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PROGRESS ON THE NEW QUEBEC BRIDGE

REVIEW OF THIS SEASON'S OPERATIONS—ERECTION OF THE NORTH SHORE CANTILEVER ARM, MAIN POSTS, SOUTH SHORE, MAIN SHOES AND ANCHOR ARM—A NOVEL FLYING BRIDGE.

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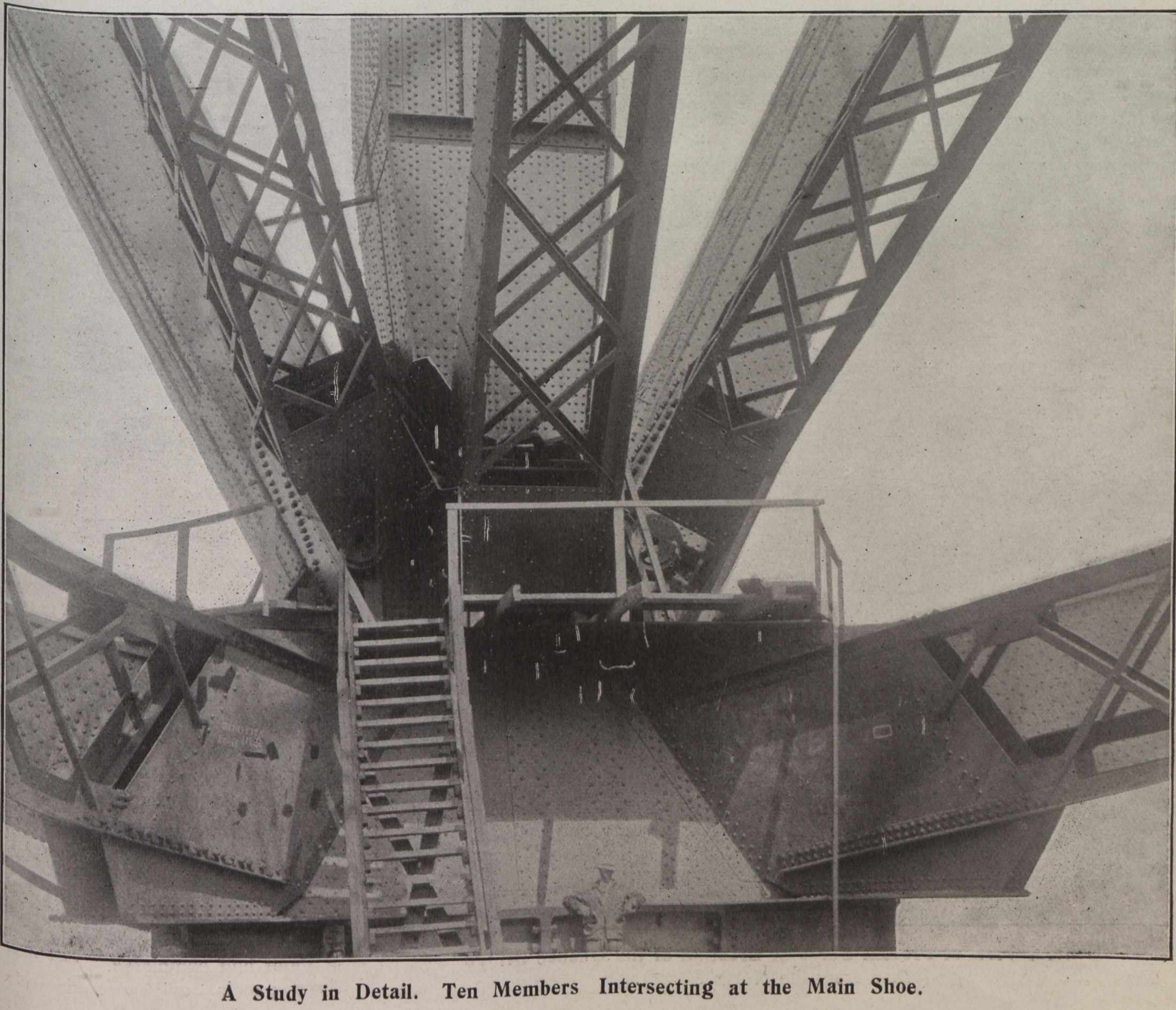
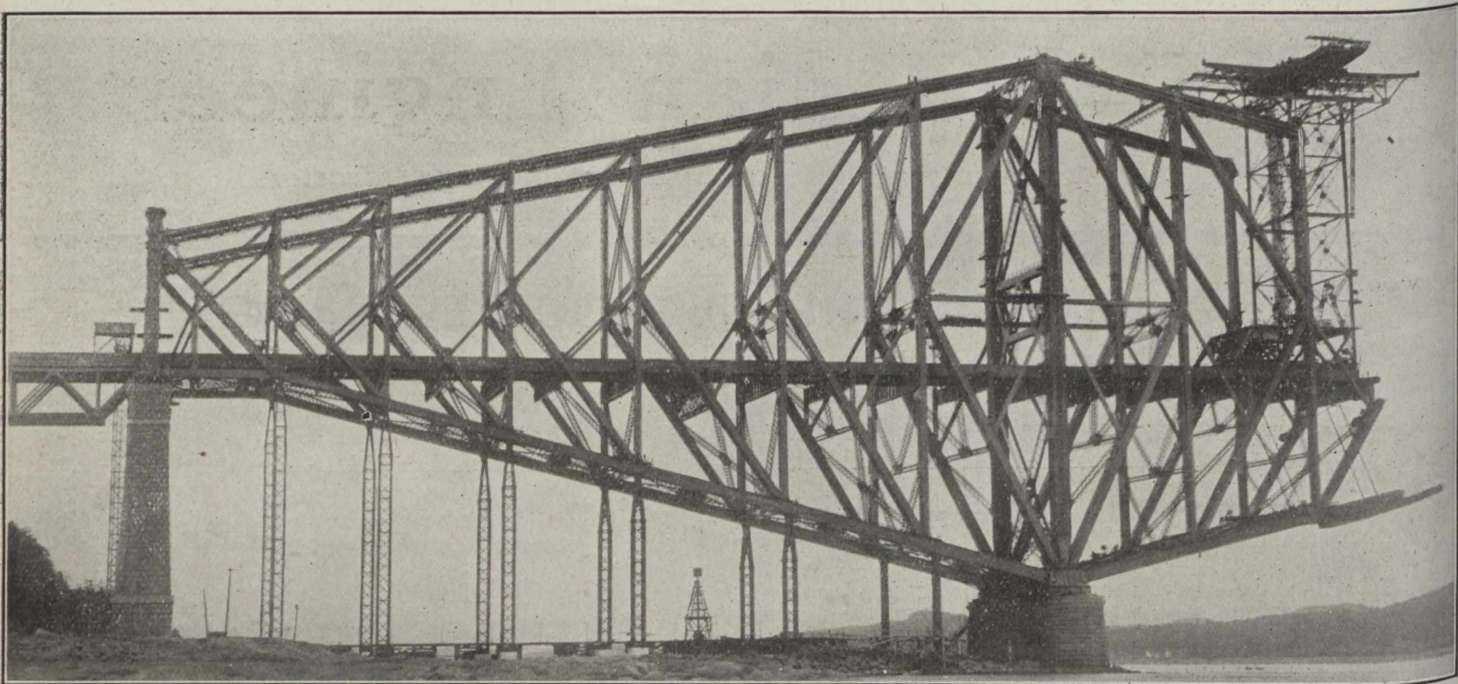
VERY satisfactory progress is being made this season in the erection of the new Quebec Bridge. At the end of last year the anchor arm was entirely erected with the exception of the upper half of two panels next the main pier, a detailed account of which was given in *The Canadian Engineer* for December 31st, 1914, page 797. During the winter the north portal was erected and a certain amount of riveting done at various points.

Erection, this spring, started about the middle of April. Since that time the programme of the contractors has been followed very closely. It was expected that the



A Study in Detail. Ten Members Intersecting at the Main Shoe.



Comparing this view with that shown in The Canadian Engineer for December 31, 1914, page 797, indicates this year's progress of erection on the North Shore. The "flying bridge" is also shown in place.

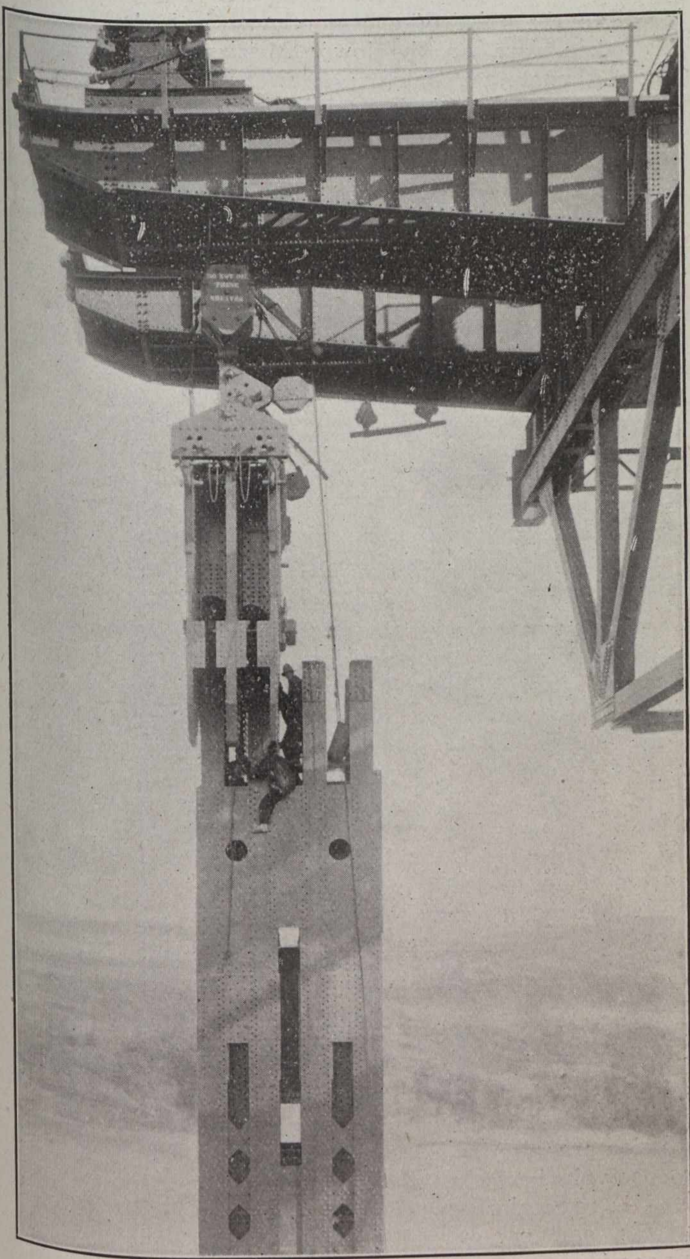
erection of the main posts would require more time than was actually the case. These posts are each shipped in twenty-seven separate main sections, and had to be assembled with splice plates attached, necessitating very careful and accurate handling by the cranes. Both posts were assembled simultaneously, the entire erection being completed in 30 days. These posts weigh approximately 1,000 tons. Although there were six horizontal field splices, the length, centre to centre of pins, was as nearly accurate as it is possible to measure. From four to six gangs have been constantly engaged in riveting up splices in these members since erection started, this work being now practically completed.

General View of Present Stage of Erection of the Quebec Bridge (taken from the North Shore).

In the erection of the cantilever arm, which is progressing rapidly, each panel is completed as the work progresses, the complete bracing being put in place by the rear booms of the traveller as it advances panel by panel. On account of the fact that there is a vertical field splice in the bottom chord between main panel points, these chords are erected in place on what is known as the "flying bridge." This bridge is a steel platform capable of taking one full panel, supported at the shore end by means of pins connected to the chords, and at the river end by links attached to the upper web members. This "flying bridge" is planked over and affords ample room for jacking and riveting operations, providing a perfectly safe platform for the men to work. As each panel is completed, the bridge is taken up by the overhead cranes and moved ahead to its new position. At the present writing the fourth panel of the cantilever arm from the main pier is about half completed. The first three panels took approximately twenty-five days each, including Sundays and lost time. As the panels progress towards the end, the members are getting lighter and splices smaller, and the speed of the work will be materially increased.

Owing to the great accuracy of the shop work, the members go together without any difficulty in the field, and no time is lost in correcting errors.

It is expected that, if too much time is not lost by bad weather, the entire north shore cantilever arm will be completed by the middle of November.



Placing Half Section of Link on Top of Main Post, 350 Feet Above the St. Lawrence River.

The traveller on this side will then be taken down, transferred to and re-assembled at the site where the suspended span will be erected.

As the erection of the cantilever arm progresses, very careful measurements and observations are made to determine whether the alignment is perfectly correct. At the present time the centre points of the floor beams of the erected portion is absolutely in line with the centre point of the pier on the south side of the river.

The erection of the main shoe on the south shore started on July 8th of this year. On account of the experience gained in the erection of the falsework and anchor arm on the north shore, the erection of the south anchor arm has been greatly facilitated and much better time made. Although the work was started this year at approximately the same time as work on the north anchor arm last season, the work at the present time is nearly six weeks ahead of last year's programme. It is expected that before the work closes down the anchor arm will be completely erected, including the main post. Next year there will be no difficulty in fully completing the south cantilever arm in plenty of time to connect up the suspended span, thus enabling trains to run over the bridge.

The suspended span will be erected at Victoria Cove, a point about three miles below the site of the bridge. This span will be erected on falsework supported by concrete piers. It will be entirely erected at this site, with the exception of a portion of the floor system, and will be floated to the bridge on specially designed pontoons. Hangers connected to the four corners of the cantilever span will be connected to the suspended span by special devices, the entire span being lifted into place by means of 2,000-ton jacks placed at each corner. The suspended span is 640 ft. long, 88 ft. wide, and 110 ft. high at the centre, and weighs approximately 6,000 tons. It is expected that late in October of 1916 the work will be sufficiently advanced to float this span into place. If this programme is carried out, it will be possible to run trains across this bridge at the close of next season.

STREET CLEANING BY DRY METHOD.

From researches, which have been conducted by many American paving experts, the almost unanimous opinion has been evolved that modern cities should adopt what is termed the "dry" system of keeping down dust on well-paved streets. Carefully prepared figures in regard to the wear and tear of pavements show that the wear is much more severe where watering is in vogue than when oiling is resorted to. The "dry" system as adopted by Providence, R.I., during the past three years, which is declared by the city's engineers to be eminently satisfactory, has many interesting features. The city is divided into sections to each of which are allotted daily patrols, while pneumatic cleaning machines pass constantly up and down the streets. The city engineer reporting on the system says: "Even if dry cleaning were not cheaper, its greater efficiency in keeping street surfaces in better condition merits its adoption. It has been proven that pavements of the bituminous kind have much greater durability when dry cleaned than when watered. When water is applied we have the condition which from all ages has been known to wear the hardest steel, and is, therefore, used in the grindstone, to wit: The application of mud under a grinding process."

At the Bjölva waterfall, Norway, a new factory is to be erected for the manufacture of sulphate of ammonia and cyanamide. Arrangements have already been made to dispose of the output of the latter production for a period of five years. The annual output of sulphate of ammonia will be about 6,000 tons. The matter is being supervised by a committee of four experts, who are at present in Sweden in order to study the new method of manufacture.

THE WATER POWERS OF THE PROVINCE OF ONTARIO.*

IN connection with the extensive water power exhibit of the Dominion Government at the Panama Pacific Exposition, the Dominion Water Power Branch has just issued a series of monographs on the water powers of Canada. The one relating to the province of Ontario is under the authorship of H. G. Acres, B.A.Sc., hydraulic engineer of the Hydro-Electric Power Commission of Ontario. The following is a reproduction of Mr. Acres' monograph, substantially in full, necessarily omitting, however, a number of most interesting interior and exterior views of power developments and sites.

The drainage system of the province of Ontario comprises four main divisions, namely, the territory drained by the Ottawa River and its tributaries, that drained by the tributaries of the Great Lakes, that drained by the rivers flowing into James Bay, and that drained by the Winnipeg River and its tributaries. As the distance between the east and west extremities of the province is 950 miles, and the distance between the north and south extremities 1,050 miles, the rivers forming the arteries of the drainage system will naturally possess variant characteristics. The extremes are represented, on the one hand, by the gently flowing rivers and creeks of the southwestern peninsula, and on the other by the slack-water pools and turbulent rapids and falls of the Laurentian rivers along the north shore of Lake Huron and Lake Superior. Between these two extremes, each possessing characteristics peculiar to themselves, lie the rivers in the limestone region of the eastern counties and the large rivers which reach tidewater by way of James Bay and the Hudson Sea.

