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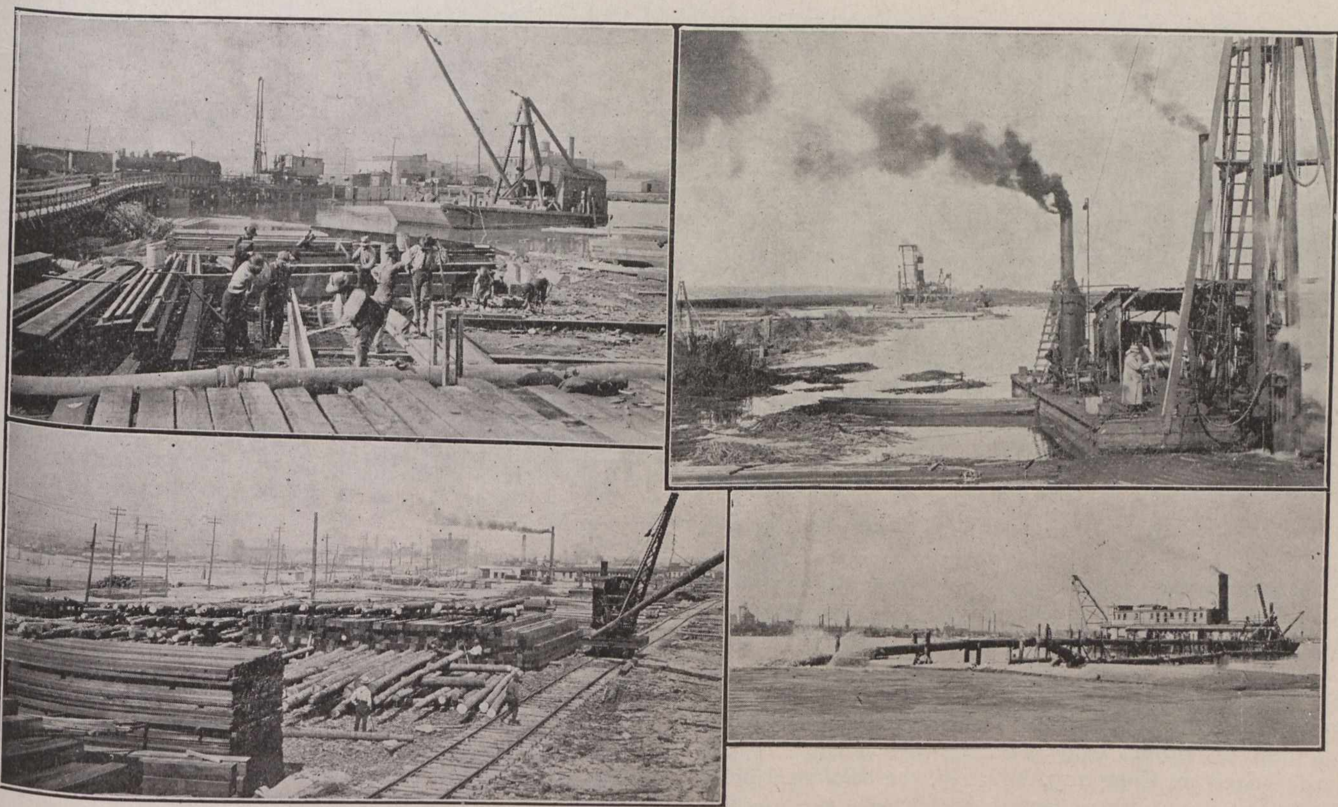
The Canadian Engineer

A weekly paper for engineers and engineering-contractors

TORONTO HARBOR AND WATERFRONT DEVELOPMENT

ENGINEERING FEATURES OF THE WORK AS OUTLINED IN THE 1913 REPORT OF THE TORONTO HARBOR COMMISSIONERS—SYNOPSIS ALSO OF 1914 ACTIVITIES.

THE report of the Toronto Harbor Commissioners covering the progress made during the year 1913 has just been issued. The general scheme of development was placed before our readers in *The Canadian Engineer* for November 21, 1912. A brief résumé of the project, the estimated cost of which was then stated to be $19,142,088, besides docks to cost five or six millions, is as follows: The construction of a modern harbor with a uniform depth of water capable of accommodating vessels up to 25 ft. draft; modern permanent docks on the central waterfront equipped with up-to-date freight sheds, warehouses and dock apparatus; large docks and industrial district at the foot of Cherry Street, with proper freight shed and warehouse equipment, etc.; a similar dock development at the foot of Bathurst Street, west of the central development; an industrial area of 1,000 acres east of Cherry Street, capable of accommodating factory buildings with a value of $30,000,000 and producing a ground rent revenue of $500,000 per year; a ship channel 6,800 ft. long, 400 ft. wide and 24 ft. deep with a turning basin 1,000 ft. square at its east end, serving the industrial district and the eastern portion of the city generally, and equipped with three miles of dockage; a dock area on the western face of this industrial division to provide an additional three miles of dockage; a new lake-front park, drive and waterway extending from the Eastern Channel to the foot of Woodbine Avenue and containing 352 acres, protected by a breakwater nearly four miles in length; a protected waterway 1¼ miles long, averaging 600 ft. in width, from Woodbine Avenue to the city limits on the east; 352 acres of additional park area on Toronto Island and new park areas from Bathurst Street to the Humber River to the extent of 190 acres and fronting on a protected waterway



Views of 1913 Activities. Preparing Sheet Piling for the North Slip Retaining Wall; Commencing the Construction of the Ship Channel; View of Pile Yard; Harbor Deepening and Reclamation Work.

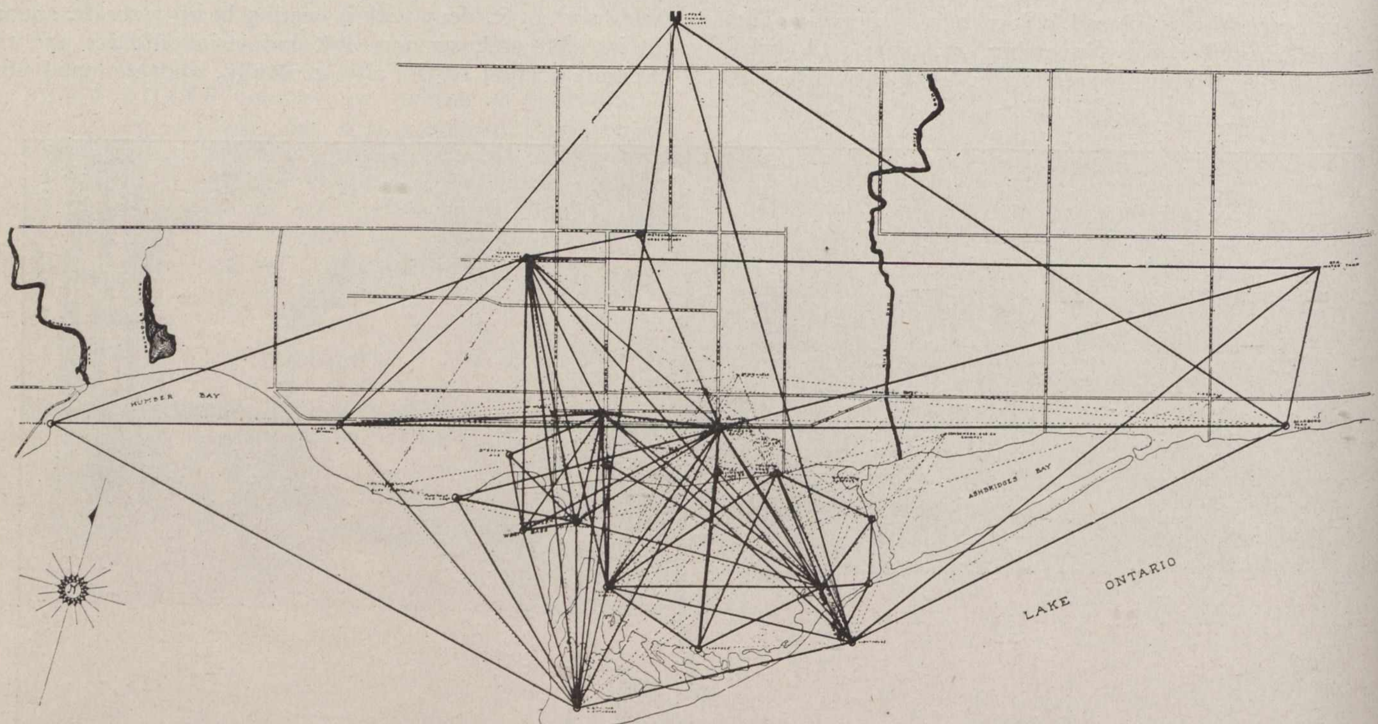
with a minimum width of 300 ft., separated from the lake by a breakwater; a bathing beach 1⅓ miles in length from Sunnyside to the Humber on a similar beach 4¼ miles in length from the Eastern Channel to Victoria Park; a boulevard system of driveways, etc., 11 miles in length across the waterfront; a protected waterway 12 miles in length with provision inside the breakwaters for equatic clubs; promenades, recreation piers, public playgrounds, etc., etc.

Preliminary plans were completed with the close of the year 1912. The general plans, providing for the development of the harbor and of the harbor industrial district, as well as for the general improvement of the outer waterfront and the construction of breakwaters for the purpose of protecting the waterfront east and west of the inner harbor were approved by the Toronto City Council and by the Federal Government in June, 1913. During the year substantial progress was made in the preparation of detailed working plans and a completion of arrangements for letting contracts and starting work. Dredging operations for the filling of the industrial district and the reclaiming of other lands were let by contract to the Canadian Stewart Company, Toronto, the minimum price being $3,950,000, with an option to increase the amount of dredging at the same unit price per cubic-yard up to a total of $6,320,000. A contract was also let by the Government to the same company for the construction of a breakwater extending from Woodbine Avenue to the Eastern Channel and another extending from the Western Channel to the Humber River, together with the construction and dredging of the ship channel in the industrial district, the total contract calling for an expenditure of $5,371,372.17. The Government also undertook the construction of lift bridges across the eastern and western entrances to the harbor and across the ship channel in the industrial district, but contracts for this portion of the work have not yet been let.

Another important event of 1913, which is more or less inter-connected with the progress of the harbor work, was the agreement between the city, the Harbor Commissioners and the various railways for the separation of railway and highway grades across the Toronto waterfront by means of a viaduct. On July 29, 1913, an agreement was finally executed and confirmed by the Board of Railway Commissioners for Canada. This agreement affected the Harbor Commission in the matter of property rights along the waterfront.

During 1913 the hydrographic and land surveys commenced in the previous year were completed with the exception of the detailed survey of Toronto Island. This latter work was held over for 1914. A very important undertaking of the Surveys Department consisted of a careful delineation of the amount of land owned by the Commissioners; *i.e.*, property surveys. For the most part, these lands are water lots with their northerly limit an old shore line whose exact position in most cases had never been thoroughly surveyed or tied in. This, combined with the fact that very few lines could be ranged or chained, being mostly over water or marsh, but that all the field work had to be done by offsets or by traverse, engendered a multiplicity of calculation with an attending greatly increased chance of error, made the progress of the work somewhat slow. Permanent monuments were placed to define the ground limits of the Commission. These monuments consist of 3-inch iron pipe filled with concrete, in the top of which is embedded a 5-inch hexagonal plate bearing a serial number and the name "Toronto Harbor Commissioners." The pipes range from 18 feet long in marsh to 3 feet in length where bolted to bare rock. In general, the tops are level with the grade adopted for the waterfront improvements.

During the year, also, a valuable series of water tables and fluctuations of Lake Ontario since 1853 was compiled, as a result of which the elevation of the zero of the Harbor Commissioner's gauge was found to be 245 ft. above mean sea level of New York. The determination of this elevation was followed by the placing of a comprehensive set of levels and bench marks across the



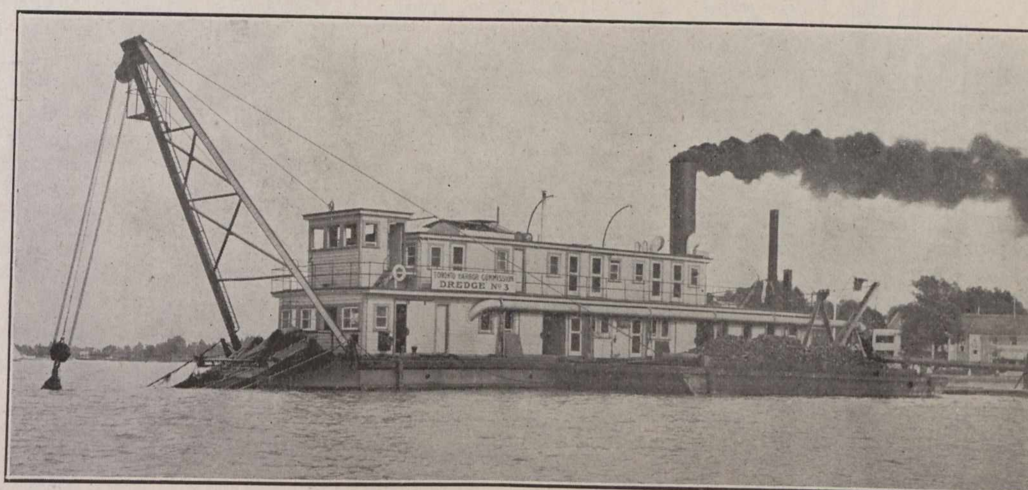
Triangle Net of Main Triangulation.

waterfront. During 1912 the Surveys Department had been seriously handicapped by the extreme lack all along the waterfront of bench marks referred to any single datum. The Department of Works of the city had under way at that time the establishment of bench marks throughout the city, but the number they proposed to establish in the region of the proposed work was insufficient. So, early in 1913, the Surveys Department of the Commission set about to establish bench marks that would be readily available when needed during the development of the waterfront. Sea level at New York Harbor was adopted for the datum, the plane of reference being, as stated, found to be 245.00 feet above such datum.

