check on a chartered bank in Canada for 2½ per cent. of the amount must accompany each tender. Separate offers may be made for any of the items set out herein.

Plans and Specifications can be had on application to the City Engineer, Calgary, Alta.

The lowest or any tender not necessarily accepted.

H. E. Gillis,
Dated at Calgary, Jan. 20th, 1909. City Clerk.

Fuses—Electric Blasting.—Double strength, per 100, 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; 20, $4.50; 10¾, $4.50 per 100 pounds. 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 are in very 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.

Iron Pipe.—Black, ¼-inch, $2.03; ⅜-inch, $2.25; ½-inch, $2.63; ¾-inch $3.56; 1-inch, $5.11; 1¼-inch, $6.97; 1½-inch, $8.37; 2-inch, $11.16; 2½-inch, $17.82; 3-inch, $23.40; 3½-inch, $29.45; 4-inch, $33.48; 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, $4.71; 1-inch, $6.76; 1¼-inch, $0.22; 1½-inch, $11.07; 2-inch, $14.76. Makers are holding prices stiff and anticipate a rise.

Lead.—Quiet and unchanged at $3.90 to $4.00. Old Country market quiet but steady.

Lime.—In adequate supply and slow movement. Price for large lots at kilns outside city 22c. per 100 lbs. f.o.b., cars; Toronto retail price 35c. per 100 lbs. f.o.b. car

Lumber.—We quote dressing pine $32 to $35 per thousand; common stock boards as to grade $24 to $28; cull stocks $20; sidings, $17.50. Norway pine is neglected in favor of Southern, which is much stronger in fibre and the price well maintained. Hemlock continues to sell pretty freely, and in car lots brings $16.50 to $17.00. Spruce flooring is quoted at $22.00 in car lots. The season being practically over for shingles, there is but little movement in them, and prices are weak though unchanged at $3.20 for British Columbia. White pine lath are scarcer, No. 1 especially, we quote $4 for No. 1 and $3.50 for No. 2 firm. A good deal of varied stuff is moving, not so much good pine as cheaper goods, such as hemlock and spruce. But all kinds of Canadian lumber are likely to continue firm.

Nails.—Wire, $2.55 base; cut, $2.70; spikes, $3. There is a fair supply and no especial activity.

Pitch.— Very quiet; price, 70c. per 100 lbs.

Pig Iron.—Business continues quiet; prices are fairly well maintained. Clarence quotes at $20.50 for No. 3; Cleveland, $20.50 to $21.00; in Canadian pig, Hamilton quotes $19.50 to $20.

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

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

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	$0.60	$0.75	$1.00	$3.25
Single junction, 1 or 2 feet long.	.00	1.35	2.70	3.40	4.50	14.63
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	.....

In steady demand; price 70 per cent. off list at factory for car-load lots; 60 per cent. off list retail.

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, with fairly good demand; 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.

Tool Steel.—Jowett's special pink label, 10½c. Cyclops, 16c.

Tin.—Markets abroad very irregular during week, but closed much steadier. Prices here lower at 30 to 31c.

Wheelbarrows.—Navvy, steel wheel, Jewel pattern, knocked down, $21.35 per dozen; set up, $22.35. Pan Canadian, navvy, steel tray, steel wheel, per dozen, $3.30 each; Pan American, steel tray, steel wheel, $4.25 each.

Zinc Spelter.—Business fairly active, market strong at $5.25 to $5.50, and more enquiry.

* * * *

Winnipeg, January 25th, 1909.

After considerable discussion with the directors of the Winnipeg Electric Railway re buying out their complete plant including their railway system and power plant the city of Winnipeg have decided to go on with the Municipal Power plant at Point du Bois, and have signed the contracts

CONTRACTOR'S SUPPLIES

NEW INCORPORATIONS.

Hanley, Sask.—Ullerich Implement Company.

Aberdeen, Sask.—Aberdeen Telephone Company.