Ottawa River and Its Tributaries.—From a hydraulic standpoint the more important rivers tributary to the Ottawa are the Mississippi, the Madawaska, the Bonnechere, the Petewawa and the Montreal. The territory drained by these rivers at one time maintained a great lumbering industry. The removal of the virgin forest has undoubtedly influenced the regimen of the streams, but the effects of deforestation have been to a certain extent neutralized by the development of second growth timber. This beneficial influence will probably be permanent, owing to the fact that the territory drained by these rivers is for the most part unsuited for cultivation and the extent of the forest cover is likely to increase rather than diminish.

The basins of these rivers contain a considerable proportion of lake and marsh, and their flow characteristics are susceptible of material improvement through the agency of artificial storage. The gradient of the streams themselves is generally steep, and concentrated natural heads, ranging from 20 to 100 feet, offer numerous opportunities for cheap development. The power capacity of these rivers is, however, not comparable to that of the Quebec tributaries of the Ottawa, owing to their generally smaller drainage areas. The basin of the Madawaska, the largest Ontario tributary, has only about one-third of the area of the Gatineau basin, which is the largest Quebec tributary. For this reason, instead of natural capacities of 10,000 h.p. and over, such as are common in Quebec, the Ontario tributaries offer facilities for the development of capacities ranging from 1,000 to 5,000 h.p. only, except in one or two isolated cases. One exception is the High Falls on the Madawaska, where the natural head can be increased to 150 feet, and 12,000 h.p. developed under natural flow conditions, and probably 20,000 h.p. with artificial storage.

The status of these water powers as regards possibility of development is peculiar and unfortunate. With the possible exception of the High Falls site, their individual capacities are not sufficient to justify development for long distance transmission, and at the same time are generally too great to permit development for local markets, most of which are now adequately supplied by existing developments of small capacity immediately adjacent to the point of consumption. Such development has taken place on the lower Mississippi at Carleton Place, Almonte and Galetta; on the Rideau at New Edinburgh, Perth, Smith's Falls, Merrickville, and Andrewsville; on the Madawaska at Bancroft, Arnprior and Mountain Chute, and on the Mattawa at Mattawa. These developments have capacities ranging from 40 to 1,000 h.p. and supply power to a large number of labor-using industries which contribute materially to the prosperity of the municipalities in which they are located. Renfrew, particularly, is developing into a flourishing industrial centre as a result of power development on the Bonnechere, the business being divided between the recently completed municipal plant having 700 h.p. capacity and the 750 h.p. plant of the Renfrew Power Company. To meet the present and future requirements of the power users on the Bonnechere River and on their behalf, the Hydro-Electric Power Commission has constructed a storage dam at Round Lake, and has reported as to the feasibility of creating additional storage should the same be required.

In connection with the development of power in the Ottawa Valley the important developments of the Northern Ontario Light & Power Company deserve special mention. This company supplies power to the mines in the Cobalt district, and it is a notable fact that the introduction of hydro-electric power has caused the use of steam to be almost wholly discontinued for the operation of mines. In 1909 the camp imported 63,739 tons of coal, between June and December. In 1910, subsequent to the advent of hydro-electric power, only 17,349 tons were imported during the same period.

This company has two hydro-electric plants in operation, one on the Metabitchewan operating under a head of 312 feet, with 8,000 h.p. installed, and one at Hound Chute on the Montreal River, operating under a head of 33 feet and with 3,800 h.p. installed. The power is transmitted to Cobalt, and the vicinity, over wood pole transmission lines 25 and 17 miles long respectively, the transmission pressure being 44,000 volts in the first case, and 11,000 volts in the latter. The distribution of the average load is approximately: Electric railways, 400 h.p.; domestic and commercial light, 200 h.p.; mining load, 10,000 h.p.

The Metabitchewan site is now fully developed, and any additional power required by the Cobalt camp must be supplied from the Montreal River. The most important undeveloped site on this river is that known as the "Notch," where a head of 100 feet is available, and where about 7,000 h.p. can be developed under ordinary low-water conditions. These are commercial possibilities in connection with the development of this water power which merit serious consideration.

Concerning the Ottawa River itself, mention has previously been made of the fact that with regulated flow, 600,000 h.p. will be available to Ontario, between Lake

*See *The Canadian Engineer* for January 21, 1915, p. 166.

Temiskaming and Carillon. This aggregate capacity will be capable of commercial development only in the event of the river being canalized, and will depend furthermore upon the creation of a market for power vastly in excess of that now existing.

Power development on the Ottawa River, in Ontario, is at present almost wholly confined to the large industries which operate at the Chaudiere Falls, and under average conditions about 36,000 h.p. is now in use. Of this amount about 17,000 h.p. is used in the mills of J. R. Booth, 5,000 h.p. by the Ottawa Power Company, 9,000 h.p. by the Ottawa Electric Company, and the balance by the city waterworks and the street railway.

With complete flow regulation it is anticipated that the minimum capacity of the Chaudiere will be 84,000 h.p. or about 25,000 h.p. in excess of the amount now developed on both sides of the river. The very considerable industrial prominence which the city of Ottawa has attained, through the development of power at the Chaudiere, will thus be further enhanced by the future development of the surplus capacity provided by regulation.

Rivers Tributary to the Great Lakes.—From an economic standpoint the rivers tributary to the Great Lakes are now, and will probably continue to be, the most important of the rivers lying wholly within the boundaries of the province. This is due to the fact that they produce motive power, either direct or through the medium of electric transmission, for a great variety of industries, many of which are large users of labor and consequently contribute greatly to the population and general prosperity of the province.

Of the rivers flowing into Lake Ontario, the Trent is the most important. On this river and its main tributaries there is about 75,000 h.p. capable of more or less easy development by reason of the works of the Trent Canal, which are now nearing completion. Of this total quantity about 45,000 h.p. is now developed between Trenton and Balsam Lake, which is the summit level of the canal.

The most important developments are those of the Electric Power Company, which company has seven plants in operation, with a rated capacity of 33,300 h.p. installed. Through the medium of about 300 miles of 44,000-volt transmission line the company supply power to a large territory, extending along the lake front from Whitby to Napanee and as far north as Madoc and Lindsay. It has also, by the wholesale acquisition of local hydraulic, steam and gas plants, obtained complete control of the light and power business in the territory served by its transmission lines.

From the above figures it appears that the undeveloped hydraulic resources of the Trent system amount to almost 30,000 h.p. The importance of these undeveloped resources is largely due to the fact that they are capable of cheap and easy utilization through the existence of the locks and dams of the Trent Canal, which concentrate all of the natural head between Trenton and Balsam Lake. In addition to this the large lake areas of the Trent basin are controlled by the Dominion Government, largely with a view to improvement of flow conditions for power purposes. The regimen of the river had previously been seriously affected by deforestation, but flow conditions have already been materially improved, and still better results are to be anticipated through the further extension of the storage system, and the development of an efficient scheme of control.

The existing market requirements of the district are now fairly met by the existing developments, but the undeveloped water powers of the Trent System, having capacities ranging from 1,000 to 10,000 h.p., offer fine opportunities for the establishment of new industries, especially in the vicinity of Peterborough, Campbellford and Trenton.

At the present time the canal water powers are developed under a form of lease issued by the Department of Railways and Canals. Latterly these leases have called for a rental of $2 per horse-power per annum for every horse-power developed.

The Grand River is the largest of the Lake Erie tributaries, and the possession of 2,500 square miles of drainage area should properly class it among the more important rivers of the province from a power standpoint. At the time of Confederation, and for some years thereafter, the Grand River supplied all the water used for power and navigation purposes on the Welland Canal. Since that time there has been developed in the Grand River basin one of the greatest agricultural districts in Canada, and an urban population supported by industries of national importance. The combined effects of deforestation, drainage and extensive cultivation, which attended this industrial growth, have transformed the Grand River into a destructive torrential stream, and largely destroyed its usefulness as a source of power.

Through similar causes, the Thames, the Maitland, and most of the smaller streams in the south-western peninsula also suffer seriously from lack of natural control. An investigation is now being carried on by the Hydro-Electric Power Commission with a view to determining some feasible method of improving the regimen of these rivers, but for the time being, at any rate, they must be regarded only as sources of intermittent power for purely local purposes.

The rivers flowing into Lake Huron possess varying characteristics as regards regimen, ranging from the Maitland, with its natural flow characteristics almost completely destroyed, and the Saugeen, which still retains in a certain degree its natural regimen, to the Laurentian rivers of the north shore, flowing from unsettled and forested basins.

The contrasted characteristics of these, Lake Huron rivers illustrates in a most emphatic manner the effect of agricultural development on stream-flow. The Maitland basin has an area of about 950 square miles, almost entirely deforested and very highly cultivated. The measured minimum run-off of this river is to its measured maximum run-off as 900 to 1. The Wahnapitae River on the north shore has practically the same area as the Maitland. The basin of this river is largely in virgin forest, and second growth, and practically unsettled. Its maximum run-off is to its minimum run-off about as 10 to 1, against 900 to 1 for the Maitland. Also its minimum run-off per square mile of drainage basin is about 13 times that of the Maitland. It is only fair to state that the regimen of the Wahnapitae is considerably influenced by natural lake storage, which the Maitland River lacks entirely, but even after giving due weight to this fact the contrast is startling.

From a hydraulic standpoint, the most important of the Lake Huron tributaries are the Mississaga, the Spanish, the Sturgeon, the French, the Maganetwan, the Muskoka, the Severn, the Saugeen and the Beaver.

The total low-water capacity of all the Lake Huron tributaries is about 166,000 h.p., this figure being reasonably conservative as it does not fully take into account the affect of artificial storage. Of the above total about 56,000 h.p. is at present developed, leaving an undeveloped surplus of 110,000 h.p.

As to industrial opportunities in this district, various quantities of power are, or will shortly be, available for purchase. The Simcoe Railway & Power Company has some 3,000 h.p. of surplus capacity available at the Big Chute on the Severn River. When the new plant at Swift Rapids is built there will be 3,000 to 3,500 h.p. available. When the South Falls development on the Muskoka River is completed, the towns of Gravenhurst, Bracebridge and Huntsville will have about 1,000 h.p. for sale. The Wahnapitae Power Company has about 2,000 h.p. of surplus capacity for sale in Sudbury and the vicinity.

The Hydro-Electric Power Commission has now in operation a 1,200-h.p. plant at Wasdell's Falls on the Severn River, and a 4,000-h.p. plant is under construction at Eugenia Falls on the Beaver River.

As to wholly undeveloped powers, those on the French River are the most important in this district, there being three sites capable of development to the extent of about 10,000 h.p. each, with the assistance of Lake Nipissing storage. The remainder of the undeveloped capacity of the district is distributed in blocks of 1,000 to 5,000 h.p., the smaller capacities being predominant, and in many cases not sufficiently accessible for commercial development at the present time. For the possibility of development in the near future the larger of these powers must look to the mining and pulp industries, in connection with which there are now two large plants on the Spanish River. At High Falls the Canadian Copper Company has 12,500 h.p. installed for the operation of its mines and smelters, and the Spanish River Pulp and Paper Company, lower down on the river, has 10,000 h.p. installed for the manufacture of pulp and paper.

The natural conditions and market prospects in the district, immediately south of Georgian Bay, are such that hydro-electric development and transmission offers little or no inducement for private enterprise, and for this reason, the hydraulic resources of the district have lain largely dormant up to the present time. An exhaustive investigation of conditions by the Hydro-Electric Power Commission, nevertheless, revealed the fact that if certain water powers were developed and transmission lines built, with 4½% money, and all consideration of selling profit eliminated, it would be commercially feasible to supply power to a number of municipalities on the east shore of Lake Simcoe and in the counties of Grey and Bruce.

At the request of the municipalities interested, the Commission obtained the consent of the Provincial Government to build the above-mentioned 1,200-h.p. plant at Wasdell's Falls, which is now supplying the towns and villages on the east shore of Lake Simcoe as far south as Cannington. The 4,000-h.p. plant at Eugenia Falls is being developed under a head of 540 ft., and it is expected that a market for this power will be found in the counties of Grey and Bruce.

Apart from the benefits which will directly accrue as a result of the construction of these two plants, it is anticipated that the power market will, in the near future, expend sufficiently to permit the further development of the power resources of the district on a commercial basis. As a result, the district as a whole will derive immense benefit from the utilization of its own local resources to the extent of some 15,000 h.p. of cheap power, a result which could never under any circumstances have come to pass through the agency of private initiative.

The watershed characteristics of the Lake Superior tributaries are generally similar throughout, as the whole area tributary to the lake has fairly uniform topographical features, and is generally forested with pine, spruce, balsam, birch and poplar. Owing to the proximity of the crest of the height of land to the north shore of the lake throughout the greater part of its length, most of its tributaries are short and turbulent and all have the high natural heads which characterize the Laurentian rivers. All along the north shore, on large and small rivers, natural falls 50 to 125 feet in height are common.

This territory is to a large extent unsettled, and in many localities practically unexplored, and it necessarily follows that no large proportion of its hydraulic resources will be developed in the very near future. At the present time about 20,000 h.p. is developed out of a total potential capacity of about 195,000 h.p. Of the developed power about 4,500 h.p. is used in the Michipicoten district for the operation of mines, 1,500 h.p. being supplied by the Michipicoten Power Company and 3,000 h.p. by the Algoma Steel Corporation. It is understood that the Michipicoten Power Company can increase its capacity considerably by the development of artificial storage.

The remaining 15,500 h.p. is used in the cities of Port Arthur and Fort William, and is mainly derived from the plant of the Kaministiquia Power Company. This company has an extensive development at Kakabeka Falls, operating a 180-ft. head. This company is said to have about 15,000 h.p. of surplus capacity capable of development.

These two cities have also, within easy transmission distance, the large water power at Silver Falls on the Kaministiquia River, at which point about 20,000 h.p. minimum can be developed under a 310-ft. head.

Concerning the Nipigon, the largest of the Lake Superior tributaries, the following facts may be set forth: The river proper is about 40 miles long and drops 255 ft. in this distance. At the head of the river in Lake Nipigon, with 1,500 square miles of water surface, receiving the run-off from about 9,500 square miles of drainage area. The effect of this immense central storage basin is to produce a flow regimen almost comparable to that of the St. Lawrence, and to make the river an ideal one for the development of power. The Nipigon basin contains one of the finest pulp-wood areas in the world. It also contains immense bodies of magnetic iron which would doubtless yield to treatment in the electric furnace.

The Nipigon water powers are within easy transmission distance of Port Arthur and Fort William, and while these cities have 50,000 h.p. hydraulic capacity available within a radius of 25 miles, the time will undoubtedly come when they will need Nipigon power.

In 40 miles of river there is 100,000 h.p. in the main, capable of easy development, and in this fact, together with the great natural resources of its basin, and the certainty of industrial expansion at the head of the Great Lakes, the Nipigon basin affords a range of commercial opportunities which can hardly be duplicated on the continent to-day.

The Winnipeg River and Its Tributaries.—The drainage system of Rainy River District is wholly tributary to the Hudson Sea by way of Lake Winnipeg, and forms part of the great basin of the Nelson River. The rivers in this district are as a general rule large and full flowing, but with low natural heads. This disadvantage from a power standpoint is in a measure offset by the splendid storage facilities offered by Rainy Lake, Lake of the Woods and Lac Seul, which, together with a countless number of smaller lakes, constitute the outstanding topographical feature of the Rainy River district. The hydrography of this territory has been studied to a limited extent only, but such information as is available indicates that the total potentiality of the various rivers is not less than 250,000 h.p. Of this total about 22,000 h.p. is now in use, leaving 228,000 h.p. undeveloped. The largest development in this district is at Fort Frances, where Koochiching Falls, on the Rainy River, has been developed by the Minnesota & Ontario Power Company. This is an international river, and half of the power is supposed to be developed on each side, the present installation on the Canadian side being 15,000 h.p., practically all of which is used for the manufacture of pulp and paper.