The method of field work did not involve the methods of precise levelling as used in connection with primary geodetic surveys, but only one of sufficient precision as to render the levels more than adequately accurate for any engineering work which might require them. An engineer's Wye level and a self-reading Chesterman rod were used, great care being taken to equalize the back and foresights. For this purpose, as well as to determine more exactly the rod reading, the reading of all three cross wires were taken. Benches were set about one-quarter of a mile apart and four lines of levels, forward and back and forward and back, run the same day and under the same conditions between consecutive benches, different turning, and set-up points being chosen in every instance. The arithmetic mean of these four differences of elevation was taken as the true instrumental difference in elevation between benches.

At 7 p.m. on Wednesday, July 9th, 1913, an evening of absolute calm, the whole Survey's staff were strung out along the entire waterfront from the Humber to Balmy Beach in thirteen locations and exactly at that hour nails were driven into convenient piles or cribs at the exact level of the water. The water lay dead calm, and there was no hesitation in assuming it a level plane. The elevations of these nails were subsequently tied each by four lines of levels to the nearest benches—in no case more than four hundred feet away—including a connection to the initial bench of the level net. On the assumption that while any two adjacent nails might have a difference of elevation, of such as much as 0.03 of a foot (the maximum sum of the personal errors of the two observers probable), yet this difference in elevation could not be exceeded though the observers were stationed at the extreme limit of the waterfront 10 miles apart. In other words, no adjustment was made to the instrumental elevations on the authority of a single water transfer, but only on the evidence of three or four in series. The level net was closed on the city bench marks. No weight was given to the elevations attached to these bench marks in the adjustment of the net, but on the completion of the adjustment, the elevation found for them by this department differed in no case more than a few hundredths of a foot for the elevation obtained for them by the Department of Works.

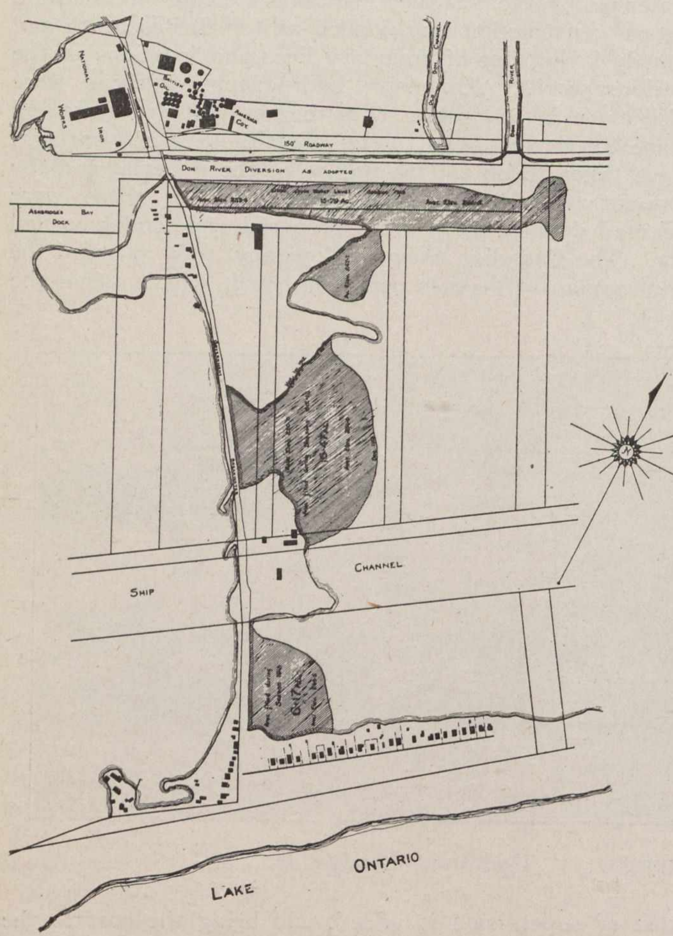
An extensive precise triangulation was proceeded with and completed in December, affording a means of measurement with the transit or sextant of the angles between any three prominent points on the skyline of the city to determine the absolute position of any point. All angles were read 12 times around the circle, bringing the resultant measured angle within a probable exactitude of at least 2 seconds of arc in the harbor. A comprehensive survey was also made locating all intake pipes, sewer outfalls, drains and conduits along the entire waterfront; and another of the northwestern portion of the industrial district showing all existing structures, power lines, water mains, etc. Survey work was executed to facilitate future construction work, such as for the accurate and speedy laying out of boundary lines and locations of the various works. Extensive hydrographic surveys were also made in connection with the contract dredging and some 8,000 soundings, together with over 200 borings, were taken to obtain the nature of the material and the amount available at various depths. After these were effected detailed plans were prepared and tenders called for. The Canadian Stewart Company was awarded the contract at 19¾ cents per cubic yard, which, when the cost of supervision is added, will bring the cost to the Commissioners to practically 22 cents per cubic yard. The preliminary estimate of the engineering department averaged 21.99 cents per cubic yard.



Harbor Commissioners' Hydraulic Dredge No. 3.

The construction department, in addition to general maintenance of all waterfront properties of the Commission, carried out the supervision of the construction of the Ashbridge's Bay docks, the sea wall from Dufferin Street westerly, the trestle across Keating's Channel to carry temporary tracks into the industrial district, the foundations of the Parkdale Canoe Club's new club house, the dredging of Point Anne Quarry slip and the complete supervision of the dredging equipment of the Commissioners. During the year Dredge No. 1 reclaimed for the city some 3.23 acres south of Hanlan's Point. Dredges Nos. 2 and 3 reclaimed to an average elevation of 250, 16.47 acres; to an average elevation of 249.5, 6.1 acres; to an average elevation of 248.5, 15.79 acres, or a total of practically 40 acres, in the industrial district.

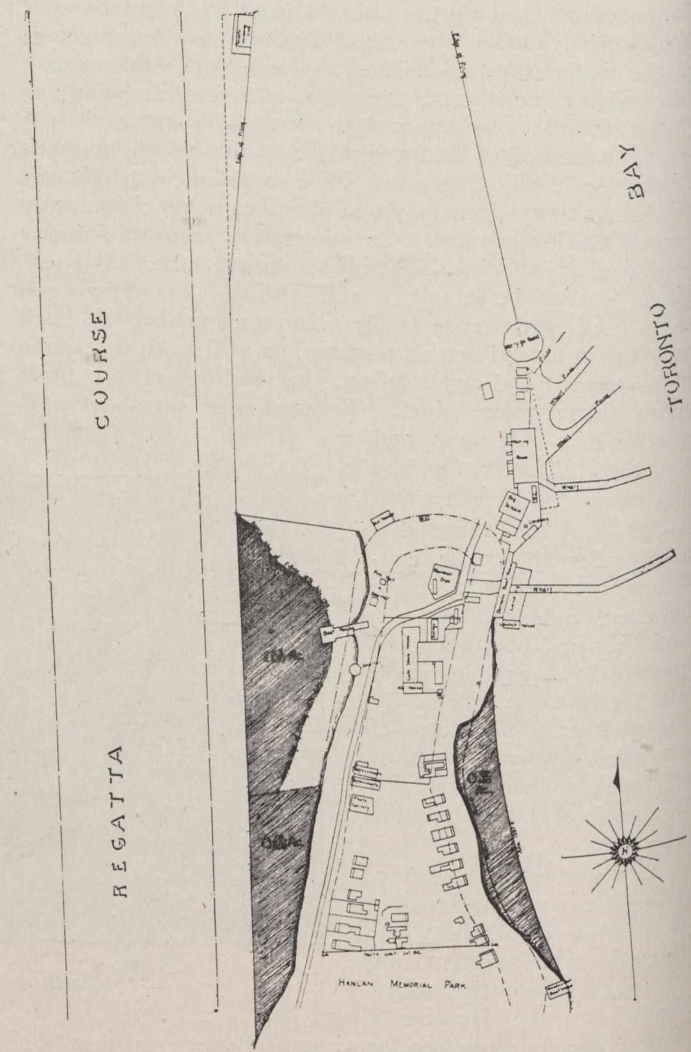
The main work of the designing department consisted of details and final studies in connection with the construction of the government portion of the work; *i.e.*, the eastern and western sea walls, the ship channel, the marginal area, and the northern slip. In addition, detailed studies were made of the various types of bridges to ascertain those best suited for use over the channels. Over $6,000,000 worth of work was designed by the department for 1913, for which over 5½ million dollars worth of work was let before the end of the year. Detailed plans, specifications and estimates were prepared in connection with the work to be undertaken by the Government, and by the Commissioners, for over $11,000,000 worth of work, of which over $9,000,000 worth was contracted for before the end of the year. The entire scheme is being carried out under the direction of the Toronto Harbor Commission, consisting of L. H. Clarke, Chairman; R. S. Gourlay, T. L. Church, R. Home Smith and F. S. Spence. The Commission holds a Dominion charter with extensive powers in the development and management of the waterfront and harbor. To it the city has deeded its waterfront holdings (85% of the entire frontage) and its right to the marshy sections that are being filled in. Mr. E. L. Cousins is chief engineer to the Commission. His assistant engineers include Mr. J. R. Wainwright, in charge of designing and Mr. N. D. Wilson in charge of surveys. Mr. A. C. Mitchell is superintendent of construction. The consulting engineer of the Commission is Mr. J. G. Sing, Toronto.



Property Reclaimed in Eastern Section by the Harbor Commission During 1913.

While the foregoing notes relate to 1913 operations only, as outlined in the annual report, it will be of interest to observe that during the present year the engineering department of the Commission has been very actively engaged in the furtherance of the work. The foundations for the new building for the Parkdale Canoe Club have been completed. The previous building was burned in February, 1913. Its location was directly in line with the improvements planned by the Commission, and the negotiations between the two organizations included the erection of foundations, by the Commission, on a different site.

The construction of the Don River diversion, a contract amounting to $171,000, and being executed departmentally, will be finished by November 1st of this year. The Commission's dredges have all been actively engaged in reclamation work throughout the harbor during the entire season. The dredge "Shuniah," of the Canadian Stewart Company, has been similarly engaged in reclamation work since July. It is expected that the "Cyclone," one of the new 24-in. dredges being built by the Polson Iron Works for this company, and nearing completion, will commence work late this fall. Its sister dredge, "Tornado," will be completed this winter and ready for operations in the spring.



Reclamation Work During 1913 at Hanlan's Point, by the Commissioner's Hydraulic Dredges.

A length of about 1,600 ft. of the western breakwater extending from the Humber River westward, one of the Government contracts, is already in place. About 8,000 ft. of dock-work is under construction, belonging to a Government contract on the eastern section of the bay. This is in connection with work on the marginal way and ship channel, and on which considerable progress has been made.

ROAD SURFACING COSTS IN NIAGARA FALLS PARK.

SOME interesting cost data was gathered by Mr. John H. Jackson, Superintendent of Queen Victoria Niagara Falls Park, in connection with a five-mile stretch of macadamizing between Chippawa and Bridgeburg, Ont. This work was included in the 1913 parking program of the Commissioners. The following figures are from the 28th annual report, just published.

Part of the mileage under consideration required a light resurfacing, and another portion required the entire reconstruction of the top courses. For these two operations the following figures will show in detail the amounts that were spent per square yard:

The Light Resurfacing Water Bound Macadam Roadway.

Time—August 5th, 1913, to October 21st, 1913.
Location—Boulevard roadway from Slater's Dock, south.
Average length of haul—3.4 miles from M.C.R. siding, Chippawa.
Area treated—Length 14,625 ft. = 2.77 miles; width 18 ft. = 29,250 square yards.

Labor:	Total.	Per sq. yd.
Loading 2-in. stone and screenings	$ 232.56	8 cts.
Hauling	442.95	1.51
Pumping and watering	45.29	.15
Repairing roadway	275.18	.94
Rolling and spiking	97.29	.33
	$1,093.27	3.37 cts.
Material:		
2-in. stone—205.5 tons at $1.25	$ 256.88	.88 cts.
Screenings—150.2 tons at $1.00	150.20	.51
	$ 407.08	1.39 cts.
Summary:		
Labor	$1,093.27	3.73 cts.
Materials	407.08	1.39
	$1,500.35	5.12 cts.

Remarks:
297 cubic yards of stone and screenings were placed on 29,250 square yards.
1 cubic yard of stone and screenings was placed on 98.5 square yards.
Ratio of 2-in. stone to screenings used—1 to .731.
Ton-mile cost of hauling materials—36.2 cts.

Wage Rates:	
Teams	55c. per hour
Laborers	22c. "
Foremen	30c. "
Cost per mile	$540.00

The Heavy Resurfacing Water Bound Macadam Roadway.

Time—August 1st, 1913, to December 15th, 1913.
Location—Boulevard roadway, from Black Creek, north.
Average length of haul—1.98 miles from Black Creek siding.
Area treated—Length 14,467 ft. = 2.74 miles; width 18 ft. = 28,934 square yards.

Labor:	Total.	Per sq. yd.
Loading 2 in. stone and screenings	$ 521.00	1.8 cts.
Hauling	1,509.00	5.2
Pumping and watering	215.00	.8
Repairing roadway	547.00	1.9
Rolling and spiking	425.00	1.5
	$3,217.00	11.2 cts.
Material:		
2-in. stone—750 tons at $1.10	$ 825.00	2.9 cts.
Screenings—324½ tons at $1.10	357.00	1.2
	$1,182.00	4.1 cts.
Summary:		
Labor	$3,217.00	11.2 cts.
Materials	1,182.00	4.1
	$4,399.00	15.3 cts.

Remarks:
895.4 cubic yards of stone and screenings were placed on 28,934 square yards.
1 cubic yard of stone and screenings was placed on 32.3 square yards.
Ratio of 2-in. stone to screenings used—1 to .433.
Ton-mile cost of loading and hauling materials—32.3 cts.