Wainwright, Alta.—Imperial Lumber Company.

Edmonton, Alta.—Yellow Head Pass Coal and Coke Company.

Hamilton.—Hamilton Bridge Works Company, $1,000,000; J. S. Hendrie, W. Hendrie, W. B. Champ.

Winnipeg, Man.—Continental Oil Co., $50,000; T. Anderton, E. Libel, J. Anderton. W. Newman Company, $100,000; W. Newman, H. C. French, W. R. Roland.

Montreal.—Walton, Ltd., $10,000; C. C. Walton, G. E. Morgan, D. E. Bigwood. Canadian British Insulated Company, $50,000; L. S. F. Grant, J. J. Creelman, H. Brown. Freeman, $300,000; F. J. Gallagher, T. J. Gallagher, J. E. Cassidy. Hill Electric Switch and Manufacturing Company, $20,000; C. J. Doherty, J. J. Dougherty, N. Desjardins. J. M. Robertson, $10,000; J. M. Robertson, F. W. Hibbard, Westmount; L. Boyer, Montreal. Mexican Northern Power Company, $10,000; W. J. White, A. W. P. Buchanan, A. W. Moffatt. Simplex Concrete Piling and Construction Company of Canada, 75,000; G. E. McCuaig D. R. McCuaig, C. H. Lewis. R. J. Devins, $19,000; L. A. Bernard, J. A. Brunet, J. E. Bernard. Dale and Company, $100,000; R. J. Dale, J. J. McCulloch, C. G. Ross. Empire Light Company, $75,0000; L. H. Packard, J. G. Watson, H. A. Barnard, G. W. Birks. Canadian Turpentine, $100,000; R. Munro, J. B. Picken, J. T. Donald. East Canada Smelting Company, $1,000,000; J. R. Allen, New York; R. L. Clarke, Silverton; G. E. Smith, Sherbrooke.

for the work which were awarded recently. This means that they will go into competition with the Winnipeg Electric Railway for supplying power to the city of Winnipeg.

Conditions in the West remain practically the same and no change of any kind has taken place in the market quotations.

Prospects for a good season's business become brighter it would seem almost every week, and there is no doubt whatever but the West will see this year a tremendous amount of building done.

In talking to one of the dealers last week he stated that they were not going to be caught napping this year in regard to cement, as he said that nearly every dealer had a great quantity of cement on hand at the close of the season, and were willing to work it off at almost any figure which made the cement market very dull. Most of the stocks that were on hand are now exhausted, and it is hoped that the cement market will pick up in the coming season.

Quotations locally are as follows:—

Anvils.—Per pound, 10 to 12½c.; Buckworth anvils, 80 lbs., and up, 10¼c.; anvil and vise combined, each, $5.50.

Bar Iron.—$2.50 to $2.60.

Beams and Channels.—$3 to $3.25 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 1,000, three grades.

Cement.—$2.65 to $2.75 per barrel.

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; ¼-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, 6¼c. 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—2 x 4, 2 x 6, 2 x 8, 8 to 16 feet, $27.25, 2 x 20 up to 32 feet, $38.

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; No 1 clear cedar, 6-inch, 8 to 16 ft., $60; Nos. 1 and 2 British Columbia spruce, 6-inch, $55; No. 3, $45.

Flooring.—No. 2 red pine, 4-inch, $43; No. 3 red, 4-inch, $38; No. 4 red and white pine or spruce, 4-inch, $28; ceiling, No. 2 white pine, 4, 5, and 6-inch, $55; No. 3 red pine, $38.

Lath.—No. 1 red and white pine mixed, $5.50; No. 2, $4.75.

Shingles.—No. 1 British Columbia cedar, $4.25; No. 2, $3.75; band sawn, $6.

Rope.—Cotton, ¼ to ½-in. and larger, 23¼c. lb.; deep sea, 18c.; lath yarn, 9¼c.; pure Manila, per lb., 13¼c.; British Manila, 11¾c.; sisal, 10¼c.