At Kenora, a flourishing flour milling industry has grown out of the partial utilization of the large water power at the outlet of the Lake of the Woods. At this point the town of Kenora has developed about 2,500 h.p., and has 2,000 h.p. of surplus capacity still available. The bulk of this plant's product is used for flour milling, and lighting load. At this point also the Lake of the Woods Milling Company has large flour mills using about 4,000 h.p. of hydraulic and electric power.

At Dryden, on the Wabigoon River, the Dryden Timber and Power Company has a 2,000-h.p. plant installed for the manufacture of pulp and wood products.

The two principal sources of power for the district are the Winnipeg and English Rivers. In addition to a large natural minimum flow, the hydraulic value of these rivers lies in the fact that the extensive lake areas in their basins provide facilities for practically doubling the low-water flow. Under such conditions White Dog Falls, on the Winnipeg River, would alone be capable of producing 75,000 h.p., and at each of several sites on the English River power could be developed in blocks of 20,000 to 40,000 h.p. More particularly in the case of the English, the natural resources of the territory drained by these rivers are rather meagre, but the completion of the Transcontinental Railway will tend to hasten the utilization of their great store of energy.

Rivers Flowing Into James Bay.—A very small amount of credible information is at present available with regard to the rivers of the James Bay slope, such detailed information as is available being confined to one or two rivers on which power has already been developed or is in course of development. The Conservation Commission in its report on the "Water Powers of Canada" quotes figures, compiled by Mr. L. V. Rorke, formerly inspector of surveys for Ontario. Mr. Rorke estimates the minimum power capacity of the James Bay Rivers to be 665,000 h.p. under natural conditions. With controlled storage he estimates their capacity to be about 1,700,000 h.p. This latter figure is based upon an assumption as to the volume of controlled run-off, which may not obtain in many instances, but if the newly acquired District of Patricia is included, a capacity of 1,500,000 h.p. may, with a fair degree of certainty, be assumed physically capable of development.

Power development in this territory is now limited to the two plants of the Northern Canada Light and Power Company on the Mattagami River. These plants supply about 3,500 h.p. to the mines and towns of the Porcupine mining district, and have about 7,000 h.p. capacity available.

The Abitibi Pulp and Paper Company has a 19,500-h.p. plant at Iroquois Falls, on the Abitibi River, which will shortly be in commercial operation. This company has secured leasehold rights to water powers aggregating 50,000 h.p. capacity, with regulated flow from the available storage in Abitibi Lake.

As in the case of the Winnipeg and English Rivers, the completion of the Transcontinental Railway will give an impetus to hydraulic development on the James Bay rivers, particularly as regards the larger water powers to the north of the railway, these having heretofore been quite inaccessible from a commercial standpoint.

International Rivers of Ontario.—In the water powers of her international rivers the province of Ontario possesses a natural asset of the first magnitude, and one which is destined to have a great and beneficient influence on her future prosperity. The greatest of these is Niagara, until recently famous only as a scenic spectacle, but inherently a vast and inexhaustible storehouse of energy, which even now yields much, but which in the future must yield more and more of its bounty in response to the increasing pressure of economic necessity.

While aesthetic opposition to the commercial exploitation of Niagara is more or less of a sentimental factor, which must fade in the face of more pressing issues, there are certain practical limitations which must always obtain, arising principally out of the fact that the proper development of power involves the diversion of water from the natural channel of the river above the main cataract and the upper rapids.

Power is now developed on the Canadian side of Niagara, under franchises granted by the province of Ontario, through the Queen Victoria Niagara Falls Park Commission. Under these franchises a total of 405,000 h.p. is to be developed, 100,000 h.p. by the Canadian Niagara Power Company, 125,000 h.p. by the Electrical Development Company and 180,000 h.p. by the Ontario Power Company. The Canadian Niagara Power Company began to deliver power in 1905, and the importance of cheap hydro-electric power as an industrial factor is impressively demonstrated by the fact that, in the space of nine years, the three above-mentioned companies have 369,000 h.p. either in actual use on maximum load, or in course of installation to meet immediate requirements. The Ontario market is served principally by the Electrical Development Company and the Ontario Power Company, the former serving the city of Toronto, while the latter serves an extensive territory in Western Ontario, through the medium of the transmission system of the Hydro-Electric Power Commission.

Although the water powers on the Welland Canal are not international, they are mentioned in connection with the boundary streams through the fact that the water which creates them is drawn from Lake Erie.

At the present time power is developed on the old Welland Canal to the extent of about 12,000 h.p., and the important industries in connection with which they are used embracing the manufacture of pulp and paper, tools, cloth, carbide, rubber, etc., contribute largely to the prosperity of the city of St. Catharines and the towns of Merritton and Thorold.

The most important power development connected with the canal system is that of the Dominion Power and

Transmission Company. This company draws water from the summit level of the canal and carries it over the Niagara escarpment at Decew Falls, where power is developed under a net head of about 265 ft., 57,000 h.p. of capacity being now in active use. Through the medium of 213 miles of 10,000 to 40,000-volt transmission line power is supplied for the operation of an extensive system of radial and street railways, and for the lighting and industrial requirements of a number of municipalities in the Niagara Peninsula, as well as to Brantford, Burlington and Oakville. The present commercial prominence of the city of Hamilton is due in a large measure to the fact that power developed by the Dominion Power and Transmission Company was made available at rates sufficiently attractive to encourage the establishment of industries.

The normal difference in level between Lake Superior and Lake Huron is about 20 ft., of which about 18 ft. is concentrated at the St. Mary's Rapids. The minimum flow at this point will produce 90,000 h.p. under an 18-ft. head, half of which capacity belongs to Ontario. For some years past this power has been partially utilized both in Canada and the United States, about 17,000 h.p. being now developed on the Canadian side by the Algoma Steel Corporation and its allied industries. This company has under consideration the remodelling of its hydraulic plant and an increase in capacity to 30,000 h.p.

So far as the province of Ontario is concerned, the power possibilities of the St. Lawrence River are limited to that portion lying between Lake Ontario and Lake St. Francis. The normal fall in this portion of the river is about 88 ft., and possibly 70 ft. of this could be effectively utilized for power development. On this basis the aggregate effective capacity, under normal low-water conditions, would be about 1,000,000 h.p., of which 500,000 h.p. would be available for use in Ontario.

At the present time there is no development in this reach of the main river, present development being confined to various small water powers created along the shores by the St. Lawrence canal system. Hydraulic plants connected with the canals are operating at Cardinal, Iroquois, Morrisburg, Milles Roches and Cornwall, their aggregate capacity being about 5,800 h.p. The bulk of this power is used locally, the two largest plants supplying the town of Cornwall.

As regards the feasibility of developing the international water powers of the St. Lawrence on a large scale, it is to be understood that such development would require the consent or co-operation of the United States. Furthermore, the construction cost of permanent works for the proper development of these powers will be abnormally high, and a market demand very largely in excess of that now existing will be necessary to place any such development scheme upon a feasible commercial basis.

Summary of Undeveloped and Developed Water Powers.—Taking the various figures for power capacity mentioned above and adding thereto the estimated capacity of a number of smaller rivers not specifically mentioned, the following approximate summation is derived for the total amount of power capable of development in the province of Ontario:

Ottawa River and tributaries	688,000 h.p.
Great Lakes tributaries	446,000 h.p.
Hudson Bay slope	250,000 h.p.
James Bay slope	1,500,000 h.p.
International boundary rivers	2,045,000 h.p.
Total potentiality	4,929,000 h.p.

Similarly the totals, for the developed power, may be summarized as follows:

Ottawa River and tributaries	71,000 h.p.
Great Lakes tributaries	137,000 h.p.
Hudson Bay slope	22,000 h.p.
James Bay slope	70,000 h.p.
International boundary rivers	462,000 h.p.
Total developed power	702,000 h.p.

Of this latter total, about 574,000 h.p. is electric energy sold for light and power, about 69,000 h.p. is used for pulp and paper manufacture, and about 59,000 h.p. is used for the most part in the form of hydraulic power directly applied. According to the above figures, the developed capacity of the Ontario water powers is about one-third greater than the capacity developed in Quebec. Ontario's advantage is mainly derived from the capacity developed for purposes of transmission, as is indicated by the fact that in Ontario 2,200 miles of 10,000 to 110,000-volt transmission line is in operation at the present time. The result of this widespread transmission system, and extensions to the same now under construction, is to make hydro-electric power available to all the cities and large towns in Ontario, and to a rapidly increasing number of smaller towns, at prices ranging from $15 to $40 per horse-power per annum.

RAILROAD EARNINGS.

The weekly railroad earnings for August are as follows:—

Canadian Pacific Railway.

	1914.	1915.	Decrease.
August 7	$2,236,000	$1,787,000	— $449,000
August 14	2,162,000	1,815,000	— 347,000
August 21	2,154,000	1,456,000	— 198,000
August 31	2,980,000	2,856,000	— 124,000

Grand Trunk Railway.

August 7	$1,106,823	$ 993,773	— $113,050
August 14	1,068,710	1,004,412	— 64,298
August 21	1,096,476	1,052,483	— 43,993
August 31	1,581,830	1,535,312	— 46,518

Canadian Northern Railway.

August 7	$ 354,400	$ 259,500	— $ 94,500
August 14	319,500	249,000	— 70,500
August 21	307,600	286,500	— 21,100
August 31	386,200	397,500	+ 11,300

The Grand Trunk Railway Company's return of net earnings for July makes a favorable showing with a gain of $250,047. Total net earnings for the month were $1,274,764, compared with $1,024,717 in the same month a year ago.

The Canadian Pacific Railway's gross earnings for July, 1915, the first month of the company's fiscal year, were $7,895,375. As working expenses for the month were $5,094,972, net profits amounted to $2,800,403. Net profits in July, 1914. were $3,778,446, or $978,043 in excess of the same month this year.

Gross and net earnings of the road for July this year compare with the previous month as follows:—

June.	1915.	Decrease.
Gross	$7,512,034	$2,542,387
Net	2,678,031	657,594
July.		
Gross	7,895,375	2,681,569
Net	2,800,403	978,043

In connection with the City of Toronto water supply system, work is now well under way on Toronto Island in the construction of a steel conduit to connect the new 84-in. pipe and the old 72-in. pipe with the new filtration plant, which is also under construction.

THE EFFECT OF END CONNECTIONS ON STRESS DISTRIBUTION IN CERTAIN TENSION MEMBERS.

An investigation of the distribution of stresses in single or built-up structural members, and its modification due to different types of end connections, are the subjects of a paper in the August number of the Journal of the Franklin Institute. The author is Prof. Cyril Batho, M.Sc., of the Department of Applied Mechanics, McGill University, Montreal. The paper describes in detail the very interesting method of investigation applied, the peculiarity of which lies in the use of a simplified form of Martens' mirror extensometer, a part of the laboratory equipment at that university. This instrument, while very simple in construction and operation, is shown to be capable, when certain precautions are observed in its use, of measuring strains accurately to 1/100,000 in. on a length as small as 2 in., and of being used in the most confined positions, such, for example, as the space between two angles placed back to back and separated by as little as 3/8 in.

The paper further reports in detail Prof. L. J. Johnson's method of determination of distribution of strains, and among other things, his S-polygon, a figure which gives at a glance the point of maximum bending stress and the value of the latter for any given load axis.

The experiments which Mr. Batho describes were made on three specimens, two single-angle members and one double-angle, shown in Fig. 1. All were ordinary shop products made by the Dominion Bridge Company of Montreal, and the angles were of uniform section 3 inches x 3 inches x 1/4 inch.

The members were of a uniform length of 55 5/8 inches over all and 35 5/8 inches between the end plates, and were secured to the latter by means of four 3/4-inch rivets having a pitch of 2 1/2 inches and by lock angles riveted to the plate by three 3/4-inch rivets and to the outstanding leg of the angle by a like number.

In earlier experiments similar angles were used, without lock angles, riveted to end plates of the same width, 3 inches, as the angles, secured directly in the grips of the testing machine, the distance from the end of the grips to the end of the angle being about 5 1/2 inches. With these end plates it was found that the restraining couple upon the angle was very small, and it was thought desirable, in the later tests, to substitute end connections more nearly similar to those met with in practice, *i.e.*, wide plates firmly secured. To this end special grips were designed to fit on the jaws of the machine. They were steel castings. The end plates, which were 1 foot 2 inches wide and 3/8 inch thick, were held by steel pins 3 inches in diameter fitting tightly into bushes in the castings, and were restrained from turning by six set screws on each side. The distance from the end of the angle to the set screws was approximately 2 inches, so that the ends of the members were quite as effectively held as in most practical cases.

The position of the pin with respect to the rivets was made different in the different specimens. In Specimens I. and III. it was in line with the back of the main angle, while in Specimen II. it was in line with the centroid of the main angle. The object of this was to find the effect of a change in the line of pull on the gusset plate,—*i.e.*, of different eccentricity of end connection. The specimens were also tested with the lock angles removed in order to study the action of the latter.

The machine used was the Emery testing machine in the testing laboratory of McGill University. This machine is of the vertical type and has a capacity of 150,000 pounds. It is eminently suited to this kind of work as the line of pull, suitable means being taken to steady the straining head, remains constant, and there is an entire absence of vibration.

An analysis of the experiments leads to the conclusion that, with a gusset plate connection of the usual type, wide and rigidly connected, the chief factor influencing the distribution of stress over the cross-section of the member is the stiffness of the end plate in its own plane. In comparison with this the effect of lock angles is practically negligible, and a considerable change in the line of pull on the gusset plate may be made without appreciably altering the stress distribution.

The bearing of the above upon the design of single and double-angle members is obvious, although it is difficult to formulate exact rules. It may, however, be definitely stated that lock angles are of little, if any,

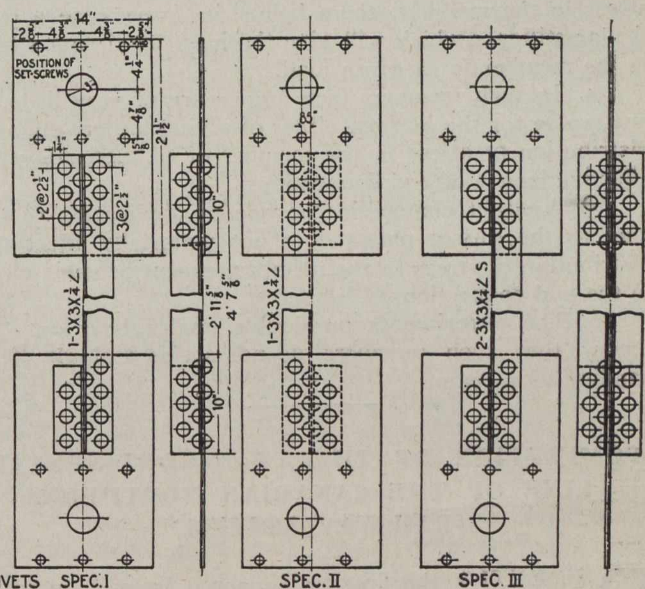


Fig. 1.—Specimens Used in the Experiments.

value, and this is perhaps the most important result of the investigation. As to the correct ratio of maximum to mean stress to be used in designing, earlier experiments of the writer have shown that with long, narrow gusset plates, unconnected at the sides, there is practically no end restraint, no matter what the thickness, within practical limits, of the plate may be, and that a fairly good approximation to the actual distribution of stress may be obtained by considering the load axis as coinciding with the line of rivets and lying slightly within the end plate. A broad, stiff connection, however, is generally advisable, and with this the ratio of maximum to mean stress is much, say 30 per cent., lower than would be given by the above rule. It is difficult to estimate exactly, however, and perhaps the same rule might be used taking a higher value for the working stress, since the tertiary stresses would also be covered by it. With a narrow plate, however, the ordinary working stress should be used, since the tertiary stresses are not included. There remains, of course, the possibility of exceeding the yield point at certain fibres without danger. This, however, it would not be safe to rely upon in the present state of experimental knowledge of the subject.

The experiments on double-angle members show that such a member with a stiff end plate is an excellent type in practice, the stress being almost uniformly distributed at the central section, but, unfortunately, it seems to be impossible to predict exactly what the distribution will be in any particular case.

The chief conclusions to which the paper leads are:

1. The only practicable experimental method at present available for investigating the distribution of stress in built-up members is by means of some form of extensometer, and the simplified mirror extensometer used in the tests described is very suitable for this purpose.

2. The assumption of a planar distribution of stress is justifiable in such members as are considered here, except perhaps close to the end connections, and the ordinary theory may therefore be applied to an analysis of the distribution of stress in these members.