Wage Rates:	
Teams	45c. per hour
Laborers	20c. "
Foremen	30c. "
Cost per mile	$1,600.00

At Queen Victoria Park rates for teams, .55c., and men .22c., the above ton-mile cost would be 38.4c.

In connection with the scarifying and re-crowning of this section of roadway a bituminous top was laid on a 2¾-mile length, and the following figures show the cost of different operations in connection therewith:

Tarvia "A" and ½-inch Stone Surfacing.

Time—September 2nd to October 16th, 1913.
Location—Boulevard roadway, vicinity of Usher's Creek.
Length of haul—3.4 miles.
Area treated—Length 14,625 ft. = 2.77 miles; width 18 ft. — 0 in. = 263,250 square feet = 29,250 square yards.
Depth—½ inch.

Labor Cost:	Total.	Per sq. yd.
Loading, hauling and placing stone	$ 861.05	2.90 cts.
Loading, hauling and placing tarvia	353.71	1.19
Placing and removing plant	56.50	.19
	$1,271.24	4.28 cts.
Material Cost:		
½-in. stone—487.5 tons at $1.30	$ 633.75	2.14 cts.
Tarvia "A"—14,307 gallons at 10c.	1,430.70	5.58
Freight, $188.35; demurrage, $32	220.35	
Soft coal for heating and operating roller	88.90	.30
	$2,373.70	8.02 cts.
Summary:		
Labor	$1,271.24	4.28 cts.
Materials	2,373.70	8.02
	$3,644.94	12.30 cts.

2.77 miles cost	$3,644.94
1 mile cost	1,300.00
1 square yard cost	12.30

This was a carpet treatment undertaken with refined tar, known as Tarvia "A." The material was shipped in tank cars to the nearest railway siding, and heated by means of a steam boiler to a temperature of 100° F. when it was forced by steam pressure into the distributing apparatus, and then hauled to the site of the work where it was attached to the steam roller. Connection was here made with the boiler and the material further heated to a temperature of between 175° and 200° F. Steam pressure at thirty-five pounds was then applied to spray it on to the road surface. The apparatus used is supplied at the rear with nozzles so constructed that upon the application of pressure the hot material is forced to the surface of the road in a fine spray. The heated tar penetrates the top surface, and the remainder is then absorbed by means of one-half inch stone chips in the proportion of one cubic yard over about sixty-five square yards of surface giving a depth of stone and tar equal to a little over one-half inch. The quantity of bituminous material for this treatment was one-half gallon to the square yard, and as indicated the total cost including labor was 12.3c. per square yard, or about $1,300 per mile for an eighteen-foot roadway. It is estimated that the only cost of upkeep to this surface will be an annual tar spraying of about one-eighth of a gallon per square yard at a cost of between three and four cents per square yard, or about $320 per mile for an eighteen-foot roadway.

In comparison with the heavy water bound macadam resurfacing it is interesting to note the details of figures for extra heavy resurfacing with a chemical binder. The following figures show the details of cost for a Rocmac resurfacing upon the main driveway of the park where the road metal was four inches:

Rocmac Resurfacing at Rambler's Rest.

Time—May, 1913.
Location—Main driveway, opposite Rambler's Rest loop.
Length of haul—3,400 ft. = .644 mile, (from Victoria Park siding).
Area treated—Length 370 ft.; width 21 ft. = 7,760 square feet = 863 square yards.
Depth removed—4 inches.
Material removed—370 ft. x 21 ft. x 4 in. = 2,590 cubic feet = 96 cubic yards (in place).

Labor Cost:	Total.	Per sq. yd.
Removing old surface (96 cu. yds.)	$ 97.20	11.26 cts.
Hauling 144 cu. yds. of stone and screenings from Victoria Park Station	119.08	13.80
Rolling	28.00	3.25
Resurfacing	63.16	7.31
Foreman	60.20	6.97
	$367.64	42.59 cts.

Material Cost:	Total.	Per sq. yd.
2-in. stone, 114 cubic yards—136.8 tons at $1.25	$171.00	19.82 cts.
Screenings, 30 cubic yards—36 tons at $1.00	36.00	4.17
Rocmac solution, 374 gallons at 45c.	168.30	19.50
	$375.30	43.49 cts.

Summary:	Total.	Per sq. yd.
Labor	$367.64	42.59 cts.
Material	375.30	43.49
	$742.94	86.08 cts.

The American Society for Testing Materials has added to its specifications for reinforcing steel rolled from billets, an intermediate grade between the structural and hard grades. This new grade is to have a yield point of 40,000 lbs., and an ultimate tensile strength of from 70,000 to 85,000 lbs.

INSTALLATION OF TRANSFORMERS FOR TORONTO POWER COMPANY.

An installation of considerable inportance has been made recently by the Toronto Power Company in the way of six kv.a, single-phase transformers at the Niagara Falls step-up station, and six 5,500 kv.a. similar single-phase units at the Toronto terminal station of the company. This installation is of special interest in view of the fact that the new transformers were especially designed and constructed to fit the existing transformer pockets which were laid out originally for lower voltage units of less than half the present capacity. The original transformers were single-phase, water-cooled units designed for 2,670 kv.a., 60,000 volts, at the generating station and for 2,400 kv.a., 55,000 volts at the terminal station. These transformers were of the familiar oval type. The new transformers are single-phase, water-cooled units of 6,000 kv.a. unit capacity at the Niagara station, designed for 86,500 volts, and similar units of 5,500 kv.a. each at the Toronto terminal station, designed for 76,100 volts.

They were built by the Canadian General Electric Company at its Peterborough factory and are assembled in square or slightly rectangular boiler plate tanks, having all seams oxy-acetylene welded. The flat sides of the tanks are braced by "T" iron straps for mechanical stability. The transformer tanks were required to stand a 26-inch vacuum test at the factory before acceptance. The usual heavy castings have been replaced in this design by channel core plates riveted together in pairs. A space is left between the channels which is arranged to come directly over a vertical duct in the iron, allowing a free circulation of oil up through the centre of the iron. These features and others which it is understood have been adopted as standard by the manufacturers of these transformers account for the remarkable increase in capacity per unit space over the original transformers in the same stations. The same factors are reflected in the gradual tendency toward smaller dimensions and lighter weights in power transformers making use of rolled steel instead of heavy castings.

STEEL RAILROAD TIES.

Steel railroad ties are being extensively used in Switzerland. At present 65 per cent. of the Federal Railways employ them. They have the form or profile of a trough into which shape they are rolled at the mills. The ends are bent down, the profile of the trough being thus closed. Holes are provided for the attachment of the rails by means of clamp plates and no tieplates are used under the rails. The weight of the trough profile is 55.47 lbs. per meter and the ties complete, with holes bored, weigh 159.84 lbs. each. According to the requirements of the Federal Railways the steel in these ties must have a tensile strength of about 59,000 to 64,000 lbs. per square inch and an entire trough piece shall admit of being bent together on its back without showing any breaking fissures.

The Gun-crete Company, of Chicago, informs us that, taking effect September 1st, 1914, they have purchased all the rights, titles, contracts and interests of the Cement-Gun Construction Company, and have also taken over the construction department of the General Cement-Gun Company. In future, the combined business will be conducted under the firm name of Cement-Gun Construction Company, with offices at 914 So. Michigan Avenue. The officers of the company are Carl Webber, C.E., president; John V. Schaefer, M.E., secretary and treasurer; C. L. Dewey, construction manager.

LOCK GATE LIFTER FOR TRENT CANAL.

THE accompanying illustrations show the steel pontoon dock that was recently built for the Department of Railways and Canals for service on the Trent Canal, by M. Beatty and Sons, Limited, of Welland. It was designed and built to lift and place into position the lock gates, and its capacity of 50 tons and clearance of 37 feet above the dock will enable it to step

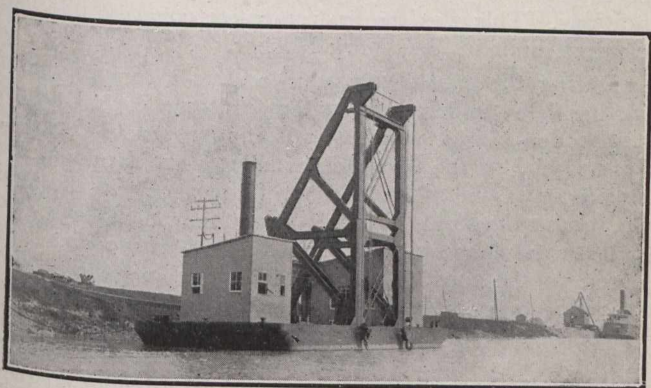


Fig. 1.—The Gate Lifter Just After Completion, Showing the Top of Derrick Raised.

any of the mitred gates throughout the entire length of the Trent Canal. The general design comprises a structural steel collapsible derrick mounted on a steel pontoon, with separate steam engines for each operation.

The pontoon supporting the derrick is made of steel plating with extra strong steel frame work, there being two longitudinal and three transverse trusses, so as to provide for the severe loads it will have to bear. The hull is constructed with rounded bilges and each end has a rake of 45 degrees. The length is 55 feet, beam 27½ feet, depth 9 feet.

The derrick is built of structural steel in two units. When in working position, the derrick is erect, as shown

Fig. 2.—Gate Lifter with Top of Derrick Lowered for Passing Under Overhead Bridges.

in Fig. 1. In transporting the lifter from one lock to another, the upper part of derrick is lowered where necessary, as per Fig. 2, which allows of its passage under overhead bridges along the canal. The operation of raising and lowering the derrick is performed by a 6 x 6-in. double cylinder engine mounted on one of the back legs. Two swivel hook padlocks are suspended, one from each overhanging top of front legs of derrick, each carrying 8 parts of ⅞-in. steel cable. The main engine has 9 x 9-in. double cylinders, double drums and is link reverse. The operating levers are brought to one position for the convenience of the engineer.

The pontoon is kept on an even keel by two movable ballast cars under deck. Each car is moved by a steel screw operated by independent 6 x 6-in. reversing engine. These engines are controlled by pendulum governors, automatically shifting the ballast to the proper position to put the pontoon on an even keel, whether it is under load or light, with the derrick upright or folded. In addition to the automatic control, the ballast car engines can be operated from the engine room above deck. Dial indicators are provided to show the position of the ballast cars at all times.

The machine has stepped to date the gates for Locks No. 1, 2, 3, 4, 5 and 6 of the Ontario-Rice Lake division of the Trent Canal and in operation has met all expectations. The total time for stepping each leaf from picking up in water to releasing in gate recess varied from twenty to forty minutes, according as an upper or lower gate

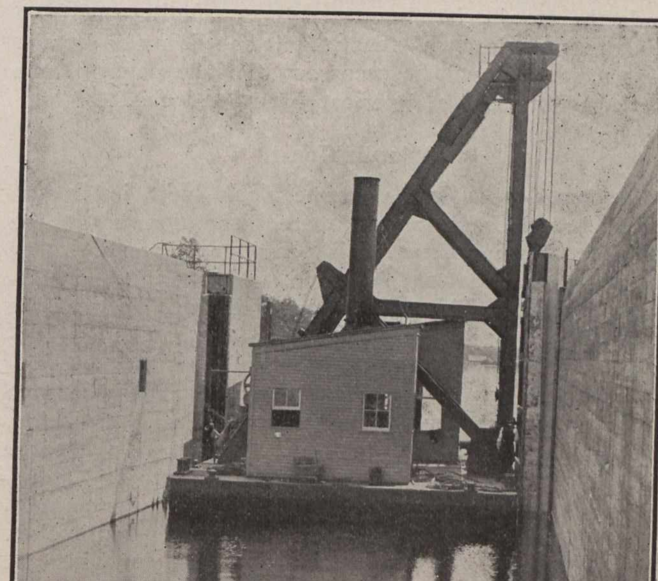


Fig. 3.—Gate Lifter Placing a Leaf in the Gate Recess of Lock No. 4, Rice Lake Division, Trent Canal.

leaf was handled respectively. At Lock No. 3 the lower gates are 37 feet high over timbers and these represent the heaviest gates the lifter is designed to handle. A view is shown in Fig. 3 of the gate lifter in the operation of stepping a gate.

SLAG IN RAILWAY BALLAST.

Slag is very largely used as railway ballast in the district of Lorraine, Germany. About 250 miles, or two-thirds of the total mileage, are ballasted more or less completely with that material. It is used chiefly on roads that have been constructed or reballasted in recent years and especially on the roads over which traffic is heavy. On smaller, less used lines where the traffic is light, gravel or whatever suitable material is at hand, is used. Slag costs about 14½ cents per cu. yd. at the furnace. It is regarded as economical ballast within a radius of 15 to 30 miles, but cannot compete with rock at a greater distance than that on account of the cost of transportation, except, of course, in places where no suitable rock ballast is to be found. It is said that the slag is far superior to gravel as ballast and that it is equal to the best variety of rock.

REINFORCED CONCRETE DOCKS IN NORTH AMERICA.

IN *The Canadian Engineer* for August 27th, 1914, an article appears dealing with the application in England of reinforced concrete to dock construction. The following article supplements the former by outlining the extent of similar construction in North America, with special reference to such works in the United States. We are indebted to the same source for this information, viz., a paper by Harrison S. Taft, read before the American Society of Civil Engineers on May 20, 1914, which paper reviews the reinforced concrete dock construction of the world.

In recording what has been accomplished in the construction of reinforced concrete docks in North America, including Porto Rico, Cuba, the Canal Zone, and Canada, such undertakings are so few and of such recent date, compared with those in European countries, that the art of building reinforced concrete docks there may be said to be hardly beyond its infancy, especially as regards out-and-out docks or piers, as the American usually understands the word, viz., long structures running out from the shore in such a way that vessels can lie on each side. Unfortunately, it will be necessary to make note of some failures among North American concrete docks.