(Continued from Page 7.

superintendent of motive power at St. Alban's.

MR. GEORGE K. CROCKER has been for the seventh time elected chairman of the Board of Water Commissioners of St. Thomas.

MR. GORDON JOHNSTON, son of J. W. Johnston, of Belleville, Ont., has been appointed engineer-in-charge of a large irrigation scheme in Mexico.

MR. JAMES FRENCH has returned to Toronto from Seattle, Wash., where he was engaged by H. C. Henry on Chicago, Milwaukee, St. Paul Railway.

MR. E. A. JAMES, former general manager of the Canadian Northern Railway, now living in retirement at the Pacific Coast, paid a hurried visit to Ottawa and the East last week.

JUDGE FORTIN has been appointed chairman of the Board of Conciliation and Investigation which was commissioned under the Lemieux Act to inquire into the dispute between the Canadian Pacific Railway Company and its locomotive engineers.

MR. J. B. TYRRELL, Mechanical Engineer, Toronto, Ont., has been elected a corresponding member of the Council of the Institute of Mining and Metallurgy, London, Eng. This society, the leading mining society of the world, requires from its members the highest technical qualifications and professional conduct.

MR. E. J. CHAMBERLAIN has been appointed vice-president and general manager of the G.T.P. Railway, succeeding Mr. Frank Morse. Mr. Chamberlain was formerly general manager of the Canadian Atlantic and his knowledge of Canadian railway affairs and men gained while with the Booth System will make him a valuable man for the G.T.P. Railway.

MR. W. C. BROWN has been elected president of the New York Central and Hudson River Railroad Company, succeeding W. H. Newman. He was formerly first vice-president of the New York Central. Mr. Brown was born in Herkimer County, New York State, 56 years ago. He early took up railroad work and rose rapidly. He had held numerous important railroad positions in the West before he became vice-president of the New York Central and its allied lines in 1902.

WHERE TO BUY.

(Continued from page 2.)

Contractors
Cleveland Bridge & Engineering Co., Ltd., Darlington, England.
Metcalf Engineering Co., Ltd., Montreal, Que.

Converters, Rotary
Toronto & Hamilton Electric Co., Hamilton, Ont.

Conveyors
Babcock & Wilcox, Ltd., Montreal.

Cranes
Dominion Bridge Co., Ltd., Montreal.
Harpell-Stokes, Limited, Winnipeg and Toronto.
Mussens Limited, Montreal, Que.
Northern Engineering Works, Detroit, Mich.
Structural Steel Co., Ltd., Montreal, Que.

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

Derricks
Dominion Bridge Co., Ltd., Montreal.
Harpell-Stokes, Limited, Winnipeg and Toronto.
Mussens Limited, Montreal, Que.
Northern Engineering Works, Detroit, Mich.
Structural Steel Co., Ltd., Montreal, Que.

Draughting Supplies
Berger & Sons, C. L., Boston, Mass.
Hart Co., John A., Winnipeg, Man.

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

Drills
Canadian Buffalo Forge Co., Montreal and Toronto.
Harpell-Stokes, Limited, Winnipeg 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 and Motors
Harpell-Stokes, Limited, Winnipeg and Toronto.
Toronto & Hamilton Electric Co., Hamilton, Ont.

Economizers
Babcock & Wilcox, Ltd., Montreal.

Electric Apparatus
Harpell-Stokes, Limited, Winnipeg and Toronto.
Hill Electric Mfg. Co., Montreal, Que.
Toronto and Hamilton Electric Co., Hamilton, Ont.

Electrical Supplies
Harpell-Stokes, Limited, Winnipeg and Toronto.
Hill Electric Mfg. Co., Montreal, Que.
Phillips, Eugene F., Electrical Works, Ltd., Montreal, Canada.

Elevators
Northern Engineering Works, Detroit, Mich.