3. In single and double-angle tension members connected at their ends by means of rivets to wide and rigidly held gusset plates the stiffness of the gusset plate in its own plane has a considerable effect on the distribution of stress in the member, there being in every case a particular stiffness which will give the least maximum stress in the member for a given load.

4. In such members lock angles are of very little, if any, value for the purpose either of giving a more equable distribution of stress in the member or of increasing the effective length of end connections.

5. A slight change in the line of application of the load to the gusset plates does not materially affect the distribution of stress in the member, except possibly close to the end connections.

6. The experiments on double angles bear out the theory that such members do not act as a single piece bending as a beam.

COMPLETION OF THE TRANSCONTINENTAL LINE OF THE CANADIAN NORTHERN RAILWAY SYSTEM.

RECENTLY the first train passed from Toronto to Vancouver over the rails of Canada's third transcontinental railway, making the trip in 91 hours.

Taken altogether, the mileage of the C.N.R. is now approximately 10,000 miles, nearly 6,500 miles of which is in the West. Over 5,500 miles have been constructed since 1910, including about 2,000 miles of main line. It was in 1911 that the contracts were let for the greater part of the transcontinental and most of the main line between Montreal, Que., and Port Arthur, Ont., and between Edmonton, Alta., and Port Mann, B.C., has been constructed since that time, work having started almost simultaneously in Ontario and British Columbia. The last spike in the section between Sudbury and Port Arthur was driven on New Year's Day, 1914. But with its eastern lines joined to those in the west at Port Arthur, there remained to be completed a line from Edmonton to Vancouver, before the Canadian Northern could achieve its full status as a transcontinental system. The distance of the located line running west from the capital of Alberta through the Yellowhead Pass, and down the valleys of the Thompson and Fraser Rivers to Pacific tidewater at Vancouver, was approximately 775 miles. Construction commenced in British Columbia in July, 1910, and was proceeded with simultaneously on the several sections. By the close of 1912, 124 miles of grade had been built, and 28 miles of steel laid. During the following year the grade had been increased to 275 miles and the mileage of steel in place to 75. On December 31, 1913, the total of constructed grade was 361 miles, and that for trackage 239 miles. In the meantime the rails had been extended west from Edmonton through the Yellowhead Pass to a point six miles past the British Columbia boundary line. The work proceeded during 1914, despite the outbreak of hostilities in Europe and the actual connection of the rails of the entire lines was effected near Basque, a small station 182 miles west of Port Mann, on the 23rd of January, 1915. In all, 19 large steel bridges were constructed. At Yale, there is a tunnel 2,075 feet in length; at Black Canyon, one, 1,320 feet long; and at Battle Bluff, a third, 2,887 feet from portal to portal. The heaviest grading work occurred between Yale and Boston Bar on the Fraser River.

The Canadian Northern transcontinental system from Montreal to Vancouver will go into full operation at an early date. The road claims, with undoubted weight, a great advantage in possessing the easiest gradients of any line of similar national importance on the continent of North America. The first road in America to cross the Rocky Mountain barrier was the Central Pacific, and its line was carried through to the coast with grades of 113 feet to the mile. Reductions were made by the Great Northern and the Northern Pacific in the extent to which this maximum was used, but not in the maximum itself. The first transcontinental in Canada, the Canadian Pacific Railway, was built with heavy grades, necessitating a subsequent enormous expenditure in grade reduction. The next line in Canada to construct to the coast, the Grand Trunk Pacific, succeeded in obtaining maximum grades of 52 feet to the mile. The Canadian Northern, however, climbs the eastern slopes of the Rockies with grades of 26 feet to the mile. The grade is continuous in its fall for the entire 500 miles from the summit of the Great Divide to the Pacific Ocean, and nowhere does the maximum against eastbound traffic exceed 37 feet to the mile. For 450 miles out of the 500 the maximum is 26 feet against eastbound and practically nil against equipment moving to the coast. The difficulties from a standpoint of operation, therefore, are not any greater in the matter of grades than would be expected in Ontario. Nature provided the means of securing an easy grade in the Fraser River, which takes its rise in the Pass. To have followed that stream, however, would have entailed a very considerable sacrifice in mileage. The Canadian Northern determined to achieve the easy grade by a direct route. So the line leaves the Fraser a few miles west of the summit, surmounts a subsidiary divide of low elevation and reaches the North Thompson River, a tributary of the former, which it follows to the confluence of the two at Lytton, from which point the Fraser is followed to the coast.

Construction of railways capable of economical operation was a problem which was comparatively easy of solution in the southern and central portions of the provinces of Alberta, Saskatchewan and Manitoba. Although there were sections in the west where the engineers of the Canadian Northern were compelled to locate lines through territories fairly well populated, a large portion of their work was simplified because the railways were developmental in character and built through the country not closely settled.

It was between Port Arthur, Ottawa and Montreal, where difficult problems had to be solved, before the 26-feet-to-the-mile grade which had been demanded was secured. Four years were consumed in exploration by survey parties, headed by the chief locating engineer of the company, Mr. H. K. Wicksteed, before the C.N.R. were certain that the standard set could be obtained. The construction work is finished now, and throughout the entire 1,016 miles between Montreal and Port Arthur, there is only ten miles where the gradients against east-bound traffic is 26 feet to the mile, or half of one per cent. That is located between Pembroke and North Bay. For the remaining 1,006 miles the line has been built to a standard which allows a rise of only 21 feet to the mile against trains moving towards the Atlantic and 26 feet to the mile against equipment moving in the opposite direction. The Sudbury-Port Arthur division is claimed to be one of the longest stretches of uniformly easy grades in the world, being comparable with that of the New York Central and the Michigan Southern between Schenectady and Toledo. But in the case of the Canadian Northern the way was through rough, unexplored territory, while the American lines traversed settled country, and run alongside the Mohawk River and Lakes Ontario and Erie for the entire distance. On the trunk line of the Canadian Northern between Toronto and Ottawa a high standard has likewise been adhered to. The maximum gradient in either direction is 26 feet to the mile.

THE ACTION OF WATER UNDER DAMS.

THE results of a study of the action of water under dams was undertaken by Mr. J. B. T. Colman at the University of Michigan, and presented in a paper before the American Society of Civil Engineers on September 15th. An attempt was made to investigate the relation existing between the height of water on the face of a dam, the length of the base of a dam measured perpendicular to the face, the distribution and upward pressure on the base of the structure, and the effect of sheet-piling placed at the heel and at the toe of the dam. In procuring complete data for the determination of the foregoing factors, a second field was entered: that of the relation existing between the elements just mentioned, the porosity and effective size of the sand grains, and the resulting movement of the water through the porous medium.

In the discussion accompanying the presentation of his results, the author points out that the principles governing the action of water under pressure in the sand forming the foundation of any structure, such as a weir or dam, may be compared with the action of water in a large number of small pipes. The upper ones would represent the sand layer adjacent to the weir floor, the second ones the next lower layer, and so on, until in a sand of relatively great depths the tubes representing the lower layers would have a length many times that of those in the first layer. These imaginary tubes extend from different points in the floor of the reservoir to points at various distances down stream from the toe of the weir.

Lines of Equal Pressure.—In taking up the discussion of the equal-pressure contours, dams without sheet-piling at the heel or toe are first considered. All lines of equal pressure start from the lower surface of the floor of the dam and extend in directions varying from nearly horizontal up stream to a similar position down stream from the structure. These lines naturally fall into three divisions: The first, or higher-pressure contours are relatively closer together, and, in carrying out the pipe analogy, would be comparable with entrance pressure. The difference in pressure between any two contours represents loss of head, and is comparable with entrance loss in pipes. The second division comprises the contours through the body of the sand. They are quite uniformly spaced, and are comparable with the loss of head in pipes due to friction. The third division is that of the lower-pressure contours, which are closer to one another and indicate a greater loss of head in the last portion. Thus it is seen that in any element of water which passes from above the dam to a position below the structure, there is, through entrance eddies in the first division, a comparatively great loss of head. After this, the flow lines become nearly parallel, and head is expended at a uniform rate until near the vicinity of exit from the sand particles. Here eddies again break up the flow lines and tend to resist the exit of the water from the sand.

Lines drawn on each diagram perpendicular to the pressure contours would indicate the paths followed by the particles of water from point to point, and show the distribution of flow. These lines would be much closer to one another just below the floor of the dam than at greater depths. This indicates that the flow is greatest near the floor and decreases with the depth.

By comparing the pressure diagrams for different lengths of floor, it is shown that the shorter floors give the greater entrance loss. It is also noticed that the flow lines in the shorter floor diagrams are concentrated near the floor more than in the longer ones. In this case there are but few lines, and a resulting small flow at greater depth.

Turning to the pressure diagrams of sheet-piling at the heel only, and comparing them with those of no piling, it is observed that the higher-pressure contours extend from the piling forward in nearly horizontal lines, and that the succeeding contours are moved forward, showing reduced pressure throughout the foundations. Short contours, back of the piling and extending from the piling to the floor, indicate a region of very small movement of water.

The greater number of flow lines follow down the face of the piling to its lower end. Here they turn down stream and rise to the surface at some distance beyond the floor of the dam. At the end of the piling they spread out fan-like through nearly a quadrant, a few turning vertically upward back of the piling. By far the greater number, however, approximate the shortest path from the bottom of the piling to a point a short distance beyond the floor. The piling increases the length of the flow lines, but exposes a greater depth of soil to the attack of the water. This, in turn, necessitates a less degree of concentration beyond the piling, and offers less resistance to the movement of the water.

To make the piling at the heel effective, it must be water-tight. It was found that a very small leakage through the piling destroyed its effect. To eliminate the increased upward pressure, resulting from the toe piling where used, the latter should be loosely driven, in order that the flow may escape.

The experiments demonstrate that the pressure decreases from point to point in the direction of the flow lines. It is also seen that the pressure decreases with the depth in front of the dam; but, beyond a certain point, which varies, if piling is used, the pressure reverses itself, being greater at a depth than nearer the floor of the dam. This lower pressure tends to continue in straight lines, and disappears only after travelling a relatively great distance.

In studying the effect of sheet-piling at the toe, it was observed that the pressures in the foundation, before and under the heel of the structure, were reduced, under the central portion they were but little changed, and under the toe they were increased. The flow lines were forced to go deeper and come to the surface at a greater distance from the structure.

In the matter of seepage it is stated that with each pressure observation the temperature and discharge per minute were recorded. These discharges, when corrected for temperature, afford a partial means of comparing the effects on the quantity seepage for different floor lengths and sheet-piling conditions, but are of no use in determining the law that governs the underflow. This law depends, not only on the length of the overlying impervious layer, the enforced length of flow, and the head of water, but on the porosity, the effective size of the sand grains, the uniformity co-efficient, and the viscosity of the water. These factors are all very complicated, and at present are so little understood that an accurate formula is impossible.

The writer attempted to determine this law, in connection with his work, but was unsuccessful. The method used imitated that used by Schlichter for determining the velocity of underground water. Through the centre of each of sixteen tubes scattered throughout the box a rubber insulated wire was passed, from the end of which the insulation for about 2 in. was cleaned. This bared wire, with the end of the pipe, formed two electrodes. The circuit was completed by connecting it with the lighting system, in one lead of which an ammeter was introduced.

The operation, as arranged and carried out, consisted of making readings of all tubes at 5-min. intervals. After two or three readings had been made, ordinary rock salt was introduced into the water above the dam. The 5-min. observations were continued until all traces of the salt had disappeared. These observations were then plotted, with times as abscissas and currents as ordinates, the peaks of the curves being taken to indicate the time required for the salt solution to reach the tube. The time required for the flow to pass from Tube *a* to Tube *b* would be $t_b - t_a$, and the velocity of flow over the distance, *d*, would be $\frac{t_b - t_a}{d}$.

In many of the readings this gave very high velocities under the toe of the dam, where the flow lines were well distributed; in fact, it frequently gave negative results, showing that the solution had passed by one tube and reached the second before influencing the reading of the first tube. After several attempts, these electrical observations, because of the unsatisfactory results and the undesirability of interfering with the pressure experiments, were discontinued.

However, the trials were sufficient to point out a more satisfactory method of attacking the problem. Each tube carrying an electrode should be arranged so that the salt solution could be charged at that point. Then, by charging one tube at a time and making readings as before, the time required for the flow to pass 1, 2, or 3 ft. could be determined. In arranging the tubes, care should be taken to make it unnecessary to trace any one charge for a greater distance than 3 ft.

The conclusions resulting from this investigation are stated as follows:

1.—The loss of pressure head of water in passing from above to below a dam may be divided into three stages: (*a*) A relatively large loss of head, occurring where the water enters the sand; (*b*) A quite uniform and comparatively small loss of head per foot of length through the body of the sand; (*c*) A larger loss of head, occurring where the water leaves the sand.

2.—The first stage or entrance loss is increased as the length of floor is decreased.

3.—The rate of flow decreases very rapidly with depth below the floor of the structure, being more concentrated for shorter floors.

4.—The flow lines, once established in a porous medium, tend to continue horizontally as such, and come to the surface only after travelling a relatively great distance.

5.—The pressure decreases with the depth in front of the dam, and below the structure it reverses itself, increasing with the depth.

6.—The porosity, effective size, and uniformity co-efficient have little influence on the upward pressure exerted against the floor of a dam.

7.—The pressure curve for the condition of no piling closely resembles the probability curve, having the general form.

$$y = \frac{h}{\sqrt{\pi}} e^{-h^2 x^2}.$$

8.—Piling at the heel of a dam reduces the pressure on the floor, and piling at the toe increases it.

9.—With sheet-piling at the heel, the pressure increases less rapidly than the hydraulic slope. With no piling, and with piling at both heel and toe, the pressure increases more rapidly than the hydraulic slope.

10.—With sheet-piling at the heel, the flow of greatest density approximates the shortest distance from the end of the piling in the toe of the structure.

11.—The centre of pressure, with no piling and with piling of any length at the heel, is $\frac{L}{3}$, measured from the heel of the dam. With piling at both heel and toe, the centre of pressure is $\frac{5L}{11}$ from the heel of the dam.

12.—For the condition of no piling, the total pressure (in pounds) exerted on 1 lin. ft. of floor is:

$$P = 62.5\, b\, s + 62.5\, c\, (d^s - 1).$$

13.—For the condition of impervious piling at the heel, the total pressure, in pounds, on 1 lin. ft. of floor is:

$$P' = [62.5\, b\, s + 62.5\, c\, (d^s - 1)]\, k\, p.$$

14.—Piling at the heel of a dam, to be effective, must be tight, very small leakage destroying its action.

15.—Piling at the toe of a dam should be loose, in order to prevent increasing the upward pressure on the floor of the structure.

16.—An impervious cut-off wall of comparatively shallow depth, say 5 ft., at the heel of the structure will greatly increase its stability by reducing the upward pressure on the floor.

17.—Variation in the weight or downward pressure against the floor of a dam has little effect in changing the intensity of the upward hydrostatic pressure.

18.—The law of seepage or underground flow cannot be ascertained by treating an area as a unit. It can be best studied by breaking the area up into very small elements.

19.—The law, $P = a\, 10^{-kxn}$, when corrected for gravity, will probably apply equally to pressures in a vertical or horizontal plane.

THE HIGH-PRESSURE STEAM TEST OF PORTLAND CEMENTS.

UNSOUNDNESS of a Portland cement, which is evidenced with age by a lack of cohesion and strength, may not be apparent for weeks or months after the cement is hydrated. This fact has created a demand for an accelerated test of soundness, in answer to which a large number of such tests have been proposed. All accelerated tests are designed to hasten the action of any expansive constituents of the cement, producing thereby evidence of unsoundness in a few hours or days.

High-pressure steam as a means of determining soundness apparently was first advocated in 1880 by Dr. Michaelas, who procured a German patent on what he termed a boiling test at higher temperatures in which the cement soundness test pieces were subjected in a steam-tight vessel to steam at 140° C. to 180° C.

Dr. Erdmenger also advocated this test, and in 1881 published a description of his method of testing soundness of cement by means of high-pressure steam. He believed originally that it was the magnesia which caused unsoundness, and that this test detected the presence of magnesia in dangerous quantities. Later, however, he modified this opinion, as he found some cements which contained very little magnesia were unsound when exposed to high-pressure steam, while some cements containing a relatively large percentage of magnesia were found to be sound. For several years thereafter Dr. Erdmenger advocated the use of his high-pressure steam test in which he employed saturated steam at from 3 to 40 atmospheres pressure, and used pats, briquettes, and expansion bars for test pieces at various times.