Atlantic Coast.

Boston.—The first concrete dock built in Boston Harbor has perhaps caused more discussion as to the feasibility of using concrete in sea water than any other American structure of this type, and, therefore, is far-famed in itself. This dock, or pier, was built at the Charleston Navy Yard about 14 years ago. The first section, consisting of a long, straight wall, was built in 1899-1900, without any resort to a cofferdam. The other two sections, consisting of plain reinforced arches, 20 ft. wide, with spandrel walls, were constructed in 1901, the space between the two walls being filled with earth and stone. The first section was built of 1:2:3 concrete throughout, and it was all placed in the wet, with an open-top bucket. The second and third sections were of different mixtures, the main body being of 1:3:6 concrete, the outer 2 ft. consisting of a 1:2:4 mixture, and the whole exposed surface was faced with 3 in. of 1:1 mortar. In these two sections the concrete was placed very dry, as was the practise at that time.

During 1913 one of the Boston public docks, Pier No. 5, was partly rebuilt in concrete. This dock consisted of a timber platform deck, 50 ft. wide and 1,150 ft. long, on each side of a solid earth fill. The new wooden piles needed were driven, and all the piles, new and old, were cut off at mean high water and capped with a deep reinforced concrete beam running athwart the piles, in the way of curtain-walls. These curtain-walls support two longitudinal reinforced concrete beams, the third or inner beam resting on the earth retaining wall. There are also two additional concrete beams under the track along the outer face of the dock, with special supporting piles. On top of the curtain-wall and longitudinal girders is laid a reinforced concrete floor-slab with a 2-in. bitulithic top. Wooden longitudinal tie members are run from top of pile to top of pile under the concrete curtain-walls, the whole timber structure being well braced with piles and wooden ties. To provide against accident from disintegration of the lower part of the curtain-walls, due to frost action or other cause, cast-iron columns, 30 in. long, are attached to the top of the piles and made integral with the curtain-walls, thus guarding against weakness in the concrete, rather than in the piles, as done in other harbors.

New York Harbor and New Jersey Coast.—A reinforced concrete dock of an experimental nature was constructed at Ellis Island, New York Harbor, in 1911. It is a rather small structure, 30 ft. wide and 50 ft. long, resting on thirty-six driven concrete piles 18 in. square. The piles were made of different mixtures, for experiment purposes, and various kinds of waterproofing were used in order to determine their efficiency under the same conditions. This was the first complete concrete pile and deck dock built in New York Harbor.

During the past seven years a semi-concrete type of dock has been under development in New York Harbor, viz., wooden piling, wooden caps, and concrete decking. In one dock, on the New Jersey side of the Hudson, the caps on top of the piles are also of concrete. In the final type, as worked out by the Department of Docks and Ferries,* the concrete slab rests directly on wooden caps secured to the tops of the wooden piles, a genuine flat slab between bents, the entire timber floor system being wholly eliminated. At present some 25 or 30 semi-concrete docks have been built on this system in New York Harbor. It has been stated authoritatively that they have proved a great success.

In building two semi-concrete docks at the Brooklyn Navy Yard a few years ago, the objectionable features of docks of the foregoing type—viz., part of the wooden pilings and bracing exposed to wet and dry conditions between low water and the decking, and the wooden cap as an additional temporary item helping to support a permanent structure—were eliminated. In the two Navy Yard docks the wooden piles were cut off a little above low water and capped with a wooden grillage. Pre-moulded concrete columns, mixed with waterproofing compounds, were set on and dovetailed into the caps, and a concrete girder-beam and deck-slab system was worked over the tops of the columns. The wearing surface consists of a creosoted wooden block pavement. Down each side of the dock there is a standard-gauge railroad.

A small concrete dock was constructed at Glen Cove as a yacht-landing, in the winter of 1909-10. It consists of eight reinforced concrete rock-filled caissons, supporting an overhead footbridge, the total length of the pier being about 330 ft.

Long Branch.—At Long Branch a Hennebique type of concrete pile dock was constructed in 1911, running some 848 ft. out into the Atlantic Ocean, as a boat landing and recreation pier. At present the pier is only 75 ft. wide, except for an 80-ft. length at its outer end, where its width is 150 ft., the intention being to make the whole pier of that width at some future time. The deck is 22 ft. above low water. The piles are 16 ft. from centre to centre longitudinally, but 20 ft. from centre to centre across the pier, except the outer two rows, which are 15 ft. from centre to centre. Most of the piles are of hollow cross-section, 22 in. external diameter, 13 in. internal diameter; the penetration was about 22 ft. To provide sufficient impermeability, the shells of the piles were made of 1:1½:3 concrete, the fill being of a weaker mixture. Apparently, no cross-bracing system was used, the outer end of the pier being stiffened laterally by inclined bracing piles at regular intervals.

Atlantic City.—At Atlantic City the famous steel pier was widened and protected in 1906 by the use of concrete. The original pier was founded on steel-pipe piles resting

*Transactions, Am. Soc. C.E., Vol. LXXVII., p. 503.

on cast-iron disks, a type of construction quite common during the last part of the 19th century. The pier extends out into the Atlantic Ocean a total length of 1,600 ft. In rebuilding the pier all the original metal work was encased in concrete and the pier was widened on both sides, 12-in. and 25-in. reinforced concrete piles, with enlarged footings, being used. The smaller piles were pre-moulded vertically, on a small platform, each pile at its final location. After hardening sufficiently they were lifted off their platform and jetted into place through from 8 to 14 ft. of sand. The larger piles were given a penetration of 16 ft. The lower 12 ft. of these piles were pre-moulded on a platform, a water-tight iron casing was secured to the upper end, and the whole was jetted into place. The dry caisson was then filled with concrete up to the proper level, the maximum total length of the 25-in. piles being 52 ft. In protecting the original piles, concrete shells were cast around them, with sufficient interior clearance, and the space was afterward filled with grout.

After the concrete work of this structure had been in the sea water for 6 months, the piles became coated with a sort of gelatinous matter which seemed to act as a most excellent protective coating against any deterioration. The same peculiar action has also been noticed in California.

Although not exactly a dock, it is of interest to note the concrete pile Boardwalk at Atlantic City. Not only is it necessary to guard against dry and wet conditions at such resorts, but the fine sands act like a sand-blast when driven like snow before the wind. In 1908 part of the old wooden structure was rebuilt with 16-in. concrete piles, supporting a concrete cap, and that in turn carried the wooden decking.

Baltimore.—It is perhaps at Baltimore that the most extensive reinforced concrete docks on the Atlantic seaboard have been built. Although the water in Baltimore Harbor may not have the same density of salt as in ports nearer the sea, these docks, thus far, have shown no sign of deterioration, though at times subject to frost action. Three of these piers are of a back-filled concrete bulkhead type, and are not docks resting on piles. Pier No. 4 is 978 ft. long and 220 ft. wide; Pier No. 5 is 1,245 ft. long and 200 ft. wide at the shore end, but 243 ft. wide at the water end; Pier No. 6 is 1,456 ft. long and 93 ft. wide at the shore end, but 212 ft. wide at the water end; all were built in 1908.

In general, these three docks consist of a series of oval-shaped concrete cylinders 25 ft. apart along the face of the docks, and sunk to about 25 ft. below low water. Along the face of the cylinders, and just above high water, there is a concrete-encased iron girder, tied back to a deadman some 28 ft. in the rear of each cylinder. A row of concrete sheet-piling was driven back of the girders to form a vertical retaining wall, the upper ends of the sheet-piling bearing against the girder, and the lower ends being driven into the muddy bottom. A horizontal box-girder encased in concrete runs along the upper face of the dock, supporting the outer edge of the concrete curb slab, on which are laid the paving blocks. The cylinders are tied together in certain cases by ties extending entirely across the docks. The face of each dock is protected by wooden fender-piles, 8 ft. apart. Another concrete dock has been completed recently in Baltimore by the Harbor Commission, the details of which are lacking. In the same harbor is found a concrete bulkhead dock, built for a private corporation—a reinforced concrete sheet-piling structure capped with a concrete girder tied back to deadmen by reinforced concrete ties.

At Sparrows Point, near Baltimore, a reinforced concrete ore dock, 600 ft. long, was built in 1911. It consists of two parallel concrete walls, about 46 ft. apart, viz., (1) a sheet-pile bulkhead on the water-front capped by heavy concrete girders with a cantilevered shelf, as it were, on the outer face, running the full length of the bulkhead; (2) a heavy retaining wall in the rear, the two walls being tied together by reinforced concrete ties about 30 ft. apart. The back wall, resting on wooden piles, not only acts as a deadman for the outer wall, but affords a means for carrying one track of the large, heavy, ore unloading crane that straddles the filled-in space between the two walls, the front track of the crane running along the outer wall. The dock face is protected by a substantial system of fender-piles and wales with heavy helical car-springs at each buttress of the face wall.

Norfolk.—In constructing the Virginian Railway Coaling Terminal, at Sewells Point, in 1907, it was not practical to carry the massive steel superstructure on creosoted piles. In place thereof groups of wooden piles were driven and cut off 1 ft. below the mud line. On top of these piles were built monolithic concrete piers, of pyramidal shape, to 4 ft. above high water. All the concrete work was done in the dry, inside a cofferdam. These piers are reported to be in as good condition as when first built.

Brunswick and Charleston.—Perhaps the most extensive development of concrete dock construction, combining concrete piles with wooden decking, is found at Brunswick, Ga., and at the U.S. Navy Yard, Charleston, S.C., built in 1906.

The Brunswick terminal consists of two piers, 500 and 900 ft. in length, respectively, and each is 140 ft. wide; there is also a coaling pier about 300 ft. long. The 16-in. bearing piles, of pre-moulded concrete, are 12 ft. from centre to centre each way. They are from 30 to 51 ft. in length, with the lower 10 ft. tapering to 8 in. The piles have a penetration of 40 ft. Their upper ends are corbeled out to support the double 8 by 16-in. wooden caps. The decking consists of 6 by 14-in. stringers and a 3-in. flooring. Each bent is well braced with creosoted wooden cross-bracing.

The Charleston Navy Yard dock is 60 ft. wide and 250 ft. long, and of the same type of construction as the Brunswick structures. The piles, 10 ft. from centre to centre each way, are 18 in. square, instead of 16 in. square, and have an 8-ft. taper to 12 in. square at their lower ends, thus giving a heavier structure than those at Brunswick. The test load on the Charleston dock was 30 tons per pile for 48 hours, though the specification required only 20 tons, or 400 lb. per sq. ft.

The outer row of piles in these docks consisted of three creosoted yellow pine sticks, two of which were driven on a batter; all were bolted together to afford sufficient protection to the dock in the form of a fender-pile system.

During the building of the Brunswick dock it was rammed by a large steamer. Although a number of the pine piles were broken, it has been stated that the concrete piles withstood the shock successfully.

Savannah.—A rather unique type of concrete dock was built at Savannah, 17 miles from the sea, in 1913. The design seems to contain many of the excellent features of the Ambursen dam. This dock consists of a series of pile bents athwart the dock supporting reinforced concrete brackets of triangular shape, the brackets in turn supporting a concrete deck-slab sloping down and toward the rear of the structure. This deck was afterward back-filled and finished off with a suitable working face. The dock forms a water-front structure, and is protected by wooden fender-piles.

Jacksonville.—In the construction of a semi-concrete dock at Jacksonville, the Braxten concrete pile was used, with very satisfactory results. In another case the Ripley concrete-encased wooden pile was adopted.

Key West.—A reinforced concrete quay wall dock, 1,589 ft. long, was completed at the U.S. Navy Yard at Key West in 1912. The main wall consists of a series of pre-moulded concrete pile bents capped by a concrete girder and a deck-slab 40 ft. wide on top. From the inner edge of the deck-slab a sloping concrete apron runs down to the top of a row of sheet-piles which forms a retaining wall for the reclaimed land. The piles are from 16½ to 20 in. square, and vary from 25 to 60 ft. in length. The bents are 10 ft. apart, with the same spacing for the piles, each bent having six piles. The face of the dock is protected by a system of creosoted fender-piles placed midway between each bent.

Port Arthur.—A reinforced concrete pile-bent dock, 1,050 ft. long and 25 ft. wide, was constructed at Port Arthur, Tex., in 1911-12. In general, the piles are 16 in. square, 44 ft. long, and 5½ ft. from centre to centre. The pile bents, of five piles each, are about 23 ft. apart, and are capped with a reinforced concrete girder. Five concrete beams, running from bent to bent, and a 4½-in. concrete slab, form the deck structure. The dock is tied back to the concrete trestle built for carrying the railroad tracks in the rear of the dock. No provision is made for any spring or other device to take up the impact forces on the fender system, as it is believed that the wooden fender-piles will afford sufficient elasticity to prevent any injury to the dock from this source.

Cuba.—Two reinforced concrete docks, 620 and 670 ft. in length, respectively, and 160 ft. wide, were built in 1911-12 at Havana, the depth of the water varying from 12 to 40 ft. Each consists of a concrete floor-slab resting directly on concrete caps placed on top of clusters of from four to eighteen reinforced concrete piles, the clusters being about 23 ft. from centre to centre in each direction. The concrete piles, 18 and 20 in. square, were designed for a load of 32 tons each. The design of the floor slab would indicate a cantilever effect longitudinally between each row of longitudinal piling.

One of the railroad companies of Cuba, also, has built a reinforced concrete dock at Havana, for coaling purposes. The structure, which is subjected to very heavy loading, rests on Chenoweth concrete piling, and was but recently finished.

Haiti.—In constructing a reinforced concrete dock at Port au Prince, during 1913, the Ripley type of concrete wrapped wooden pile was adopted. This dock has a total length of 2,326 ft., varying in width from 24 to 60 ft. The piles are 10 ft. from centre to centre, longitudinally and transversely, and are capped by heavy concrete girders of rectangular section for the inshore end of the dock, otherwise by arched girders. The deck system consists of a series of reinforced concrete beams supporting the concrete deck-slab, built with a crown, in order to shed water. The dock is protected by a creosoted fender-pile system.