Engineers, Consulting
Beaubien, Gaspe de, Montreal.
Francis, W. J. Montreal, Que.
Fuce, Ed. O., Galt.
Metcalf Engineering Co., Ltd., Montreal, Que.
Mitchell C. H., C.E., Toronto, Ont.
Nold, Henry N., Hamilton.
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.

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
Harpell-Stokes, Limited, Winnipeg and Toronto.
Mussens Limited, Montreal, Que.

Generators, Alternating and Direct Current
Harpell-Stokes, Limited, Winnipeg and Toronto.
Toronto & Hamilton Electric Co., 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.

Mechanical Draft Motors.
Canadian Buffalo Forge Co., Montreal and Toronto.

Motors
Harpell-Stokes, Limited, Winnipeg and Toronto.
Mussens Limited, Montreal, Que.
Toronto & Hamilton Electric Co., Hamilton, Ont.

Motors
Harpell-Stokes, Limited, Winnipeg and Toronto.
Toronto & Hamilton Electric Co., 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.
Sterling, W. C. & Son Co., Monroe, Mich.

Portland Cement
Hartranft Cement Co., Wm., Montreal, Que.

Preservatives
Carbolite Carbolineum Co., Toronto.

Presses, Hydraulic and Power
Mussens Limited, Montreal, Que.
Wood & Co., R. D., Philadelphia, Pa.

Pressure Regulators
D'Este Co., Julian, Boston, Mass.

Pulleys
Harpell-Stokes, Limited, Winnipeg and Toronto.
Mussens Limited, Montreal, Que.

Pumps—Steam and Power.
Canadian Buffalo Forge Co., Montreal and Toronto.
Harpell-Stokes, Limited, Winnipeg and Toronto.
Mussens Limited, Montreal, Que.
Petrie, H. W., Ltd., Toronto, Montreal, Vancouver.
Wood & Co., R. D., Philadelphia, Pa.

Purifiers
Babcock & Wilcox, Ltd., Montreal.
Wood & Co., R. D., Philadelphia, Pa.

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.

Rock Crushers
Mussens Limited, Montreal, Que.

Rope, Manilla and Wire
Harpell-Stokes, Limited, Winnipeg and Toronto.
Mussens Limited, Montreal, Que.

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
Mussens Limited, Montreal, Que.

Springs
Coghlin & Co., B. J., Montreal, Que.
Montreal Steel Works, Montreal, Que.

Steel, Speedicut High-speed
Hamilton Brick Works Co., Ltd. Hamilton.
Montreal Steel Works, Montreal, Que.

Steel, Structural
Cleveland Bridge & Engineering Co., Ltd., Darlington, England.
Dominion Bridge Co., Ltd., Montreal.
Hamilton Bridge Works Co., Hamilton, Ont.
Harpell-Stokes, Limited, Winnipeg and Toronto.
Structural Steel Co., Ltd., Montreal.

Steel, Tool
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.
Gurley & Co., W. & L. E., Troy, N.Y.
Hart Co., John A., Winnipeg, Man.

Tanks, Steel and Iron
Structural Steel Co., Ltd., Montreal.
Wood & Co., R. D., Philadelphia, Pa.

Tool Grinders
Armstrong Bros. Tool Co., Chicago, Ill., U.S.A.

Track Jacks
Montreal Steel Works, Montreal, Que.
Mussens Limited, Montreal, Que.

Transformers
Harpell-Stokes, Limited, Winnipeg and Toronto.
Toronto and Hamilton Electric Co., Hamilton, Ont.

Transmission Machinery
Harpell-Stokes, Limited, Winnipeg and Toronto.
Mussens Limited, Montreal, Que.
Toronto and Hamilton Electric Co., Hamilton, Ont.

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.
Harpell-Stokes, Limited, Winnipeg and Toronto.
Mussens Limited, Montreal, Que.

Wire, Switchboard
Harpell-Stokes, Limited, Winnipeg and Toronto.