It is the general opinion that the primary cause of unsoundness in Portland cement is attributable to the presence of free or loosely combined lime. Recent work by Phillips and Klein in confirmation of this opinion reveals additional facts concerning the action of free lime in cement. Their conclusions may be summarized as follows:

Free lime is generally noted in small amounts in well-burned, higher limed cements and in underburned, lower limed cements. On hydration, free lime, according to its fineness, hydrates as crystalline or amorphous calcium hydroxide. The disruption in cements in accelerated tests is due to the formation of the crystalline calcium hydroxide. Calcium hydroxide crystals are found in cement hydrated under normal conditions, but are not as large in size as those found in cement subjected to high-pressure steam.

Since there is no chemical means by which the percentage of free lime in cement can be determined and the identification of this constituent by optical means is difficult and limited, investigators have endeavored to find an economical physical test that would detect the presence of free lime in its dangerous form where it is liable to cause disintegration, cracking, and weakening of the cement.

To effect the quick expansion of the free lime or other expansive constituents, various experimenters have employed heat and water at various temperatures, steam at atmospheric pressure, and steam at pressures from 3 to 40 atmospheres. Accelerated tests may also be divided into qualitative and quantitative tests. In qualitative tests the unsoundness of the cement is exhibited by the development of cracks, the warping of test pieces, or their disintegration. In quantitative tests the amount of expansion of the cement or the effect on the strength of the cement is taken as the measure of the unsoundness.

In 1912 Force recommended the use of a high-pressure steam test and in 1913 issued a specification* for soundness, known as the Force autoclave test.

Several railroads and other corporations adopted this test into their specifications, which brought about considerable controversy between its advocates and the cement manufacturers. Many of the cement manufacturers refused to furnish cement upon a specification which included this test, believing the test to be an abnormal one not in any way measuring the relative soundness or cementing value of Portland cement as used normally in concrete.

The U.S. Bureau of Standards has just issued a report, prepared by R. J. Wig and H. A. Davis, on the value of the high-pressure steam test. The report is the result of an investigation made to establish, if possible, a relationship between the behavior of Portland cements in high-pressure steam and their physical properties under normal conditions of use and exposure, and to determine what value, if any, the high-pressure steam test has as a means of detecting unsoundness which might cause a weakening or disintegration of the cement or concrete.

The test used consists of subjecting an ordinary soundness pat, which has been stored for 24 hours in a damp closet, to a steam pressure of 300 pounds per square inch for at least one hour, the total time in the high-pressure boiler being three hours. A cement was said to pass this test when it exhibited no cracking, warping, or disintegration on examination after the treatment. The quantitative high-pressure steam test consists of molding six briquettes of neat cement at normal consistency, storing these test pieces 24 hours in a damp closet, then subjecting three of them to an atmosphere of steam at 300 pounds pressure for at least one hour; total time in the high-pressure boiler being three hours. The briquettes (both treated and untreated) are then broken in a shot-testing machine. A cement was said to pass this test when the treated briquettes exhibited greater strength than the untreated ones. Throughout this paper cements are classified into three types, respectively: (1) A cement which fails to pass the standard atmospheric steam test; (2) a cement which passes the atmospheric steam test but fails when treated in high-pressure steam; (3) a cement which passes both atmospheric and high-pressure steam tests.

In order to ascertain what proportion of the cements as at present manufactured were sound after exposure in high-pressure steam, all routine samples received for a period of about nine months were subjected to the qualitative high-pressure steam test. Other tests were performed to determine the effect of a small amount of free lime on soundness. A series of mortar and concrete strength tests were made, employing 9 different samples of cement. Tests were also made to determine the linear change occurring in these cements when stored in air, water, or treated in high-pressure steam and also on specimens to the cement in which sand or waterproofing compound had been added.

The following is a general summary of the report:

The general soundness tests show that some cements mixed neat, which are sound according to the standard specification atmospheric steam test and unsound after exposure in high-pressure steam, exhibit signs of unsoundness when stored under normal conditions in dry air. This unsoundness may require nine months or more to develop where the test pieces are of neat cement.

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* See *The Canadian Engineer*, September 11, 1913, p. 444.

The tensile strength tests of 1:3 mortar fail to show that a cement passing the high-pressure steam test is superior in cementing value to a cement which does not pass this test but passes the standard specification test. The briquettes made from the cement unsound in atmospheric steam do not show inferiority in strength to those made of sound cement. A striking feature of these tests at the later periods is the high value attained by two of the cements which were unsound in the atmospheric steam test.

The compressive strength tests of 1:3 mortar in 2-inch cubes show a comparatively low strength at the earlier periods for type 1 cement, which is unsound in the atmospheric steam test, and a high strength at all periods of type 3 cements which pass the high-pressure steam test. In all cases where several samples of the same brand, some classified as type 2 and some as type 3 cement, the test pieces which contain the type 3 cement give higher strength values throughout.

The compressive strength tests of the concretes composed of one part Portland cement to two parts sand and four parts of gravel show a superiority at the earlier periods of type 2 and type 3 cements, which are sound in atmospheric steam and high-pressure steam, respectively, over the type 1, which is unsound in atmospheric steam, and little or no difference in strength between type 2 and type 3 cements at any periods.

There is no consistent relation existing between the strength of type 2 and type 3 of the same brand, sometimes type 2 being stronger and at other times type 3 is stronger. There is a large range in the strength of samples of the same brand received at different times irrespective of the type, and a considerable range in the different brands both for type 2 and type 3. It was noted that cylinders tested in the winter and spring months consistently gave lower values than similar cylinders tested in the summer and fall, but no explanation can be offered for this variation. It is interesting to note that one of the cements giving one of the strongest concretes throughout was taken from a delivery rejected on account of unsoundness in steam and is a type 1 cement.

The results of the tests of linear change of neat cement prisms of both type 2 and type 3 cements as a whole show no difference that could be attributed to the type of cement when the prisms are stored in air and water. There is more variation between the different brands than between different types of the same brand. However, in one case a neat cement containing type 2 cement at four months began to expand in air and continued to expand to a great degree up to the last period measured. This test prism also began to warp and show signs of disintegration. Several of the other prisms containing type 2 cement showed some warping, but no prisms containing type 3 cement exhibited any warping or other signs of unsoundness.

The treatment of neat cement prisms in high-pressure steam showed an expansion of from 1.86 to 10.80 per cent. for type 2 cement (in some cases the prisms completely disintegrated), while prisms containing type 3 cement expanded in high-pressure steam from less than 0.1 up to 0.31 per cent. Increasing the pressure from 100 to 300 pounds affects the amount of expansion of the prisms but little, if any. The addition of a small amount of water-repellant compound to the cement does not affect the amount of its change of length when stored in air or water. The addition of sand to a prism containing type 2 cement reduces the amount of expansion in high-pressure steam for a 1:1 mortar to 96 per cent. of that of the neat, and for a 1:2 mortar to 69 per cent. of the neat, all being subjected to the same high-pressure steam treatment.

Seventy per cent. of a total number of 51 brands of cement tested passed the high-pressure steam test.

Of cements normally unsound in the standard atmospheric steam or high-pressure steam test, if the finer sized particles are removed and tested separately, they will generally be found more sound than the original cement tested in the same manner, and in many cases they will be found entirely sound. Further, if the coarse particles of a cement which is sound after exposure in high-pressure steam are removed and tested separately, they may be found to be unsound in this test. While fineness is not essential to soundness, it appears to be the coarse particles of a normally unsound cement which cause the expansive action and the cracking and disintegration of the pat.

A cement originally unsound in the high-pressure steam test will usually be found sound if exposed to this test after ageing from two to six months.

If a cement which will not meet the requirements of the high-pressure steam test is mixed with water and formed into a pat, it sometimes becomes sufficiently sound to pass the high-pressure steam test, if the pat is stored from six months to a year in either air or water prior to exposing to high-pressure steam.

The maximum tensile strength of sound cement exposed to steam appeared to be attained at a pressure not exceeding 150 pounds per square inch; but this may vary with different brands and different durations of the steam treatment. Type 2 cement begins to fail when subjected to steam at a pressure as low as 25 pounds.

The following conclusions were reached by the investigators:—

1. The high-pressure steam test should be made on all cements that are incorporated in cement, mortar, or concrete products that are to be cured in steam at pressures above atmospheric.

2. The high-pressure steam test may be of value as forecasting the behavior of neat cement or a very rich mortar when exposed under normal conditions in dry air, but it will not forecast the behavior of cements in concretes as normally exposed.

3. The cement passing the high-pressure steam test is not superior in cementing quality, as determined from the compressive strength of concretes, to cement that fails to pass this test.

4. The cement passing the high-pressure steam test does not make more permanent or durable concrete than cement which meets the requirements of the standard specification but fails to pass this test.

5. Cement failing to pass the standard specification atmospheric steam test but meeting the other requirements of the standard specification shows in some instances a normal strength in concrete.

6. For practical work under normal conditions of construction, the results of this investigation fail to show that the high-pressure steam test is of value as a means of determining the ultimate soundness of concrete.

The total mileage of Government experimental road at present under construction is 465 miles, according to a recent statement from the United States Department of Agriculture.

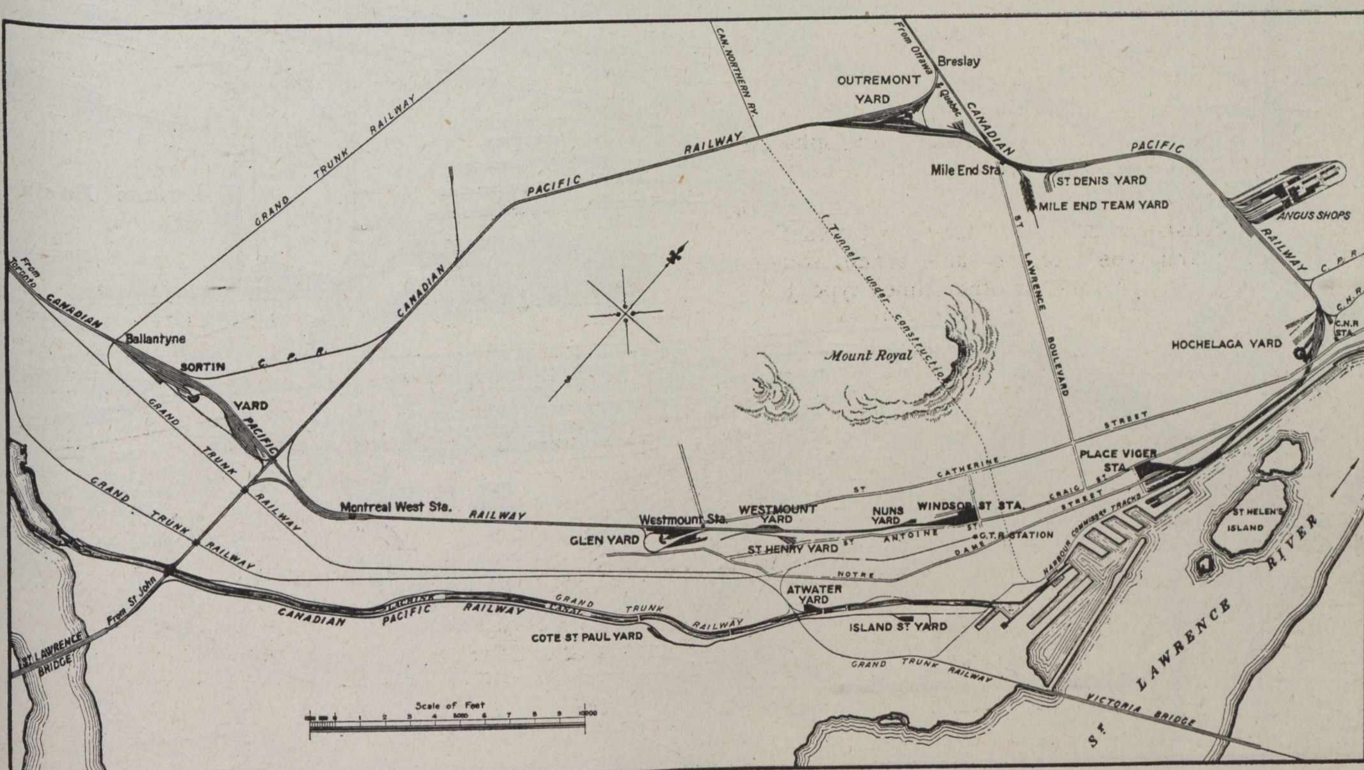
A NOTABLE GROUP OF RAILWAY TERMINALS

ILLUSTRATING BY DIAGRAM AND BRIEF DESCRIPTION THE OUTSTANDING FEATURES OF THE CANADIAN PACIFIC RAILWAY TERMINALS AT QUEBEC, MONTREAL, WINNIPEG AND VANCOUVER.

THE efficiency of a modern railway terminal is not manifested in bells and bustle. To perfect a terminal organization and management, efficient as well under ordinary conditions as when subjected to tests involving maximum demands and extreme conditions, is the greatest problem for the executive head of a busy transcontinental. Nowhere in the complexity of the business world is there greater justification for employing methods which have back of them principles harmonizing with the results of scientific study and research, toned down by the best skill that training and experience can command. Such a terminal must be the acme of organization, but it must first be well located and well arranged. A terminal system cannot be here to-day and there to-morrow to comply with the vicissitudes of restless traffic.

The Canadian Pacific Railway has stragetically located its more important terminals at St. John, Quebec, Montreal, Toronto, Fort William, Winnipeg and Vancouver. In a single year (1913) this railway earned nearly $90,000,000 from freight, and $35,500,000 from passenger traffic. Or, the standard of its terminal organizations is perhaps better illustrated by the manner in which it met the exacting demands created by the complete disorganization of business in 1914 and the necessity of economy arising out of depression and war. The rapidity and uniformity with which the company, in a few months, reduced maintenance and transportation expenses over its 12,900 miles of track, is one of the most remarkable evidences of terminal organization and management.

Thus, while a would-be but belated traveller may occasionally deign to recast, in a twinkle, the whole system, there is much to be learned from a study of the terminals that handle the major portion of Canada's long-haul traffic. Only a few will be referred to here: The eastern terminals at Montreal and Quebec, the terminal at Vancouver, where transcontinental trains connect with coastal and trans-Pacific steamers, and the Winnipeg yards, through which rolls an enormous volume of traffic between eastern and western Canada.



Canadian Pacific Railway Stations and Yards at Montreal.

C.P.R. Terminal at Montreal.

As the accompanying plan indicates, the tracks of the Canadian Pacific Railway very nearly surround the city of Montreal with main lines radiating to the north, west and south. The line to the north leads to Quebec, the Laurentian Mountains and Ottawa; the line to the west leads to Toronto and is at the same time the short line to Ottawa. The line to the south, which crosses the St. Lawrence River on the new double track bridge, leads to all points east and south on the C.P.R. on the southerly side of the St. Lawrence River.

Passenger trains for the east, south and west run from the Windsor Street station with stops in Montreal at Westmount and Montreal West. Trains for the north run from Place Viger with a stop at Mile End. The passenger equipment in the one case is handled at Glen Yard, which lies opposite Westmount station. In the other case the passenger engines are handled at Hochelaga yard and the other equipment in the Place Viger station and the adjacent coach yard.

The entire freight business in the Montreal terminals is handled in the three main yards: Outremont to the north, Sortin to the west and Hochelaga to the east. In addition, Sortin is the base yard for the territory between Montreal West and Windsor Street and for the territory on both sides of the Lachine Canal; Outremont yard for the northern and part of the eastern portion of the city and Hochelaga yard for the import and export business at the wharves and the Place Viger local freight terminal.