Panama and Canal Zone.—The United Fruit Company in 1909 built a combined reinforced concrete and wooden pile dock at Bocas del Toro, for the docking of fairly large steamers. The wooden piling is surrounded by a 4-in. concrete shell up to about 1 ft. above the high-water line. The piles are extended up to the deck as reinforced columns, with a concrete beam and deck-slab system. Up to the present time the dock is said to have given good results.

In the Canal Zone the U.S. Army Engineers have constructed a reinforced concrete dock, 706 ft. long and 55 ft. wide, for unloading timber. There are fifty-five concrete piers or columns, 8 ft. in diameter and about 80 ft. long arranged in two rows, 35 ft. from centre to centre across the dock, and 30 ft. from centre to centre longitudinally, and built in the form of hollow reinforced concrete sectional cylinders. After these cylinders had been sunk to bed-rock, they were filled with concrete, being reinforced vertically with eight rails. On top of the columns there is a concrete girder, deck-beam, slab system. The girders are about 5½ ft. deep, the beams about 4½ ft. deep, and the slab 6 in. thick. The railroad track runs over one row of columns. The floor system is designed for a load of 400 lb. per sq. ft., with a concentrated load of 105 tons over the track beams. The depth of water for a mean sea-level tide is 40 ft., the total fluctuation in the tide being 20 ft.

Two other concrete docks of extensive size are now in course of construction in the Canal Zone, with still more to follow.

Pacific Coast.

On the long stretch of our Pacific Coast, perhaps is found the greatest development of reinforced concrete dock construction in the United States. This section is making vast harbor improvements in anticipation of the opening of the Panama Canal.

San Diego.—At this most southern port on the California Coast an extensive reinforced concrete dock is now under construction. It consists of two parts, viz., the dock itself, 800 ft. long and 130 ft. wide, and a quay wall or bulkhead, 2,675 ft. long and 25 ft. wide. Wooden piles are driven into the soil and cut off "at any point between mean and low water and 18 ft. below city datum." Each of the 42-in. concrete columns encases one wooden pile and supports a system of structural deck-beams, a concrete slab covering the whole. The columns are 15 and 13 ft. 4 in. from centre to centre. The entire structure is protected by a wooden fender-pile system having the so-called San Francisco type of steel spring shock-absorbers.

San Pedro.—In connection with extensive port developments at San Pedro, a semi-reinforced concrete dock was recently completed in the outer harbor. It consists of pre-moulded concrete piles, 10 ft. from centre to centre in each bent, the bents being 16 ft. apart. The tops of these piles are corbeled out to support two 10 by 16-in. wooden caps, which in turn support the wooden floor joist and wooden decking. The piles are tied together with a wooden cross-bracing system above mean high tide. The structure is also stiffened against lateral blows on its face by inclined bracing piles. The wooden pile fender system has a car-spring to assist in taking up lateral forces. The dock is of the quay type, 48 ft. 6 in. in width, the total pier head frontage being 12,000 lin. ft. A railroad runs parallel to the inner edge on the inshore fill.

Redondo.—It is of interest to take note of the ocean pier at Redondo, Cal., though it is not a dock. It extends some 637 ft. out into the Pacific Ocean, and supports the intake pipe (for cooling purposes) of a power station. The pier consists of concrete pile bents, 20 ft. apart, each bent having four piles. As considerable surf runs at times under this pier, the outer bents have an extra outside pile driven with a batter of 2 in. per ft. The piles consist of a thin steel shell, 18 in. in diameter, closed at the lower end. After the steel cylinder had been driven to the proper depth of penetration, the reinforcement was inserted and the cylinder was filled with concrete. The piles of each bent have a structural steel cap encased in concrete, with a system of diagonal bracing in a horizontal plane connecting the tops; there is also a longitudinal system of ties at the tops of the piles, above the reach of the water. This structure, as a whole, is said to possess considerable elasticity.

Long Beach, Cal.—In 1907 a concrete pile pier was built at Long Beach, extending some 1,300 ft. out into the ocean. The head of the pier is 100 ft. long and 300 ft. wide, the approach being 1,299 ft. long and 32 ft. wide. The deck is 30 ft. above mean low water, so as to be kept clear of the 24-ft. waves which at times roll in from the ocean. The piles and columns are 4½ ft. in diameter, and are arranged in bents. Under the head of the pier the bents and piles are 16 ft. from centre to centre. The approach bents are 20 ft. apart, with two columns each. The columns are sunk from 10 to 18 ft. into the sand, in order to be absolutely safe, as it is said that at times the undertow digs out the sand to a depth of 13 ft. The pile caps consist of steel I-beams, on top of which rest wooden stringers carrying a wooden decking.

Santa Monica.—At Santa Monica, an ocean pier, built in 1908-09, extends 1,600 ft. out into the ocean. It was built on driven concrete piling, ranging from 14 to 22 in. in diameter, in lengths up to 75 ft., with from 16 to 20 ft. penetration. Although the pier was built primarily to support the outfall sewer carrying the sewage effluent to a point far seaward, it is also used for recreation purposes. The pier is about 35 ft. wide at the deck line, with three platform spaces of 43 by 89 ft. at intermediate points and at the end. The bents are 20 ft. from centre to centre and consist of three piles, the piles being 13 ft. 6 in. from centre to centre. Each bent has a concrete cap on which rest the wooden joists covered with 2-in. planking, and the latter is covered with a 3-in. wire-mesh concrete slab, having the proper pitch to carry off the water. The bents are tied together by three longitudinal reinforced concrete tie-beams running from top of pile to top of pile. The piles are bulb-pointed.

San Francisco Bay.—Although the dock engineers of New York City have developed a type of semi-reinforced concrete dock, viz., a wooden pile structure supporting a concrete slab, especially adaptable to local conditions, the dock engineers of San Francisco have developed a type of full reinforced concrete dock based on wooden sub-piling, concrete column piers, steel or concrete deck-beams, and concrete floor slab, the concrete encasing the steel beams and the floor being made monolithic, with details varying to suit special conditions. Although the type as worked out presents no difficulty in the way of construction, outside of building the main columns, that part of the work has been done successfully, but with considerable difficulty. The mud line at the bottom of the bay is said to be approximately level, yet, at the outer ends of some of the piers there is a depth of only about 18 in. of mud over the rock; at the shore end, however, there is a depth of 35 ft. of mud. Piles can be driven to a rock bearing in some places, but it is impossible to use wooden piles throughout. Along a portion of the waterfront, where it is not possible to reach the rock, there is a hard soil capable of bearing from 4 to 6 tons per sq. ft., thus doing away with the necessity of any sub-piling.

The method used in building the column piers is to sink a hollow steel caisson, of such length that it will not be overtopped by the water, dredge out the interior to the desired depth, and build the reinforced column in the dry. In some cases the columns rest on solid rock, in others, wooden piles have to be driven inside the cylinders to obtain the necessary bearing support. The size of the columns varies according to conditions. In two docks built in 1910, 140 ft. wide and 780 ft. long, where the mud covering the rock was less than 50 ft., the columns were seated directly on the rock. Where the mud is more than 50 ft. deep the columns rest on five 15-in. wooden piles driven to refusal, the piles being cut off 35 ft. below the water line and encased by the concrete columns to that height. The columns are 6 ft. in diameter to a height of 7 ft., and then 3½ ft. to the top.

In laying out a vast dock improvement proposition at Fort Mason, San Francisco, the government has planned for the immediate construction of three docks of the usual San Francisco type, each to be 500 ft. long, two 81 ft. wide, the third 118 ft. wide. The concrete columns are to be supported by groups of seven wooden piles driven in a circle 6½ ft. in diameter, and 18½ ft. from centre to centre each way. The piers are to be 8 ft. in diameter up to 12 ft. above the dredge line, and are then to be reduced to a diameter of 4 ft. for the remainder of their length. The wooden piles will extend some 11 ft. up into the concrete columns, the bottom of the concrete being well below the mud line. In building the first of these docks, an attempt was made to construct the column forms of 4-in. staves, sufficiently reinforced with bands, and sink them into position by driving. The method did not prove a success, and resort was made to the steel cylinder caisson method, as described previously.

Up to 1911 there were only four modern reinforced concrete column docks under the control of the San Francisco port authorities. Since that time they have added largely to the number by replacing some of the older wooden pile docks with reinforced concrete structures. The first addition was Pier No. 17, 800 ft. long and 126 ft. wide, with suitable railroad track accommodations. It consists of wooden piles protected by concrete shells, the deck-beams being of structural steel encased in concrete, and the stringers and decking are of timber—a sort of semi-concrete pile semi-concrete dock.

The next docks reconstructed were Piers Nos. 26, 28, 30, and 32, all of the same type, having reinforced concrete columns resting on the hard bottom, without any piling, with a complete system of reinforced concrete deck-beams, girders, and slabs. These docks are equipped with up-to-date cargo-handling machinery.

The net addition was Pier No. 39, 150 ft. wide, this being in process of construction at the present time. The concrete columns rest on groups of from 4 to 10 wooden piles, the entire deck system being of reinforced concrete.

In another type of construction at San Francisco the wooden piles are wrapped with wire fabric, or otherwise, and a concrete shell is placed around them after the piles have been driven to place. This method, apparently, has proved successful, though it must be carried on in such a way that the concrete can be poured, set, and hardened in the dry, and not in sea water, if permanent results are to be obtained.

Recently, the City of Oakland, Cal., built a genuine reinforced concrete pile dock, 295 ft. long and 124 ft. wide, standing in 30 ft. of water. The piles are of pre-moulded concrete, 16 in. in diameter, octagonal, and of a 1 : 1½ : 3 mixture for a distance of 5 ft. from the top, the remainder of the pile being of a 1 : 2 : 4 mixture. The bents and piles are approximately 10 ft. apart. Each row of piles has a concrete cap or girder running athwart the dock, the deck-beams and deck-slab being also of concrete. For lateral stiffness, 12-in. concrete curtain-walls were built at three points in the dock, for about one-third of its width, between the piles in three bents.

Portland.—Being 112 miles from the ocean, on a fresh-water river, it is possible to use wooden piling at Portland, in the construction of docks. A massive concrete dock terminal, now being built by the city, consists of four concrete warehouses along the water-front. The dock part of this project as designed consists of a reinforced concrete platform, 1,030 ft. long and 100 ft. wide, 32 ft. above low water, resting on wooden piles driven in groups and cut off at about mean low water. Resting on each group of wooden piles, 20 ft. from centre to centre, are the reinforced columns supporting the upper platform, composed of steel I-beams encased in concrete, and a concrete floor-slab. For a length of 300 ft., a low-level deck, 14 ft. below the main deck, is provided. As the Columbia River is subjected to high- and low-water stages, due to floods, it was necessary to provide this lower platform for use by river steamers during low-water periods. The rise and fall of the Columbia River attains a maximum of about 28 ft., though 18 ft. is about the average, all based on mean low-water level. Thus the lower platform will seldom be under water.

Puget Sound.—Though there are several large shipping ports on Puget Sound, up to the present time, no reinforced concrete dock construction of a commercial nature has been undertaken in these waters. As lumber is so plentiful in that part of the country, it is only natural that such a section should be one of the last shipping centres to take up the building of reinforced concrete docks; but as the destructive teredo is very active there, the engineers of the Northwest are beginning to seek a more stable type of construction than creosoted wooden pile docks, especially the United States and Canadian governments, and some of the railroads, because "in government (and publicly owned) docks, a small saving in first cost is of minor importance, but weakness and frequent need of repairs are well nigh intolerable. On the other hand, in private ownership of docks a saving in first cost is usually of serious importance, while the cost of maintenance, repairs, etc., is met by earnings of the dock and is less felt," unless they become so excessive as to make a concrete proposition more economical in the long run.

At the U.S. Navy Yard in Bremerton, Wash., a reinforced concrete dock, consisting of concrete columns, steel and concrete beams, and a concrete slab, was completed in 1912. It is 402 ft. long and 60 ft. wide. The columns are 3 ft. in diameter, with a flared-out footing to a diameter of 6 ft., 16 ft. from centre to centre, each way, there being four columns to each bent. The caps and girders over the tops of the columns are of I-beams encased in concrete. A concrete beam is run midway longitudinally between each of the four steel beams. The I-beam caps are cantilevered out 6 ft. on each side of the dock. The columns were built as hollow concrete cylinders with a 3-in. shell of 1 : 2 mortar, and filled with a 1 : 2 : 4 concrete after being sunk to place. As hollow cylinders, they avoided any coffer-dam work. The dock has a standard railroad track down each side over the outside columns, also an ordinary wooden fender system.

A still heavier concrete dock is now in course of construction at the same Navy Yard. It is 490 ft. long, 80 ft. wide, and is designed for a load of 600 lb. per sq. ft. The approach of the dock consists of a wooden pile structure, 210 ft. long, of triangular shape. As designed, the structure is supported by sixty-eight concrete columns, 4 ft. in diameter, with an 11-ft. base (of the same type as in the dock just mentioned), 20 ft. from centre to centre athwart the dock, and 30 ft. longitudinally. The columns are capped by extremely heavy reinforced concrete beams which support a series of built-up structural beams, about 36 in. deep, carrying a thick concrete floor-slab. The side of the dock is cantilevered out 8 ft. beyond the columns. A standard railroad track runs over the centre line of the outside rows of columns on each side of the dock. On account of the nature of the soil, some of the piers rest on sub-piling, others, nearer the shore, on hardpan.*

Vancouver.—The Great Northern Railroad has very recently completed an extensive reinforced concrete dock of the quay type, in connection with a new terminal it is building at Vancouver. The total width of the terminal dock is 302 ft., the concrete dock proper being 456 ft. long, and 50 ft. wide on each side of the terminal, the space between being a rock and earth fill, with a proper rip-rapped slope at its faces. Each concrete dock structure consists of nineteen reinforced concrete columns, 4½ ft. in diameter, 25 ft. from centre to centre, parallel to the face of the dock, resting on the rock stratum that underlies the location of the terminal. These columns support a heavy longitudinal concrete girder into which are tied heavy cross-girders, 12½ ft. apart. The cross-girders are cantilevered out beyond the longitudinal girder about 16½ ft., and their inboard ends rest on two driven concrete piles 34 ft. back from the centre of the columns. Four concrete beams of suitable size are run longitudinally with the dock. The entire girder and beam structure supports a concrete slab. The railroad track is over the longitudinal girder running from column to column. The two parts of the dock are tied together by suitable concrete beams running across the interior fill. The terminal is considered to be one of the most substantial and up-to-date structures on the Pacific Coast. The dock is well protected by a wooden fender-pile steel-spring system.