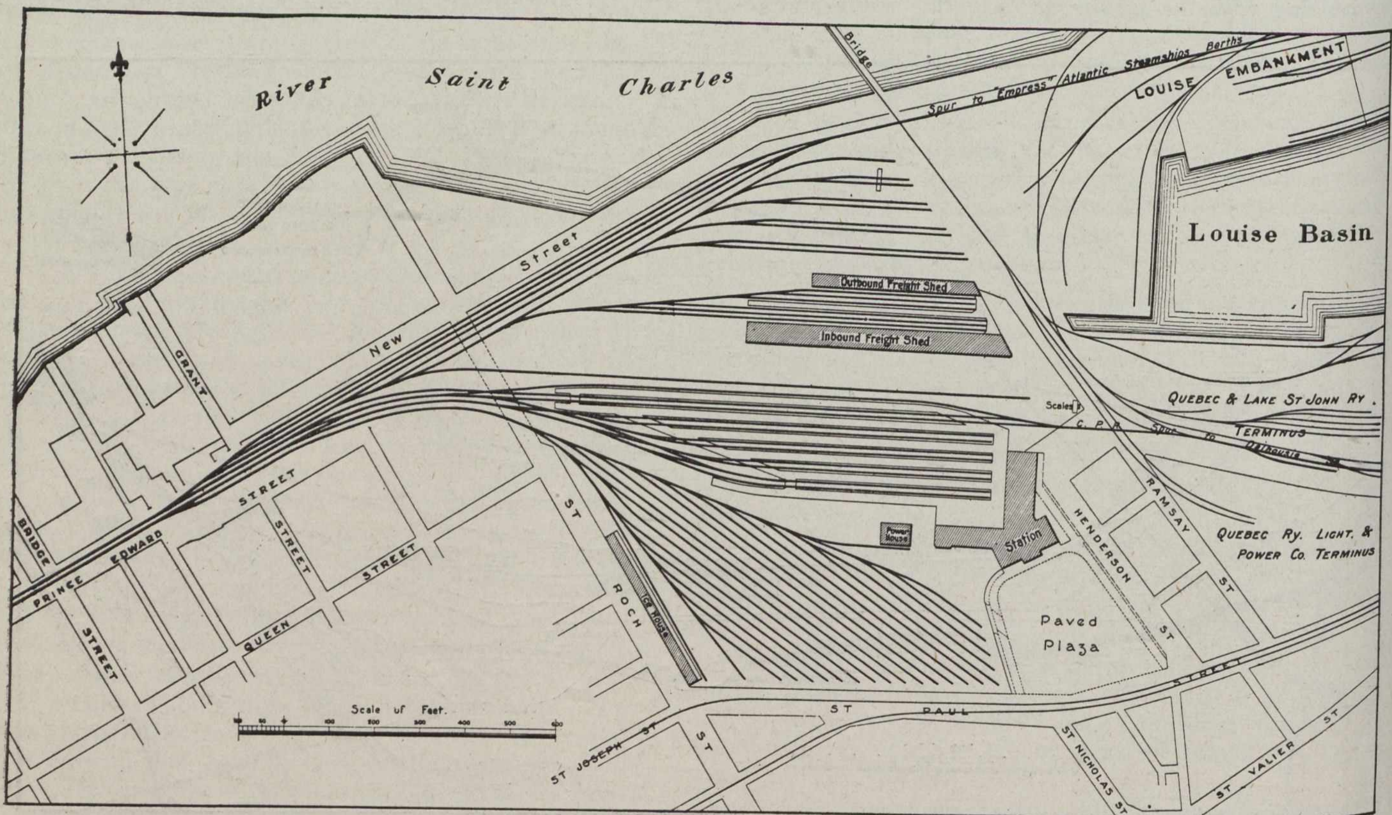
This local freight terminal is the main point from which both car-load and L.C.L. freight are distributed for the down-town district and is the largest single unit for either class of freight in the Montreal terminals. Other units are located in the easterly end of the city at Moreau Street, Iberville Street, St. Denis Street, Mile End and Park Avenue. The westerly end of the city is served by units at St. Henry, Westmount and Montreal West and by various yards along the north and south bank of the Lachine Canal which are tributary to what are known as the North and South Bank branches. The city has not yet developed sufficiently along the line between Montreal West and Outremont to warrant the construction of more than very minor local freight facilities through this territory.

The Angus shops lie adjacent to and north of the main line between Place Viger and Mile End.

The Quebec Terminals.

The plan of the terminal arrangements at Quebec, which appears herewith, is the result of an entire remodelling of both passenger and freight sections. This became a necessity on account of the growth of business during recent years, and on account also of their proposed use by both the Canadian Pacific Railway and the National Transcontinental Railway as a union terminal. The work, which was started during the summer of 1914, includes the construction of a new passenger station building and yard with the necessary adjoining coach yard, new freight sheds and team tracks, new engine facilities and main yard and a double track main line through the terminals. It is intended to have all this work completed by 1917.

The track leading to the Louise embankment and the Empress wharves is to be relocated further to the north. This permits of constructing a new and enlarged team yard in such a position that teams need not cross the heavy train movement to and from the wharves. This yard of about 105 cars capacity will be built chiefly on ground reclaimed from the St. Charles River.



The New Quebec Terminal of the C.P.R.

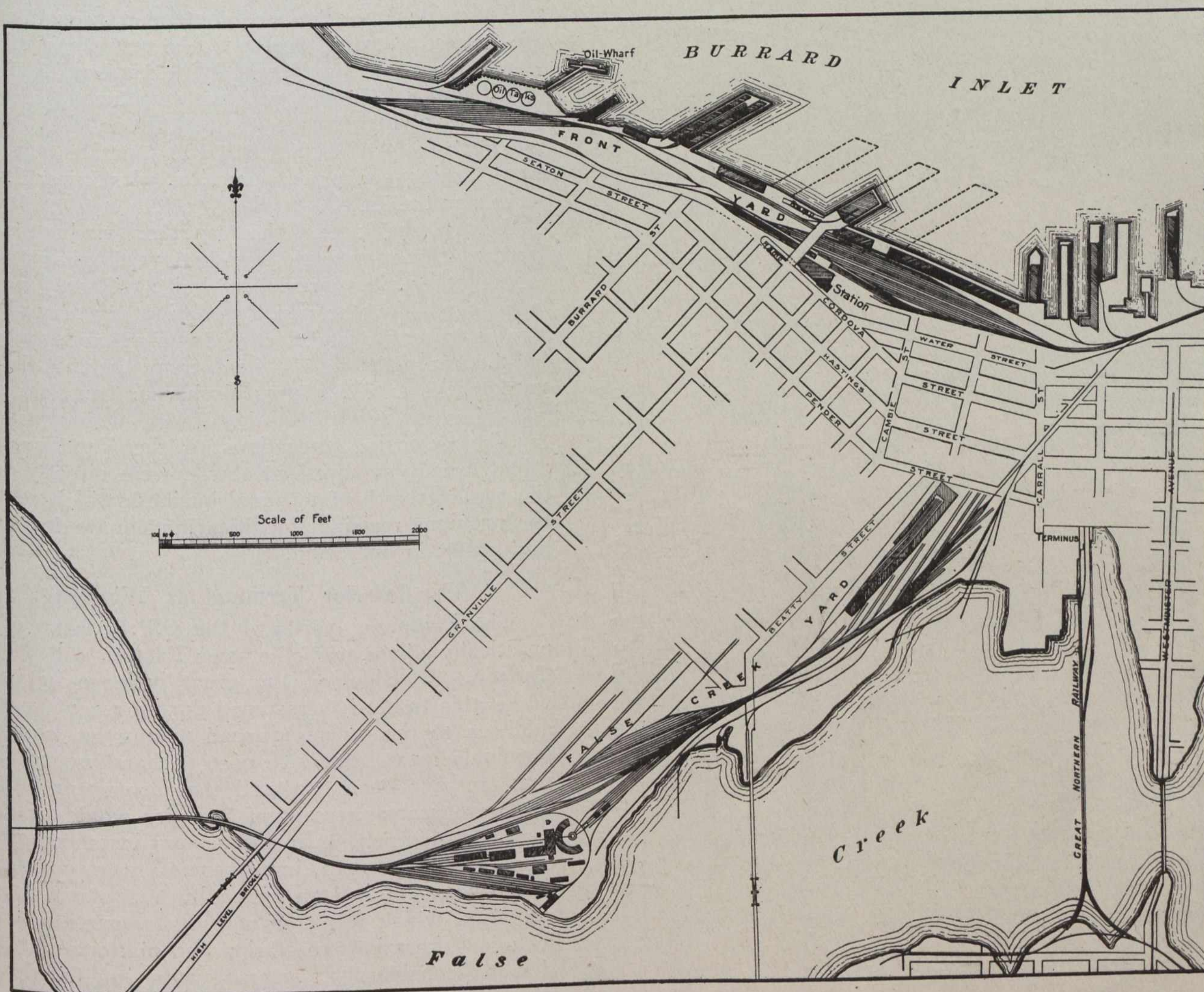
The new freight sheds are now complete and in service. The outbound shed is 30 ft. wide and 360 ft. long, while the inbound shed proper is 50 ft. wide and 460 ft. long; the balance of its length being given over to a two-story office building. Each shed is served by three tracks—the outbound having a capacity of 27 cars and the inbound a capacity of 39 cars, while a trucking platform between the two sets of tracks permits of their ready use for L.C.L transfer purposes. The sheds are so located that they may at any time in the future be increased in length as more capacity is required.

The new passenger station is now under construction, and will be in use early in the new year. The building is a most interesting adaptation of the Chateaus of the Loire in France, and has been specially designed by the architect to meet the requirements of the old and historic city of Quebec in this respect, as well as to amply fulfil the requirements of the present day and far future, from the utilitarian point of view. The building is located on the site of the old freight sheds, its main entrance being on St. Paul Street. That portion of it facing on the proposed plaza, 200 ft x 300 ft. long, will be given over to ticket booths, baggage checking counters and similar public facilities. The waiting rooms will be in the north wing and the baggage, mail and express facilities in the west wing. The first floor will be devoted to the local offices of the Canadian Pacific Railway and also of the Transcontinental Railway.

The station yard will include, at the present time, eight stub end passenger tracks, varying in capacity from 7 to 10 cars and an engine, and three through tracks varying from 12 to 14 cars and an engine. The through tracks are providing for handling pilgrimage trains which run through to St. Anne de Beaupre. The tracks are arranged in pairs at 13-ft. centres with 18-ft. combination baggage and passenger platforms between the pairs. Space has been left for future additional tracks between the present stub tracks and the baggage wing of the station.

The coach yard will lie to the south of the station and have a capacity of 130 coaches. Its construction has not yet been undertaken as it is on the site of the present station and station yard which must be maintained in service until the new station is completed. The heating of this yard, the station and station yard and the freight sheds will all be handled from a central power house located just west of the baggage wing of the station. The ice house on St. Roch Street is intended to provide both for the railway requirements and the Chateau Frontenac.

The existing engine facilities which lie just to the west of Bridge Street, will be maintained in service until such time as the new and much more modern facilities can be constructed. The location of these new facilities has not yet been decided upon, but will be, in all probability, at a point some three or four miles from the Palais Grounds where it will be possible to build a freight terminal yard of a size and layout such as is required for handling both the local and export freight business. The double track will be constructed westwardly from the Palais Grounds and extend well beyond the new freight yard to the point where the joint C.P.R.-N.T.R. terminal ends.

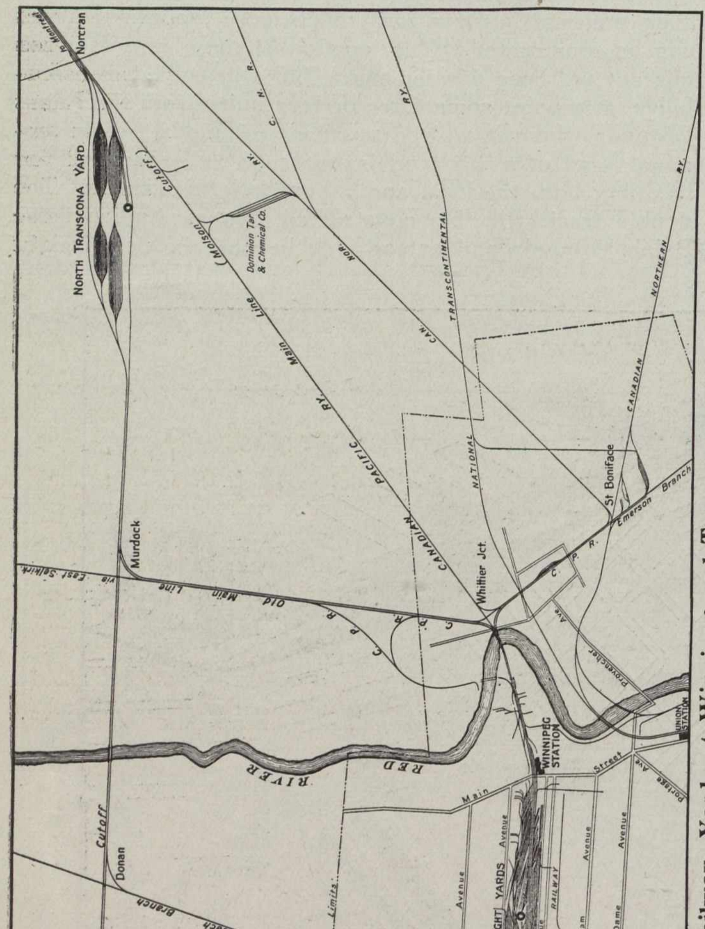


C.P.R. Ocean Terminal at Vancouver.

The Pacific Terminal at Vancouver.

The somewhat unusual arrangement, as illustrated by the accompanying plan of the Vancouver terminal situation, provides for the easy interchange of traffic between railway, steamship lines and the city itself. As compared with other large terminals, it is unusual also from the suburban traffic point of view. In Vancouver this is notable for its absence. The trains are not numerous, but they are long and are frequently run in sections. Moreover, they carry an unusual variety of traffic.

The present layout is the result of alterations commenced in 1912 and completed in July, 1914. The old passenger station built in 1898 at the foot of Granville Street, with offices, etc., at street level, and baggage



The Canadian Pacific Railway Yards at Winnipeg and Transcona.

room at track level 30 ft. below the street, was removed and an entirely new structure erected in its stead. This new station has its main entrance on Cordova Street, its baggage rooms, etc., on the lower floor, the two levels being connected by a complete elevator system. Passenger traffic between station and trains is carried over the tracks by a foot bridge directly connected with waiting rooms, and giving access to the track platforms, which are covered.

There are four through passenger tracks, two for incoming and two for outbound service, with provision for future additions. They lie between the station and the freight yard, at an elevation 5 ft. greater than that of the old track level, thereby reducing to about 25 ft. the difference between the floor levels in the station itself.

The freight yard was rearranged to advantageously connect with the present steamship piers, as well as those that will be constructed when future business requires.

Granville Street has been extended by viaduct over the tracks, affording access to the new steamship pier which comprises two levels. The viaduct itself is 80 ft. in width. The pier has a substructure of creosoted timber involving the use of about 3,000 piles ranging in length from 85 to 110 ft. The superstructure is of slow-burning timber construction. Its lower level is served by tracks.

It will be noted that another viaduct carries Burrard Street over the terminal yard, giving access to the other piers previously built. There are two large sheds for the accommodation of trans-Pacific steamship traffic, and five sheds on adjoining wharves for the use of the coastal steamers of the C.P.R. The yard tracks extend along this harbor front for about 1½ miles.

The extensive alterations to the Vancouver terminal, briefly summarized above, were directly due to the rapid growth of terminal business which rendered the previous terminal facilities inadequate for service and costly in operation.

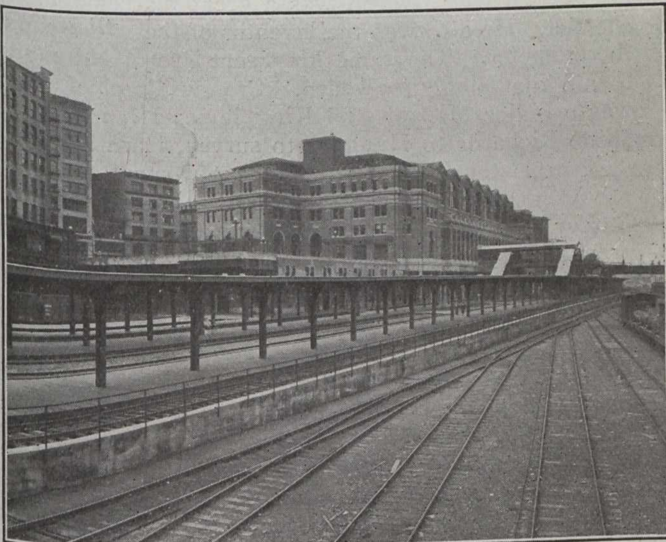
The Interior Terminal at Winnipeg.

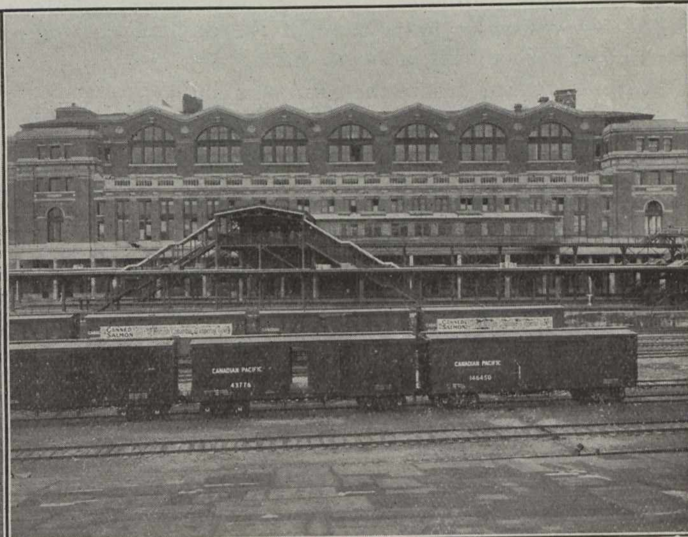
The Winnipeg yards of the C.P.R. have cleared practically all the traffic between Eastern and Western Canada. Considering the great increase in volume which this traffic has assumed during recent years, in addition to the potent railroad axiom that congested terminals mean excessive cost of handling traffic, it was to have been expected that sooner or later an extensive rearrangement of facilities would be necessary in Winnipeg, as in the several instances already cited. In May, 1913, improvements were commenced which have entailed an expenditure of about $2,500,000, and which are now nearing completion. They included alterations to station and platforms, in addition to considerable rearrangement of freight and passenger tracks. Associated with them, also, was the construction of an entirely new terminal at Transcona, a few miles distant, and of a double track cut-off around the city of Winnipeg, the cost of which is not included in the above figure.

The Winnipeg alterations were accomplished under some severe difficulties. City and railway traffic had to be maintained throughout. The subway which carries Main Street under the tracks was removed and replaced by a structure raising the tracks 6 ft. above the old level in order to do away with level crossings for the passengers in transit between train and waiting room. The Main Street subway, erected ten years ago, was of concrete reinforced by rails and heavy bars. Owing to a civic by-law prohibiting the use of explosives, the demolishment of the old structure was necessarily expensive and slow. Concrete was removed with the aid of air drills and the reinforcing cut by oxy-acetylene blow pipes. Traffic was kept open on the tracks above during the operations of removing the old structure and building the new subway.

The present arrangement provides eight passenger tracks reached by subway and stairways, the former leading directly to the level of the street. It was found necessary, in order to secure head-room for the handling of passengers underneath the tracks, to lower a portion of the main waiting room. The entire north end was accordingly lowered about 4 ft. The baggage room has been moved from the extreme west of the building to the eastern end and under the elevated tracks. This department now faces Maple Street, a portion of which is used almost exclusively for the handling of baggage. A trucking subway running parallel to the tracks above and terminated by elevators, is a feature of the interesting arrangement of handling the baggage.

The improvements at Winnipeg included extensions to the Royal Alexandra Hotel.





The C.P.R. Station at Vancouver, Showing Separation of Freight and Passenger Tracks, Covered Bridge and Platforms.

ENGINEERS AND WAR.

By R. O. Wynne-Roberts, Consulting Engineer, Toronto, Ont.

THE great European war is the absorbing topic; it concerns every citizen, for the stakes at issue are serious; and it has disturbed the commerce, finance, national and social affairs of the whole world in a manner which transcends anything previously experienced in history. The war being of special interest to engineers of various classes, it was thought that it would be appropriate in a journal which is devoted to engineering affairs, to trace the part played by engineers in wars. It is not proposed to treat this subject in its technical aspect, for those who desire such information can consult the many standard publications treating on military engineering. The subject will be dealt with in a general way.

The Right Hon. D. Lloyd George, the Minister of Munitions, in a speech delivered a few days ago at Bristol, asserted that the present war was a terrific contest between the engineers of the warring nations. The "Forum," in 1902, stated that the military question is in many respects an engineering question. Mr. Obertin Smith, in an article on "Who is an Engineer," wrote that the beginnings of engineers evidently were in the line of military engineering. Having sufficient brains, and being spurred forward by emperors and kings under the penalty of death or the loss of his ears, the engineer had to build forts, roads and bridges and to construct catapults and other appliances. Col. I. F. Maurice, in an able article in the British Encyclopedia, expressed his opinion that "the laboratories and workshops of science in recent years have produced and forced on a change in the nature of fighting of a kind which, it is safe to say, never entered the mind of any one of the inventors whose skill made it necessary."

Although the great Duke of Wellington made full use of engineers in the Peninsula War of 1808, and earlier supported Major Lambton in his organization of the trigonometrical survey of India in 1800, yet, when the question arose later on as to the capabilities of engineers to command armies in actual war, he was not in favor of the idea, as he considered an engineer was a scientific officer, thus apparently disproving the oft-quoted statement of the "science of war." This idea has since been proved to be wrong, as will be shown farther on. The Duke, however, must have been in a petulant mood owing, perhaps, to the persistent advocacy of engineer generals when he declaimed that engineers were either "mad, married, or Methodists." The first two perverse conditions were forgivable, but in those days to be a Methodist, which meant being a non-conformist, was a veritable anathema to the aristocrats, and to call a man a Methodist was a polite way of committing him to perdition.

Engineers have been prominent in wars of all ages. The Assyrians employed engineers in making military machines, battering rams and catapults, as is recorded on the frescos and bas-reliefs which was the Assyrian method of writing history. The harbors of the Phoenicians and the palaces and sewerage system of Nimroud are evidence of the skill of engineers. Engineers must have been employed to throw the bridge of boats across the Dardanelles for Xerxes to transport immense armies into Europe.

The present Suez Canal occupies practically the same line as the canal which was cut in 650 B.C. by Darius, son of Hystaspis, to keep out the horde of barbarians after the conquest of Egypt by the Persians.

The Roman and Grecian wars called for machines for attack and defense. The ablest mathematicians and philosophers were pressed into military service. Archimedes was slain by soldiers about 250 B.C., while applying the best scientific knowledge of the day in devising means of defense during a siege.

Antonius states that the Romans built 372 great military roads 48,000 miles in length, connecting the conquered countries with Rome. The great sewers and aqueducts of Rome were monuments of engineering skill. These were built as the result of the vast extent of the Roman military exploits and their successes which had their reflex on the grandeur and opulence of Rome. It is recorded that in the reign of Tarquin I., 606 B.C., a Roman soldier was so proud in demeanour that he would destroy himself rather than construct common sewers. The Roman engineers were skilful enough to transport great obelisks from Egypt to Rome.

The Pelasgian period of Greece was one of utilitarian construction as contrasted with the national tendency to the development of art and learning of subsequent times. Alexander the Great brought the east and west together and the Romans nearly united all the then known world into one great empire by the work of engineers, to retain possession of the conquered territories and to derive the commercial advantages accruing therefrom.

Engineers were employed and mechanical appliances were brought into use in the transportation of the statue of Ramses II., which is computed to weigh 887 tons. The mighty twin colossi erected in honor of Amenhotep III. at Thebes was brought hundreds of miles down the Nile from Assuan. This sitting statue is 47 feet high and is reckoned to weigh about 847 tons. The great pyramid of Cheops was built of huge blocks of stone raised to a great height, and if built to-day by a contractor at 25 cents per cubic foot, it is calculated that the cost would be in the vicinity of $20,000,000. Wars were directly or indirectly the reason for all of these great engineering achievements.

Coming to more recent times, William the Conqueror had a chief engineer, for in the Domesday Survey, A.D. 1086, there appears the name of "Waldivus Ingeniator." Previous to this, even bishops were employed, for Bishop Grundulf, in 1078, designed and build the White Tower of London. Later on, in 1150, Geoffrey, the King's engineer, was convicted of poaching in the King's forest, but the penalty was afterwards remitted. In 1300 the name ingeniator appears to be changed to that of atillator, and some think it possible that the word artillery was derived from it, but this is doubtful. In 1319 the Scots threw back King Edward II. forces and it is recorded that the defenses of Berwick were constructed by "the stout old Crabbe—the Flemish engineer" Edward III. first employed cannon in 1338 and in 1344 it is stated that an artillery train was formed and engineers were in charge. Cannons caused the death blow to feudal castles and new fortifications had to be built in Italy, France, Germany and Britain. Some of these guns were said to be able to throw stone shot several hundred pounds in weight.

In 1414 Nicholas Merbury was master of the King's works, guns and ordnance. A little later the French employed cannon at the siege of Harfleur. Those guns "by the force of ignited powder blew forth stones of monstrous size, which threw down the walls with a frightful noise." It is interesting to learn from Froude's "History of England" that King Henry VIII. "entered into military engineering, not with the condescending incapacity of a royal amateur, but with thorough workmanlike understanding."

King Charles I. employed Dutch engineers and one of them, named Drebel, was a great mathematician and chemist. He also was the inventor of the microscope and thermometer. The same king sent five of his engineers to aid the King of Sweden. Cromwell's chief engineer was a Major Morgan and King James II., in 1685, sent Jacob Richards to Hungary to survey, learn and observe the fortifications, artillery and the movement of the army. Richards submitted a lengthy report and referred to a Father Gabriel, a Franciscan Friar of Savoy, who had prepared a projectile containing powder and musket balls. In more recent times we find that General Shrapnel introduced similar projectiles for use by the British army.

European engineers were early prominent in the art of building fortresses. Marchiavelli built the citadel at Pisa. Michael Angelo was engaged on similar work and Leonard du Vinci gained such a reputation that he was considered to be the greatest of Italian engineers of those days. It is stated that Peter of Navarre, engineer to Gonsalvo of Cordova, when the castle of Naples was besieged in 1503, used gunpowder to blow up the walls.

We read to-day of the German aspirations to take Calais. It was in 1540 considered to be the strongest fortress in Europe, but 18 years later the Duke of Guise, by means of imported engineering facilities, took the place.

Italian engineers, owing to their international reputation, were in the 16th century in general request to build fortresses in various countries in Europe. Paciotto d'Urbino built Turin, Cambrai and Antwerp fortresses. The last one took over one year to construct and was deemed by military experts to be the masterpiece of the age. It was nevertheless criticized by La None Hugenot and his prognostications proved true, for it was soon destroyed by improved guns and explosives.

The French engineers next occupied the leading position in the estimation of military authorities. Vauban "had in his early days a pretty good knowledge of mathematics and fortifications." During his lifetime he built about 160 fortresses. Among them were Dunkirk, Lille and Strassburg—familiar names at the present time. According to Capt. Daley of the United States Engineers, the foundation of modern siege was laid in 1673 by Vauban. Vauban did much to improve the efficiency of the engineers, whom he styled as the "martyrs of the infantry," presumably because of the great hazards which constitute the essential features of the military engineer's experience, and was the inventor of the socket bayonet. The next great French engineer was Montalembert, from whom the German engineers acknowledged they learned a great deal; in fact, it would appear that Montalembert was, if anything, more highly esteemed in Germany than in France.

The Belgian engineer, Brialmont, built the Antwerp fortresses on modern lines and it was thought to be invulnerable until a few months ago, when it crumbled under the effect of the great Austrian guns.

Editorial

ONTARIO'S WATER POWERS.

In this issue a copious abstract appears of a monograph relating to the water powers of Ontario. It is one of a series prepared under the direction of J. B. Challies, C.E., Superintendent of the Dominion Water Power Branch of the Department of the Interior on the general hydro-electric and power situation in the various provinces of Canada at the present time. Five brochures have been specially written for distribution among engineers attending the International Engineering Congress in San Francisco this week. They have been prepared by representative engineers, prominent in the profession in Canada and thoroughly familiar with the territory covered in their respective monographs. They are: "Water Powers of British Columbia," by G. R. G. Conway, Consulting Engineer, Toronto, (previously Chief Engineer of the B.C. Electric Railway Company); "Water Powers of the Prairie Provinces," by P. H. Mitchell, Consulting Engineer, Toronto; "Water Powers of Ontario," by H. G. Acres, Hydraulic Engineer, Hydro-Electric Power Commission of Ontario, Toronto; "Water Powers of Quebec," by F. T. Kaelin, Assistant Engineer, Shawinigan Water and Power Company, Montreal; "Water Powers of the Maritime Provinces," by K. H. Smith, Resident Engineer, Dominion Water Power Branch, Halifax, N.S.

The information regarding water powers in Ontario, to which considerable space is devoted in this issue, is, without doubt, the most authoritative and instructive that has been published to date. The summary of undeveloped and developed powers, as given by Mr. Acres, should dispel many erroneous ideas concerning the extent of this marvellous asset. A summation of nearly 5,000,000 horse-power capable of development, less than 15 per cent of which has already been utilized, indicates clearly the opportunities for manufacturing industries within the province. Of the 702,000 horse-power now in use, it is stated that about 574,000 horse-power is electrical energy sold for light and power; about 69,000 horse-power is used for pulp and paper manufacture, and about 59,000 horse-power is used for the most part in the form of hydraulic power directly applied.

Mr. Acres has analyzed the power possibilities of the province by grouping into districts those developments that fall together from a natural and topographical standpoint. Thus he has described the present and possible developments of the Ottawa River and its tributaries, the rivers tributary to the Great Lakes, the Winnipeg River and its tributaries, the rivers flowing into James Bay, and the international rivers of Ontario, and has outlined the hydrological and geological characteristics of each group. As a result of this, the reader is given a clear and impressive idea of the magnificent potentialities of the rivers of Ontario, together with an idea of the commercial feasibility of their early development.

The same is true of the other pamphlets relating to water power elsewhere in the Dominion. They outline its abundance and the feasibility in each instance of its utilization. Taken altogether, a more authoritative accumulation of information on Canadian water powers is not to be found, and no time could be more fitting for commending it to the attention of engineers, manufacturers and financiers of this and other countries.

DETERMINATION OF BIOCHEMICAL OXYGEN DEMAND BY A NEW METHOD.

The saltpeter method of determining the biochemical oxygen demand of sewage and polluted waters was lengthily referred to in an article which appeared in *The Canadian Engineer* for July 15, 1915. Briefly, the method depends upon the denitrification of a sodium nitrate solution by the sewage bacteria present. Experimental investigations have shown that the amount of saltpeter oxygen absorbed by the organic matters on incubation is the same as if fresh water oxygen were used. This, then, should prove a very important discovery, as the method lends itself to easy manipulation. After preliminary tests with varying quantities of saltpeter to ascertain the strength of the sewage, a definite excess of the nitrate may be employed, without resulting in an increased oxygen consumption. This obviates a great deal of the preliminary work attending fresh water dilution tests.

The saltpeter method cannot be applied indiscriminately, however. A municipal sewage may contain a considerable quantity of trade waste without losing entirely the characteristics of a domestic sewage, in which case the method may be employed without modification. However, sewage or trade wastes occur containing caustic alkali or acid, or a germicidal or antiseptic substance. Wastes from stock yards, tanneries and the corn products industry are examples.

According to Dr. Arthur Lederer, of the Chicago Sanitary District, who discussed this subject recently before the American Chemical Society, with the packing house waste mixed with domestic sewage, the method remains the same as with domestic sewage. This waste resembles somewhat a concentrated domestic sewage, with a high organic nitrogenous and carbonaceous content. In the case of cornstarch and glucose industries there is also an admixture of sewage with consequent high bacterial content. Here the presence of carbohydrates often results in a fermentation during the incubation, forming organic acids which inhibit denitrification. Again, the effluent may be slightly acid, on account of the presence of free sulphurous acid, but this acidity will quickly disappear on standing.