Great Lakes.

Although extensive use of concrete has been made in some of the ports of Lakes Superior, Michigan, Huron, Erie, and Ontario, in the construction of massive ore-docks, it is not proposed to discuss that particular phase of the subject in this paper. These docks are of excellent design, some built on concrete piling, others on wooden piling or cribs. Concrete piles in fresh water are not subject to the same deterioration as those in salt water. On the other hand, they have to withstand extremes of temperature, frost and ice, in addition to severe treatment, due to the heavy traveling machinery above them.

Some of these docks will be discussed, in order to bring out the important features of their special design.

Chicago.—One of the first attempts at using concrete for dock work on the Great Lakes was made at South Chicago, in the winter of 1898-99, in the rebuilding of an old wooden quay dock wall. The concrete structure is 1,680 ft. long, and consists of a heavy mass concrete stepped-back wall, 10½ ft. high, 8 ft. wide on top, and 18 ft. on the bottom, supported by a timber structure consisting of three rows of piling cut off 3½ ft. below mean water level, with longitudinal caps crossed by a heavy wooden grillage. A timber sheet-piling bulkhead under the face of the wall acts as a retainer for the slag fill. On one occasion the wall was rammed by a large steamer, but suffered absolutely no damage. The damage to the steamer, however, was rather extensive. A year or so later, a similar quay dock wall, 2,300 ft. long, was constructed at the same steel plant.

*In the actual construction the built-up structural beams were replaced by reinforced concrete.

Due to the decay of a long wooden water-front bulkhead on the Chicago River, it became necessary to replace it. This was done by constructing a reinforced sheet-pile bulkhead almost ½ mile in length, capped by an I-shaped concrete beam, some 3 ft. wide and 5 ft. high. This beam rests on pre-moulded piles, which are 20 ft. apart and are secured to buttresses, also 20 ft. apart, which run back about 12 ft. from the sheet-piling, the land ends of the buttresses being supported by other piles. The buttresses are also tied back to deadmen some 35 ft. back from the wall. As the bulkhead has about 18 ft. of water along its front, vessels can dock alongside.

Marquette.—The most extensive reinforced concrete ore-loading docks on the Great Lakes are without doubt at Marquette, Mich., and were built in 1912. The substructure consists of a heavy concrete slab and facing-walls, similar to a channel beam placed on its back, 1,500 ft. long and 60 ft. wide, resting on wooden piling. Under the face of the walls there is a wooden sheet-piling bulkhead which retains the sand fill around the piles under the dock structure. The depth of the concrete web is 3 ft., the walls that correspond to the flanges being 9 ft. high. The substructure supports a very massive reinforced concrete superstructure for loading ore into vessels, the whole dock being a very substantial and shock-resisting structure. A steel plate is worked along the face of the two concrete walls from 6 in. below the water level to 3 ft. above it, to prevent disintegration of the concrete due to frost and ice action at the water level.

Two Harbors.—At Two Harbors there is an ore-loading dock consisting of a steel superstructure supported by a mass concrete wall running along each face of the dock, and tied together with concrete beams at regular intervals. The concrete walls rest on wooden piles with a wooden sheet-piling bulkhead to retain the interior fill. The substructure is 1,400 ft. long and 52 ft. wide.

Detroit.—The concrete ore-loading dock at Detroit is 200 ft. long. It consists of three bearing walls of a T-rail shape, 9 ft. deep, running parallel to each other, the two outer walls being 28 ft. apart, the third or back wall being 173 ft. from the middle wall. The three walls rest on a double row of oak piling cut off 3 in. above the water level. Being capped by the concrete walls, no part of the wooden piling is exposed to the air. The outer wall stands in about 10 ft. of water, the middle wall in 3 ft., and the rear wall is far back on the dry land. The two outer walls are tied together by reinforced concrete beams, 5 ft. deep, at intervals of 10 ft., with cantilevered brackets on the water face of the outer wall opposite the tie-beams. The concrete deck-slab on top of the brackets is 12 in. thick, but only 6 in. thick between the two outer walls. The dock has a suitable wooden fender-pile system.

Between the middle and back walls there is a 12-in. reinforced concrete floor-slab, supported on a series of piles, 5 ft. from centre to centre each way, stated to have been designed for a load of 6,800 lb. per sq. ft., or 85 tons per pile. The ore floor is tied into the middle and back bearing walls opposite each cross-beam in the dock proper. The three walls support an ore bridge tower, used for unloading ore from vessels to cars on the track just behind the middle wall, or into the ore bin between the middle and back walls.

Toledo.—At Toledo, Ohio, there is an ore-unloading dock, consisting of a plain concrete wall running along the water-front, resting on wooden piles, and tied back to deadmen some 100 ft. in the rear. The land is reclaimed back to the middle wall, a row of sheet-piling under the river wall retaining the earth in place. Parallel to the river there are three other walls to support the legs of the ore-unloading bridges which run on tracks placed on all four walls, spanning the four car tracks and the ore piles. The distance from the front wall to the inmost land wall is 419 ft.

Cleveland.—There is a full reinforced concrete ore-unloading dock at Cleveland, Ohio, completed in 1912 by the Pennsylvania Railroad. It consists of a reinforced concrete water-front wall, 985 ft. long, supported by a double row of pre-moulded concrete piles. The face wall is tied back by reinforced concrete tie-beams to another reinforced concrete wall supported by three rows of concrete piles about 81½ ft. in the rear. The tie-beams are 30 ft. apart, and rest on concrete piles 6 ft. apart. The space between the two walls, that is, under the concrete tie-beams, is back-filled with rip-rap, the whole mass being pumped full of sand. A concrete sheet-piling bulkhead under the front wall retains the fill in place. The dock has the usual wooden fender-pile protection. The tracks for four 17-ton Hewitt unloading machines run along the inner and outer walls. So far as the writer has been able to discover, this was the first concrete pile dock built on the Great Lakes.

Another ore-unloading dock at Cleveland consists of a reinforced wall of the same type as that at Detroit, the two structures having been designed by the same engineers. The cantilevered face of this wall is supported by brackets at intervals of 15 ft., with rear buttresses opposite them. The buttresses rest on a concrete base slab, the rear edge of which rests on a row of wooden sheet-piling, the base-slab evidently being monolithic with the rest of the wall. The space between the sheet-piling and the wooden piles that support the concrete wall (11 ft.) is filled with slag. In general, the cross-section of the wall is dumb-bell shaped.

General.—In discussing the ore docks of the Great Lakes, it is necessary to consider the special and peculiar conditions under which they are operated, as they are designed to meet these conditions, and not vice versâ. The larger portion of the freight carried on the Great Lakes is of heavy bulk form, viz., ore and grain on the downward trip, coal on the upward trip. Thus ore and coal cargoes form the two heaviest items handled in bulk masses at the terminals. Nowhere in the world is found such massive and modern machinery for the economical and expeditious handling of bulk freight as at the upper and lower ports of the Great Lakes. Consequently, such docks, wooden or otherwise, must not be judged by the type used along the seaboard of the Atlantic, the Gulf, or the Pacific.

It appears that the various types of reinforced concrete docks as worked out by the American engineers are far more numerous than in foreign practice, as is evident from the foregoing descriptions. Although the Atlantic Coast engineers seem to favor pre-moulded concrete piles, the Pacific Coast engineers apparently favor large concrete columns. Perhaps in time a typical American concrete dock will be designed or devised, as in the case of the long-standing type of wooden pile dock structures.

In the foregoing review of American reinforced concrete docks, an effort has been made to include each and every port wherein such types of docks exist, as well as to mention each and every dock already built, so far as the writer has been able to acquire sufficient information concerning them, in order that the exact situation as regards the development of reinforced concrete dock construction in America up to the present time may be known to all.

ROGER'S PASS TUNNEL CONSTRUCTION.

NOTABLE progress has been made by the Canadian Pacific Railway Company on the construction of its double-track tunnel, 26,400 feet in length, through Mt. Macdonald of the Selkirk Range. The following information, together with the illustrations, show that there has been great activity since the establishment of plant and actual commencement of operations.

The elimination of the loops referred to means a reduction of the summit of the line from 4,330 ft. to 3,791 ft., and a reduction of the distance between certain points on the line of from 23 miles to 18 miles. Further, the length of maximum grades upon the present line is 22.15 miles, whereas the length of maximum grade on the proposed line will be only 6.61 miles.

The preliminary work included a large amount of excavation and fill in order to obtain grade for entering the

Enormity of Roger's Pass Tunnel Scheme as Viewed from One of the Portals.

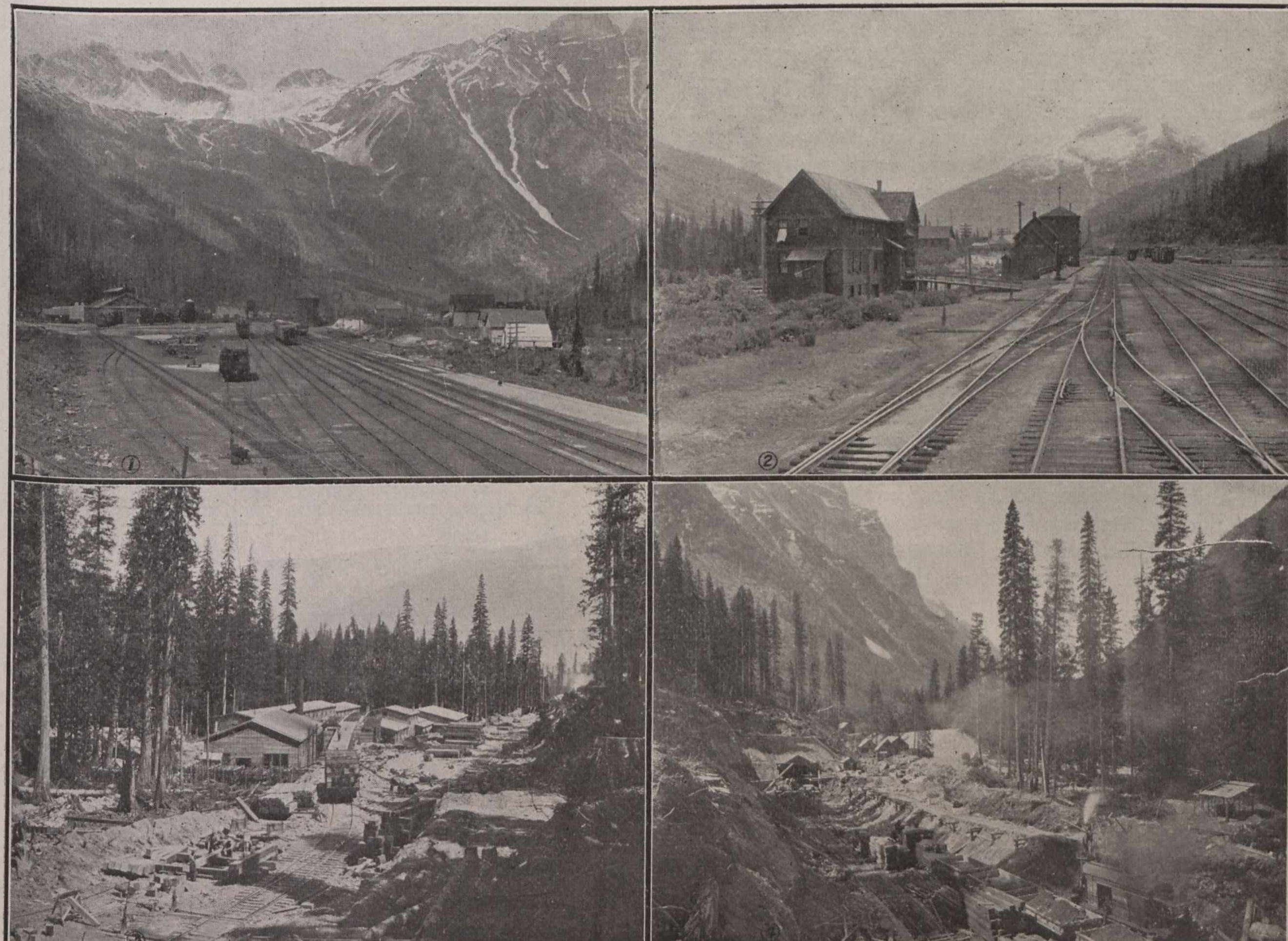
Readers of *The Canadian Engineer* are referred to our issue of April 23, 1914, for a general description of the undertaking and also for a detailed outline of the plan adopted by the contractors for its successful carrying out. The tunnel, it will be remembered, is to enable the Canadian Pacific Railway to dispense with its "loops," together with many miles of snow sheds, to reduce the distance from valley to valley, to effect an enormous grade reduction, to obviate the use of "pusher" engines over the long section of main line, and, in short, to eliminate the use of one of the most costly sections, from a railway operating point of view, to be found on the continent.

tunnel at the western portal. At the present time this work, with the exception of a small portion, has been completed. Another preliminary undertaking, and one that had some very novel features connected with it, was the deviation of the Illecillewait River so as to utilize its old bed for an approach. A trench nearly a mile in length was excavated and the river now takes a new course in front of the spot chosen for the entrance of the tunnel, while lower down the valley a culvert was constructed to return it to its original course. A similar task was necessary in the Beaver Valley on the eastern slope.