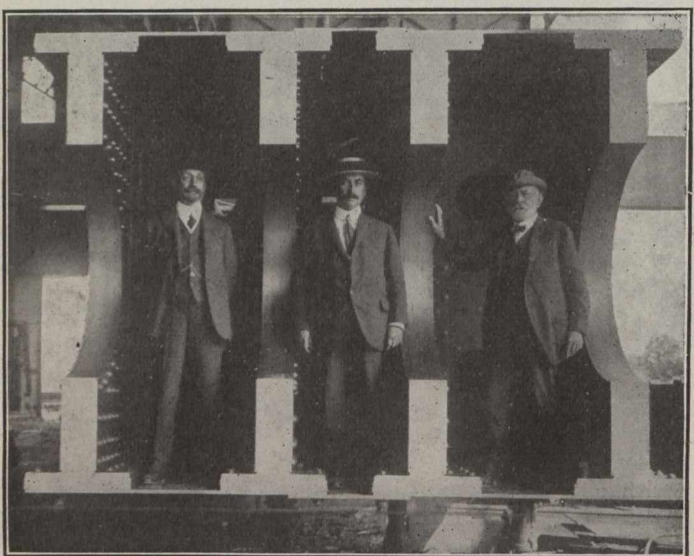
In tannery wastes caustic alkali is particularly likely to occur, varying considerably in strength and necessitating neutralization with hydrochloric acid. It is to be noted here that time must be allowed for the neutralization in the case of a waste strong in caustic alkali as the free lime in the sediment does not combine very rapidly with the acid. These particular effluents, resulting from the liming process in the tanning industry, do not lend themselves readily to biochemical demand determinations by either the saltpeter or the dilution method. In a mixed tannery waste, however, suspended lime is ordinarily not present in quantities sufficient to interfere with the reliability of either mode of procedure.

The term oxygen demand has often created misconceptions. The fact that the oxygen is entirely supplied by the nitrate in this method does not mean that the oxygen demand so determined will have to come from the available oxygen in the stream into which the sewage is discharged. On the contrary, while most of the oxygen may be derived from the stream, the rest may come from the air by absorption or from the plankton. No definite rule can be given, for each particular case is a matter of individual study. Whether all of the oxygen must be supplied from the stream or not, the saltpeter method affords a reliable and simple comparison of the strength of a sewage or waste from the deoxygenating standpoint. This and the amount of settling suspended matter are the items most interesting to the sanitary engineer or chemist.

Dr. Lederer asserts that the great advantage of the saltpeter method lies in the fact that the oxygen consumption can be determined after any desired interval in a much more reliable and comparable manner than can be accomplished by methods involving fresh water dilutions. To the sanitary engineer this is a matter of great importance.

BOARD OF ENGINEERS, QUEBEC BRIDGE.

The accompanying reproduction is from a most unique photograph of the Board of Engineers of the new Quebec Bridge, this year's progress on the construction



of which is outlined elsewhere in this issue. The centre figure is Mr. C. N. Monsarrat, chairman of the Board and chief engineer. Mr. Ralph Modjeski is on his right and Mr. C. C. Schneider on his left. They are seen standing at a 45-inch pin hole in the end section of one of the bridge members.

The impurities in many copper ores impair the accuracy of the electrolytic assay, and the tedious operations for their complete removal tend to cause loss. Low's iodide method is one of the most accurate, practical methods yet devised for the assay of copper, although the more simple cyanide assay is also excellent if properly carried out. As a matter of fact, the distinct end-point is the main reason for the usual accuracy of the iodide method compared to the cyanide. Notwithstanding all statements to the contrary, all the copper can be precipitated by boiling with aluminum, taking care that acids other than sulphuric are absent, and that the bulk of solution is as it should be.

VARIOUS USES FOR REROLLED RAIL STEEL.

By C. A. Tupper in "The Iron Age."

THE rerolling or working up of rail steel for industrial purposes has assumed considerable importance. The production of bars for reinforcing concrete is probably the largest single use for rerolled rail heads, while flats, channels, angles, tees and diamonds can be secured from the rail section as a whole, including the web and flange, together with straight and U-bars of various dimensions. Such bars and shapes now find an extremely varied application, as in the manufacture of agricultural machinery and implements, such as spreaders, plows, harrows, cultivators, mowers, rakes and harvesters. This is, in point of tonnage, the most considerable use and includes all of the material above mentioned, with some special shapes.

The furniture industry affords another important outlet, including bars and angles for metal beds, couches and springs, especially the numerous combination and folding types used in apartment buildings. Likewise metal school and office furniture, store fixtures, show cases, etc., take large quantities. Wagon and carriage builders are naturally among the heaviest consumers. Bars for sleigh shoes and runners and for toe caulk steel also come from rerolled sections. In a similar category are boat keels, angles and clamps. In the manufacture of narrow gauge cars and trucks, wheelbarrows, and other conveying or transfer equipment a rapidly growing use for the material is found. Apparatus for exercise and play, represented to the greatest extent by lawn swings, takes an appreciable quantity of bars and angles, with some minor specialties.

The production of builders' hardware offers a further field, and one fast being extended, for the utilization of rerolled steel, particularly the smaller shapes made from webs and flanges. Angles and bars for telegraph and telephone line material were called for early in this movement, followed by their application to electric power and railroad systems for transmission, feeder and trolley circuits, also as hangers for electric transformers and lightning arresters and as built-up poles or supports for various electric power equipment. Analogous to the last named is the use of bars and angles for power line towers or wind mill towers, where their service in withstanding the shock and strain of storms, vibration from the passage of heavy interurban cars, etc., has been notably good.

With the return of normal prosperity a factor in the situation will be the availability of this material in lots suited to the requirements of the average manufacturer, who is otherwise apt to be placed at a disadvantage compared with larger buyers or those more forehanded in placing orders. Mills rolling bars and angles from rail steel are generally in a position to make quicker shipments of short lengths and varied sizes than other plants, and they naturally have a greater interest in caring for this class of trade.

It is to be noted further that the extension of rerolled rail steel products into so many branches of manufacturing is a matter of congratulation to the entire metal field, because of the impulse it has given to all accessory lines, such as bolts, nuts and screws. Also, by maintaining the scrap value of old rails, it should add to the likelihood of replacements, and in this way exert an influence decidedly beneficial to the industry as a whole.

COAST TO COAST

Yorkton, Sask.—The C.N.R. will shortly open a 25-mile branch line between here and Wroxton.

Vancouver, B.C.—The Georgia Harris viaduct, completed a few months ago, has cost the city some $494,000.

West Vancouver, B.C.—The $40,000 dock, known as the Dundarave wharf, which has been under construction this summer, has been practically completed.

Edmonton, Alta.—The end of steel on the Alberta and Great Waterways Railway is now 140 miles from Edmonton, or a little over one-third of the way to Fort McMurray.

West Vancouver, B.C.—The municipal council has spent $175,000 this summer in the construction of roads and sidewalks. The North Shore Marine Drive cost about $100,000.

Quebec, Que.—There is a large amount of street paving under way in the city. The Quebec Paving Co., the Sicily Asphalt Co., and Madden & Son are the principal contractors.

Winnipeg, Man.—In connection with the carrying of the Shoal Lake Aqueduct under the Red River at Victoria Park, Messrs. Henderson and Snyder have been awarded the contract for the core drilling at a price amounting to $1,920.

Kenora, Ont.—The International Joint Commission has recently been in session at several points in this district in an endeavor to adjust and settle disputes arising between the two counties concerning the effect of variation of water levels upon the navigation of Lake of the Woods.

Chatham, N.B.—A new bridge is being constructed across Black Brook. It is a covered Howe truss span, 63 ft. long, between massive concrete abutments, with retaining wall approaches. Another highway bridge across Barnaby River has recently been completed. It is also a steel structure with concrete abutments, and with 300 ft. of approach fills.

Calgary, Alta.—Mr. C. D. Howe, chief engineer of the Dominion Grain Commission, has tested the new elevator at Calgary, and it is now in service. The elevator has a capacity of 2,500,000 bushels, can handle over 200 cars in a day of ten hours, and has three loading and three unloading tracks connecting with the C.P.R., C.N.R. and later on with the G.T.P.

Vancouver, B.C.—The Canadian Northern Railway were recently to have called for tenders for the False Creek sea wall in connection with the construction of their terminals in this city. The specifications, however, were found by the city engineer to be slightly unsatisfactory, and some delay has resulted. It is expected, however, that tenders will be called in a few days.

Montreal, Que.—The city is suing the Harbor Commissioners to the amount of $150,000 for the construction of a sewer, and $6,000 a year for its maintenance. It appears that wharves and piers built by the harbor authorities in 1834 caused stagnation, and a breakwater built in 1898 diverted the current of the St. Lawrence River, necessitating the construction of the sewer.

Ottawa, Ont.—The agitation for the Prescott highway, a 58-mile improved road to be constructed between Prescott and Ottawa, is still a matter of controversy. It is not likely that any constructional work will be done before next year. There is now another proposal, *viz.*, a 42-mile roadway connecting Ottawa with Morrisburg. The former, however, appears to be the more likely of the two.

Berlin, Ont.—The Grand River experienced an unprecedented rise during the storm of September 12th. According to Mr. W. H. Breithaupt, C.E., who took some observations at Bridgeport, on the outskirts of Berlin, during the storm the river rose 6 9/10 feet above summer level in 24 hours, with an increased flow of between 9,000 and 10,000 cubic feet per second and a velocity of 3 7/10 miles per hour.

Vancouver, B.C.—The prevention of a shortage of water supply is receiving the attention of the city waterworks department. Mr. F. L. Fellowes, the city engineer, is reporting upon conservation methods. The investigation arises from the application of North Vancouver for an extra 10,000 gallons a day, and is focused upon the question of a permanent and sufficient supply at the Capilano and Seymour Creek intakes.

Toronto, Ont.—It has been intimated by Hon. Findlay Macdiarmid, Minister of Public Works for Ontario, that the new provincial highways act may be shortly taken up by the government. It is likely, however, that in a majority of cases the question of creating new highway organizations with a view to entering upon county highway systems or other important highway work will be left to the new county councils to be elected next January.

Victoria, B.C.—Fine progress has been made this year on the tunnel sewers in the north-west section of the city. The general plan is a south-westerly route with an arm to West Bay. Concrete pipe, manufactured by Moore and Pethick, and the outfall at Macaulay Point is of steel, installed by the Burrard Engineering Co. and completed three months ago. The concrete pipe varies in diameter from 27 to 36 inches. The work has been carried out under the direction of Mr. C. H. Rust, city engineer.

Le Pas, Man.—Between here and Armstrong Lake, on the new Hudson Bay Railway, a weekly train has been placed in operation. This portion of the completed line is 210 miles in length, of which practically half has been ballasted. Track laying has reached the Nelson River and grading has been completed to within 50 miles of Fort Nelson. There are two large bridges to be built, one of which is now under construction at Armstrong Lake, and the other near Kettle Rapids on the Nelson River. Both are of the cantilever type.

Toronto, Ont.—A few weeks ago a steel twin-screw car ferry, Ontario No. 2, was launched at the yards of the Polson Iron Works, Limited, Toronto. The vessel will have a capacity of 30 loaded cars and 1,000 passengers, and will ply between Cobourg, Ontario, and Charlotte, N.Y. She is of the shelter deck type, 318 feet long and 54 feet beam, and is built with solid plate floors and extra heavy scantlings. She is equipped with transverse and longitudinal bulkheads and has a gross tonnage of 5,400. On her initial trip last week she carried 21 loaded cars.

Sudbury, Ont.—The Sudbury-Copper Cliff Suburban Electric Railway line is nearing completion, and the greater part of it will be in operation early next month. This project was outlined in *The Canadian Engineer* for July 23rd, 1914. The line is being laid with 80-pound T-rails on cedar ties at 20-inch centres. Tubular steel poles in the towns and wooden poles in the country carry a No. 0000 copper trolley-wire. The line operates on direct current at 600 volts. The power station is at Ramsay Lake, where a supply at 2,300 volts, 3-phase and 60 cycles, purchased from the Wahnapitae Power Company is converted to d.c. Tenders are now pending for the electrical equipment.

Vancouver, B.C.—The Burrard Inlet Tunnel and Bridge Co. held an annual meeting recently at which the company's business for the past year was reviewed. A description of the proposed bridge across the Second Narrows was given in *The Canadian Engineer* for August 20th, 1914, although a number of revisions have since been made to the plans, following the report of Mr. Ralph Modjeski on the three designs submitted. Delay in commencing construction has been largely of a financial nature, the Provincial Government and the District of North Vancouver being the chief causes of procrastination. The company's charter expires in April, 1916. The Dominion subsidy on the bridge is contingent upon its being completed by August, 1917.

PERSONAL

JAMES W. FITZGERALD has been appointed township engineer of North Monagan, Ont.

THOMAS SEFTON, formerly bridge inspector on the Intercolonial Railway, has been appointed government superintendent on the construction of the new Moncton bridge.

W. A. KINGSLAND has been appointed general superintendent of the Canadian Northern Quebec Railway with headquarters at Montreal, succeeding the late Mr. F. M. Spaidal.

J. W. LEONARD, formerly assistant to the president of the Canadian Pacific Railway, has been re-elected general manager of the Toronto Terminals Railway Co. at its recent annual meeting. All the other directors and officers were likewise re-elected.

W. G. ROSS, president of the Harbor Commission of Montreal, has been elected first vice-president of the American Association of Port Authorities. The next convention will be held in Montreal in September, 1916.

R. W. POPE, secretary of the American Institute of Electrical Engineers, was a guest at the September meeting of the Vancouver Branch of the Institute. He gave an interesting address on its growth since its inception in 1852.

G. T. HOLLAWAY, chairman of the Nickel Commission appointed by the Ontario Government last July, has been making a personal inspection of all the refining plants in the province. Mr. Hollaway, who is a noted British metallurgist and chemist, took up his official duties as chairman of the Commission last month.

R. H. MURRAY, who has for some years held the position of sanitary engineer of the Saskatchewan Bureau of Public Health, has received a commission in an English organization known as the London Sanitary, which has to do with sanitation problems in connection with our armies at the front.

WALTER F. WRIGHT, manager of motor sales, Canadian General Electric Co., Toronto, has resigned to accept a position as Ontario manager for the Eugene F. Phillips Electrical Works. Mr. Wright's headquarters will be in Toronto. He is a graduate in engineering of the University of Toronto, a member of the class of 1904.

OBITUARY.

A cable despatch relates to the death of Lieut. Morrow Alexander of the British Aerial Corps. Lieut. Alexander is the son of Prof. Alexander of the University of Toronto. Before enlisting with the Mississauga Horse he was employed by the Canadian General Electric Co. After training at Niagara, he attended the Wright Aviation School at Dayton, Ohio. The deceased was 23 years of age.

The death occurred in Vancouver on September 14th of Mr. H. B. Abbott at the age of 68. The deceased was the first general superintendent of the Vancouver division of the Canadian Pacific Railway.

AMERICAN ELECTRIC RAILWAY ASSOCIATION CONVENTION.

The 34th annual convention of the American Electric Railway Association, which will be held in San Francisco October 4 to 8, will be of unusual importance to the industry that it represents. The programme includes 22 addresses and papers, 80 reports of committees, and a number of written discussions. Many men distinguished in public life or by their achievements in the field of electric transportation will speak before the convention. The Engineering Association's committees on power distribution and way matters will present reports of unusual value. The report of the committee on heavy electric traction, and the joint report of the Engineering and Transportation and Traffic Associations' committee on block signals will be thorough and comprehensive.

One of the speakers, Mr. Bion J. Arnold will discuss "The Foundation Principles of the Valuation of Electric Railways." Mr. Arnold has been the chief consultant of executive, or both, in the building or direction of many great transportation lines. He was the chief engineer and chairman of the board of supervising engineers in the rebuilding of the Chicago traction system, and is still at the head of its directorate. He is consulting engineer of the Public Service Commission, First District, New York City, on matters connected with subways and street railway properties; consulting engineer, Detroit United Railway, and also holds a similar position with the cities of Pittsburg, Providence, Kansas City, Los Angeles and San Francisco.

COMING MEETINGS.

INTERNATIONAL ENGINEERING CONGRESS.—To be held in San Francisco, Cal., September 20th to 25th, 1915. Secretary, W. A. Catell, Foxcroft Building, San Francisco, Cal.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.—Annual convention to be held in San Francisco, Cal., October 4th to 8th, 1915. Secretary, E. B. Burritt, 29 West 39th Street, New York.

NATIONAL PAVING BRICK MANUFACTURERS' ASSOCIATION.—Annual convention to be held in Dayton, O., October 11th and 12th, 1915. Secretary, Will P. Blair, B. of L. E. Building, Cleveland, O.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—Annual convention to be held in Dayton, O., October 12th to 14th, 1915. Secretary, Charles Carroll Brown, 702 Wulsin Building, Indianapolis, Ind.