As stated in the article previously referred to, the method of tunneling includes the driving of a "pioneer" shaft. This is a heading 7 x 9 ft. in cross-section, which is being driven 45 ft. from the centre line of the main tunnel, but with 10 ft. greater elevation. The main line of the tunnel will then be worked from cross-cuts. This is a new method of tunnel projection which is being tried out by the contractors to expedite operations. The pioneer bore, when completed, will be an entirely separate tunnel paralleling the course of the main passage through the mountains. The activities of drillers can thereby be concentrated at many different points simultaneously.

handfuls between the stoping and its use has been pronounced exceedingly satisfactory. The excavation is being effected by steam shovel, which will be used until rock has been encountered. The 600 men at present at work on the tunnel are accommodated in two camps, one at each portal.

The work commenced in June and is to be completed by December, 1916. It is under the direction of Mr. J. G. Sullivan, Chief Engineer for Western Canada of the Canadian Pacific Railway. The contractors are Messrs. Foley, Welch and Stewart, of Seattle, Wash. The estimated cost of the scheme, with related improvements in



Roger's Pass Tunnel, Selkirk Mountains, B.C., Present Terminal Stations and Constructional Views.

The course of the pioneer bore on the west side of Mt. Macdonald is in a downward direction, beginning several hundred feet above the cutting. It descends on a 50% grade for the first 300 ft., after which it proceeds horizontally. Since last April, when it was stated in these columns that over 1,100 ft. of the pioneer tunnel had been driven from the eastern portal, over 2,000 ft. more has been projected, while practically 1,000 ft. of the main tunnel has also been driven from the eastern portal. On the west side the bores for the main tunnel are not advanced to such a stage, but are well under way, and three cross-cuts have been driven.

An interesting feature of the boring operations in the soft material at the western entrance of the main tunnel is the use of hay to arrest the flow of loose earth and water as the excavation proceeds. The hay is placed in

the way of electrification of the tunnel portion of it and double tracking, exceeds $10,000,000.

At the Foundry and Machine Exhibit held in Chicago, September 5 to 11, the Wernicke Hatcher Pump Co., Grand Rapids, Mich., displayed in operation a new compact type of air compressor. It has a balanced rotary movement giving positive displacement, and works up to 100 lbs. or more in a single stage. This is obtained with unusually efficient cooling and low-power consumption; while the rotary principle means a steady flow of air uniform running and low-starting torque. It also permits direct connection to a high-speed electric motor, with ready control at all speeds up to maximum. The machine is portable and requires neither a heavy foundation nor piping.

HARRISBURG FILTER CASE.

In *The Canadian Engineer* for September 18, 1913, a review was given of a decision handed down by the United States Circuit Court of the Middle District of Pennsylvania in connection with the "negative-head" patent case between the New York Continental Jewell Filtration Company and the City of Harrisburg, Pa.

The case, which has been on trial since 1908, has just been the recipient of another decision, this one from the United States Circuit Court of Appeals of the Third Circuit. It was handed down on September 15th, 1914, and reverses the decision of the Lower Court.

In view of the attention which the long trial has occasioned, the following notes respecting the new decision may be of further interest.

The opinion starts with a brief statement of the claims of the patents in suit and follows with a general discussion of the principles of filtration and the state of the art. A very extended review of the language of the various patènts referred to in the suit is then given, followed by a discussion of the principles of suction as applied to this case.

The court points out various patents which were cited by the city as anticipations of the patents in suit and reviews in this connection several instances of prior use claimed by the city, and proceeds then to a discussion of the scientific principles involved in the patents in suit and the theories of the patents as disclosed by the evidence. The judge writing the opinion gives the impression that the plaintiff company has not proved its case in this regard, and cites the testimony of several witnesses on both sides which apparently created in the court's mind a doubt about the matter, but the judge expressly refrains from making any decision on these matters. This is clearly indicated in the summing up of all this discussion in the following words:

"However, it is probably enough to say that (at the best) the evidence in behalf of the company leaves us in much uncertainty whether the theories of the patents are sound. We do not feel bound to go the length of declaring the patents invalid—the re-issue patent, indeed, has already expired, leaving the patentee only a claim for royalties—but we are prepared to say that while the subject is so surrounded by uncertainty the company cannot reasonably object to the application of a test that tries the Harrisburg filters by the theories of the patents."

The court specifically declines to state that the patents in suit are not valid, or that the scientific principles and theories upon which the plaintiff company based its claims are incorrect.

But in reviewing the testimony of what actually happened at Harrisburg, the court decides that that was not sufficient to create an infringement, concluding with the following words:

"In our opinion, therefore, the case may safely be decided by finding upon the evidence that the city has not infringed either patent."

In brief, it appears that this decision, while reversing the decision of the Lower Court as to Harrisburg, does not decide that the theories of the court below were wrong with respect to the basic principles upon which that court decided the case, and leaves open the entire question as to validity of the patents.

It is reported that probably one of the largest contracts ever secured by Chilean manufacturers was recorded on July 6, when the Government placed a home order for railway equipment to the value of $8,240,000.

SOME TUNNELING COSTS.

(Continued from last week's issue.)

Marshall-Russell Tunnel.

Location: Empire, Colo.

Purpose: Mine drainage, development and transportation.

Cross-section: Rectangular.

Size: 8 feet wide by 9 feet high.

Length: 11,000 feet projected; 6,700 feet driven January 1, 1913.

Character of rock penetrated: Granite and gneiss.

Type of power: Purchased electric current; also a small auxiliary hydraulic plant.

Ventilator: Fan.

Size of ventilating pipe: 12 and 13 inches.

Drills: 2, pneumatic hammer.

Mounting of drills: Vertical columns.

Number of holes per round: 18 to 20.

Average depth of round: 9 to 10 feet.

Number of drillers and helpers per shift: 2 drillers and 2 helpers.

Number of drill shifts per day: 1.

Explosive: 40 per cent. gelatine dynamite; with some, 80 per cent.

Number of muckers per shift: 4.

Number of mucking shifts per day: 1.

Type of haulage: Horses.

Wages: Drillers $4, helpers $3, blacksmiths $4, helpers $3, muckers $3.25, trammers $3.75, dumpmen $3.25, power engineer $3.50, shooters $3.25.

Maximum progress for any calendar month: 187 feet, June, 1909.

Average monthly progress: 125.

Cost of Driving Tunnel 6,700 Feet.

	Cost per foot of tunnel.
Labor	$ 9.37
Powder, fuse, caps and blacksmith coal	3.35
Drills, steel and repairs (less 30 per cent. salvage)	1.34
Power	1.41
Permanent equipment and general expense (less 30 per cent. salvage on permanent equipment)	3.41
	$18.88

Mission Tunnel.

Location: Santa Barbara, Cal.

Purpose: Water supply.

Cross-section: Trapezoid.

Size: 6 feet wide at the base, 4½ feet wide at the top, 7 feet high.

Length: 19,560 feet.

Character of rock penetrated: Shale, slate and hard sandstone.

Ventilator: Pressure blower.

Size of ventilating pipe: 10 inches.

Drills: 1 pneumatic hammer.

Mounting of drills: Horizontal bar.

Number of holes per round: 12 to 14.

Average depth of round: 7 to 8 feet.

Number of drillers and helpers per shift: 1.

Number of drilling shifts per day: 3.

Explosive: 40 per cent. and 60 per cent. gelatine dynamite.

Number of muckers per shift: 4.

Number of mucking shifts per day: 3.

Type of haulage: Electric.

Wages: Drillers $3.50, helpers $3, muckers $2.75, blacksmiths $4, helper $3, motormen $2.75, dumpmen $2.50, power engineers $2.75.

Maximum progress in any calendar month: 414 feet, February, 1911.

Average monthly progress: 210 feet.

Cost of Driving the South Portal, Mission Tunnel, 5,515 Feet.

	Cost per foot of tunnel.
Administration	$ 1.14
Labor	9.20
Power	2.12
Explosives	1.97
Timbering (563 feet)	.30
Track and pipe	1.22
Miscellaneous supplies	2.46
Drill parts (including steel)	1.02
Bonus	.48
	$19.91

"Administration" includes superintendence, office supplies and general charges. "Miscellaneous supplies" includes candles, light globes, shovels, picks, blacksmiths' supplies and fuel and machinists' supplies.

NEWHOUSE TUNNEL.

Location: Idaho Springs, Colo.

Purpose: Drainage and transportation.

Location: Idaho Springs, Colo.

Purpose: Drainage and transportation.

Cross-section: Square.

Size: 8 by 8 feet.

Length: 22,000 feet.

Character of rock penetrated: Idaho Springs gneiss.

Type of power: Purchased electric current.

Ventilator: Pressure blower.

Size of ventilating pipe: 18 inches.

Drills: Pneumatic hammer.

Mounting of drills: Vertical column.

Number of holes per round: 14 to 22.

Number of drill shifts per day: 1 and 2.

Explosive: 40 per cent. gelatine dynamite, with some 100 per cent. in the cut holes.

Number of muckers per shift: 3.

Number of mucking shifts per day: 1 to 2.

Type of haulage: Electric.

Wages: Drillers $4 to $4.50, helpers $3.25 to $4, muckers $3.50, motormen $3.50, dumpmen $3, blacksmiths $3.50 to $4.50, helpers $3.

Cost of Driving the Newhouse Tunnel.

	Jan. to Aug. 1909, 2,233 feet.	Sept. to Dec. 1909, 1,098 feet.	April to Aug. 1910, 693 feet.
Labor	$ 6.72	$ 6.98	$11.73
Explosives	4.15	3.52	4.57
Fuse and caps	.39	.36	.44
Transport'n of materials broken	1.49	1.47	2.22
Power	1.99	2.16	2.82
Blacksmithing	1.57	2.61	2.00
Use of drills, repairs and steel	1.50	2.74	2.86
Equipment, ties, rails, pipe, etc.	1.74	1.78	2.19
Sundries	.79	.80	1.85
	$20.34	$22.42	$30.68

RAWLEY TUNNEL.

Location: Bonanza, Colo.

Purpose: Mine drainage and development.

Cross-section: Trapezoidal.

Size: 8 feet wide at the base, 7 feet wide at the top, 7 feet high.

Length: 6,235 feet.

Character of rock penetrated: Tough, hard andesite.

Type of power: Steam with wood for fuel.

Ventilator: Pressure blower.

Size of ventilating pipe: 12 and 13 inches.

Drills: 2 pneumatic hammer.

Mounting of drills: Horizontal bar.

Number of holes per round: 23 to 25.

Average depth of round: 8 to 9 feet at first, 5 to 6 feet later.

Number of drillers and helpers per shift: 2 drillers and 2 helpers.

Number of drill shifts per day: 2 at first, 3 later.

Explosive: 40 per cent. and 60 per cent. gelatine dynamite (in the proportion of about 2 to 1).

Number of muckers per shift: 4.

Number of mucking shifts per day: 2 and 3.

Type of haulage: Horses and mules.

Wages: Drillers $4.50, helpers $3.75, muckers $3.50, blacksmiths $4.50, drivers $3.50, power engineers $4.

Maximum progress in any calendar month: 585 feet, July, 1912.

Average monthly progress: Approximately 350 feet.

Cost of Driving the Tunnel 6,235 Feet.

	Cost per foot of tunnel.
Drilling and firing	$ 5.25
Mucking	2.16
Tramming	1.13
Track and pipe	.44
Miscellaneous underground expenses	1.44
Power plant	2.50
Blacksmithing	.73
Miscellaneous surface work	.83
General expenses	1.98
Permanent plant	3.24
Timbering (1,618 feet)	1.18
Boarding house, debit balance	.04
	$20.98
Credit by salvage on permanent plant	1.11
	$19.87

ROOSEVELT TUNNEL.

Location: Cripple Creek, Colo.

Purpose: Mine drainage.

Cross-section: Rectangular, with large ditch at the side.

Size: 10 feet wide by 6 feet high.

Length: 15,700 feet.

Character of rock penetrated: Pikes Peak granite, chiefly.

Type of power: Purchased electric current.

Ventilator: Pressure blower.

Size of ventilating pipe: 16 and 17 inches.

Drills: 3 pneumatic hammer.

Mounting of drills: Horizontal bar.

Number of holes per round: 24, usually.

Average depth of round: 6 to 7 feet.

Number of drillers and helpers per shift: 3 drillers, 2 helpers.

Number of drill shifts per day: 3.

Explosive: 40 per cent., 60 per cent., and some 100 per cent. gelatine dynamite.

Number of muckers per shift: 4, usually.

Number of mucking shifts per day: 3.

Type of haulage: Horses and mules.

Wages: Drillers $5, helpers $4, muckers $3.50, power engineer $4, blacksmith $5, helper $3.50, dumpman $3.50, drivers, inside, $5, outside, $4.

Maximum progress in any calendar month: 435 feet, portal heading, January, 1909.

Average monthly progress: Portal heading, 300 feet; shaft headings, 270 feet; all headings, 285 feet.

Cost of Driving Tunnel.

Total cost of portal work	$111,980.06
Contractor's percentage	11,404.88
Cost of shaft headings	262,126.55
Total cost of tunnel	$386,421.49
Number of feet driven	14,167
Average cost per foot	$27.27

Cost of Driving the Portal Heading.

	Feet.	Cost per foot.
1908—February and March	514	$22.690
April	262	30.970
May	268	26.760
June	187	35.010
July	203	29.600
August	300	21.760
September	351	19.600
October	287	23.000
November	360	21.120
December	334	18.350
1909—January	435	16.410
February	290	22.206
March	340	21.745
April	316	21.266
May	402	18.762
June (8 days)	62	40.600

Cost of Driving Shaft Headings.

	Feet.	Cost per foot.
1908—October (2 headings)	49	$105.52
November (2 headings)	141	44.38
December (2 headings)	177	40.11
1909—January (2 headings)	261	24.06
February (2 headings)	601	23.70
March (2 headings)	639	26.256
April (2 headings)	670	25.02
May (2 headings)	552	28.34
June (2 headings)	498	27.375
July (1 heading)	319	32.871
August (1 heading)	410	27.747
September (1 heading)	355	32.40
October (1 heading)	380	28.178
November (1 heading)	298	34.20
December (1 heading)	251	35.153
1910—January (1 heading)	282	28.82
February (1 heading)	259	30.636
March (1 heading)	344	27.62
April (1 heading)	376	25.313
May (1 heading)	393	24.856
June (1 heading)	373	26.616
July (1 heading)	350	25.247
August (1 heading)	372	25.029
September (1 heading)	342	28.45
October (1 heading)	372	27.361
November (1 heading)	192	27.786

Typical Distribution of Expenses, Portal Heading, July, 1908, 203 Feet.

	Cost per foot of tunnel.
Machinery and repairs	$ 0.61
Air drills and parts	.99
Picks, shovels and steel	1.90
Ditch men	1.09
Explosives	6.90
Candles	.36
Oil and waste	.09
Electric power	2.06
Blacksmith supplies	.09
General expense	.16
Liability insurance	.17
Lumber, ties and wedges	.01
Horses and feed	.01
Compressor men	1.79
Drillers and helpers	4.21
Blacksmiths and helpers	3.43
Muckers and drivers	4.11
Foremen	1.50
Bookkeeper	.12
	$29.60

Typical Distribution of Expenses, Shaft Heading, February, 1910, 259 Feet.

	Cost per foot of tunnel.
Maintenance of buildings, tents, etc.	$ 0.096
Machinery and repairs	1.158
Air drills and parts	1.930
Shovels, picks and steel	1.930
Pipe and fittings	.193
Ditch men	1.480
Explosives	5.032
Lamps and candles	.217
Oil and waste	.252
Electric power	2.440
Blacksmith supplies	.150
Liability insurance	.213
General expense	.342
Lumber, ties and wedges	.119
Horses and feed	.324
Machine men and helpers	4.050
Muckers	3.065
Blacksmiths and helpers	1.362
Engineers	1.300
Pipe and track men	.675
Drivers and dumpmen	2.355
Foremen	1.753
Mine telephone	.008
Bookkeeper	.193
	$30.636

(To be continued.)

Preparations have been completed by the Quebec Government to open new districts to the lumber and pulp industries. During August and September, limits in the Abitibi and Lake St. John districts were auctioned off. In the Lake St. John region, the territory to be opened is north of the lake and in the basin of the Mistassini and Rat Rivers. In the Abitibi district, it is situated south of the Transcontinental, but on the north slope in the basin which empties into James' Bay. This tract is traversed by the Poisson Blanc, Harricana and Bella Rivers. Both limits have been carefully surveyed by the forestry service.

Editorial

AVOIDING THE MUNICIPAL BREAD-LINE.

Directly in line with what we have been endeavoring to impress upon public bodies throughout the Dominion in the matter of undertaking works such that will provide employment to those whose need of it is to be anticipated, it is worthy of note that the Toronto Hydro-Electric Commission has sought special permission to borrow $2,000,000 for extension work to be carried out this fall and winter. It is reported also that the town of Orillia has made arrangements with the Ontario Government for the clearing of a large tract of bush land during the winter by the unemployed, it being anticipated that the work will be sufficient to provide all the employment required in that town. It is also notable that the Toronto City Council has agreed to the Hamilton-Toronto highway proposal, commented upon in our issue of September 24th, thereby authorizing the expenditure of Toronto's share, $150,000, toward the enterprise.

Such undertakings as these are admirable at this period when so much depends upon the projection of work that will reduce as low as possible the numbers of unemployed that will accumulate in our towns and cities as winter sets in. The Lord Mayor of London recently expressed a feeling that is prevalent at this time not only in England but throughout the Empire's Dominions: "If we can go forward as far as possible," he said, "with our building, manufacturing and other enterprises, limiting unemployment and preserving wages, we shall be doing a very patriotic work." Even in England, whose connection with the European combat is incomparably closer than our own, the enlargement of enterprises of local authorities and other public bodies is going on apace. On the suggestion of the Local Government Board of England, most of the corporations and district councils in the country have already begun to prepare and carry out important schemes of engineering in order that during the coming winter full employment may be found for every workman, and any men thrown out of work from other industries may be kept fully employed. Special facilities for the immediate execution of such schemes are being afforded by loans and by grants from the Local Government and Road boards. Manufacturers of plant and materials for municipalities are acting upon the wise counsel to prepare well in advance for the demands which the above activities will make upon them. It is also to be remembered that the British Parliament has passed the Housing Act providing £4,000,000 for the erection of laborers' cottages. Moreover, H.M. Office of Works has decided to proceed with all services in its charge, to employ as many men as possible in the carrying out of such services, and to develop and expedite its building program in every practicable way. Optimism prevails throughout Great Britain that private individuals, companies, firms and contractors will spare no effort to follow the policy of the government in this matter.

The provision of employment is a subject which should be more seriously considered by our municipal councils. Every town or city has works of some light and unimportant nature that have been persistently overlooked and sidetracked for the sake of more important undertakings. There may be small matters of grading or diversion within the corporation, cleaning of water mains and sewerage systems, or any one of a number of odd jobs which have long awaited attention and which may well be taken up at this time. There is, for instance, always a greater or less need for more activity in the matter of street and property cleaning. Clean-up weeks have produced very beneficial results in a few cities at home and many abroad. A widespread activity throughout the Dominion would mean much toward the health and picturesqueness of communities. Besides, the cleaning up of our streets and alleys and the straightening up of our parks and playgrounds, if completed this fall, will have a decided effect upon the health and appearance of our cities when the snow takes its departure in the spring. There is always the possibility of work going ahead with such a rush at the opening of the season as to necessitate the shelving, once again, of such jobs as these, with undesirable result. Every small amount of work of this nature afforded by our municipalities is going to make better citizens, prevent long bread-lines, and display a true spirit of patriotism.

LIEUT.-COL. HON. JOHN STRATHEARN HENDRIE.

The appointment of Lieut.-Col. Hon. J. S. Hendrie, M.P.P., C.V.O., to succeed Sir John Gibson as Lieutenant-Governor of Ontario, is one that has come to pass during the past few days. Those who are familiar with Col. Hendrie's devoted service as a member of the Hydro-Electric Power Commission of Ontario, and with his connection with the Hamilton Bridge Works Company, now as president, and for many years as general manager, know him to be an engineer with high technical attainments and business qualifications. It is conceded that it will be difficult to fill his place so adequately upon the Commission, but undoubtedly the service which he will render to the province in his new office will be most creditable, both to himself and to the choice of man for the high position he has undertaken to fill.

RUBBER-PAVED ROADS.

It is not yet practicable to construct roads with surfaces of rubber except at a cost of $25 per super yard. But there is little doubt that they will ultimately be adopted. At the International Rubber Exhibition held in London last July, rubber paving was shown both for use on footways and on carriageways which attracted a considerable amount of attention. In each case the rubber constituted a surface cushion on blocks of jarrah wood, the material being held tightly in position by dovetailing, while a special joint locked the paving, preventing, when laid, the access of water to the concrete foundations. It is contended that thinner foundations are necessary owing to the reduced amount of vibration which occurs by heavy and fast-moving traffic, and further, that it never becomes slippery and that motor vehicles do not "skid" upon it under unfavorable conditions of weather. A section of rubber paving has been laid in the Old Kent Road, London, for nearly 12 months where the traffic is heavy, amounting to 90 tons per square foot per hour for 24 hours, and is not perceptibly worn.

Another section of road is about to be laid in Cannon Street in the heart of the City of London, the corporation having granted the necessary permission to the acting agent of the Federated Malay States Government in order that its advantages can be better observed by all interested in the new development.

ROAD OIL SPECIFICATIONS AND TESTS.

IN the California Highway Bulletin for July, 1914, Mr. Clarence B. Osborne, Geologist to the California Highway Commission, presents the following specifications for and results of tests of asphaltic oil for road building. He states that in the preparation of such specifications the engineer has three problems presented: (1) He must have requirements controlling the chemical purity of the oil, i.e., he desires an oil that is free from foreign material and products of decomposition produced during refining. (2) He must control the chemical composition of the oil. (3) He must control the physical properties of an oil so that it will actually perform its proper function in the road construction.

Specifications for chemical purity of road oil are as follows:

(1) It shall not contain more than one-half of one per cent. of sediment by volume.

The presence of even ten times this amount of sediment is not detrimental, as the oil in use on the road eventually carries as high as 90% of mineral aggregate. This specification is used to prevent the buying of sediment at the price of road oil.

(2) It shall not contain more than one per cent. of water by volume.

The presence of water in a road oil makes the oil difficult to handle when heated above 212° F., because the steam formed makes the oil boil or froth. Also, as in the case of sediment, unless the proper deduction is made water will be paid for at the price of road oil.

(3) It must, when freed from water, be soluble to at least ninety-nine and five-tenths per cent. (99.5%) in pure carbon disulphide.

This will give the per cent. of bitumen in the road oil.

(4) The bitumen soluble in carbon disulphide must be soluble in carbon tetrachloride to the extent of at least ninety-nine per cent. (99.0%).

The failure to pass this specification is supposed to be an indication of an overheated or "cracked" oil. Carbon tetrachloride is not a stable solvent in bright light and the solubility test is influenced if the test is performed in bright light.

Another specification sometimes used to determine a "cracked" oil is as follows:

(5) In CS_2 bromide solution. The bitumen soluble in carbon disulphide must be soluble to the extent of at least ninety-nine and eighty-five one hundredths per cent. (99.85%) in a solution of one hundred and thirty-five (135.0) milligrams of bromine to one hundred (100.0) cubic centimeters of the carbon disulphide, when twenty-five (25.0) cubic centimeters of the solution are poured on two (2.0) grams of the oil in an Erlenmeyer flask, which is then shaken in the dark for three (3.0) minutes, the solution being immediately filtered through a Gooch crucible using a suction equal to a column of mercury more than eight (8.0) inches high.

When the solution has all passed through the crucible, the crucible is washed with pure carbon disulphide, dried at from two hundred and twelve (212.0) to two hundred and twenty degrees Fahrenheit and weighed.

This test had its origin in the examination of vegetable and animal fats. The unsaturated fatty acids form insoluble bromides. This bromide carbon disulphide solvent is not stable, however. An oil having an excess of 0.15% of insoluble material would fail to pass this specification, and yet this failure might be due entirely to the unstable solvent.

The specifications to govern the different constituents that make up the bitumen of the road oil are partly included in the specifications numbered (3), (4) and (5).

The road oils are generally classified as to their asphalt content. This asphalt is not a definite chemical compound determined by chemical analysis. To determine the asphaltic content, the road oil is hardened by heating it in an asphalt oven at a high temperature. Part of the light or volatile oils, is driven off in this heating and the residue is hardened. The degree of hardness is measured by the depth of penetration of a No. 2 needle when acting under a load of 100 grams for five seconds, the residue being maintained at 77° F. If the needle penetrates 8 mm. in this test the residue, called asphalt, is said to be asphalt of 80 penetration. As can readily be seen, this residue may contain many different bitumens. The test is not a measure of a definite chemical compound.

If the assayer for copper should call all the metal extracted "copper" when the metal was of a certain hardness, then it can readily be seen that any alloy of soft and hard metals that made this certain hardness would be classified as copper. This is the practical result of the specification for a road oil when it is required to contain a certain percentage of asphaltum.

The early oil-bound macadam roads built with asphaltic oils usually required an oil containing 70 to 75% of asphalt of 80 penetration. This oil was not heavy, that is, it lacked body (*i.e.*, low viscosity), and it was a weak binder but it was easily applied to the road surface.

The use of pressure tank wagons with sprayers for applying heated road oil has made it possible to use an oil of much higher asphalt content and of higher viscosity. The road oil that is now commonly demanded for oil-bound macadam, or for bituminous-covered concrete highways, is one that contains 90% of 80 penetration asphalt. The following specifications are suggested for such an oil:

(6) It shall contain 90 per cent. of 80 penetration asphalt.

This per cent. of asphalt is determined by heating 20 grams of the road oil in a 2-oz. salve tin in a standard asphalt oven, the temperature of the oven being maintained at 400° F. When the asphaltic residue has a penetration of 80, the oil shall not have lost in excess of 10% by weight.

The asphaltic content is the classification of the oil refineries of their different grades of road oil. The specification is of value more on this account than for any information of practical value furnished to the road builder.

(7) It shall show an open flash point not less than 350 degrees Fahrenheit.

This requirement prevents the use of an oil carrying very volatile constituents that would readily evaporate and might also be dangerously combustible at the time the oil was being sprayed on the road at the high temperature necessary for spraying.

The physical properties of a road oil are of the greatest importance to the road builder. The following specifications deal directly with the measurement of the important physical properties:

(8) It shall show a float test of not over 1,000 seconds when tested at 90 degrees Fahrenheit. This test is described in Bulletin No. 38 issued by the Office of Public Roads, United States Department of Agriculture.

This float test is the measurement of the viscosity of a road oil. The requirement will prevent the use of excessively viscous road oil, one that is difficult to apply and is slow to absorb the mineral aggregate necessary to the building up of the proper wearing surface.

(9) The oil shall show a specific viscosity of not more than one hundred (100) when tested with the Engler viscosimeter at a temperature of two hundred and twelve (212) degrees Fahrenheit.

This test will prevent the use of an oil that is too viscous to be readily applied to the road surface from the oil-spraying wagon.

(10) It shall show an adhesive test of not less than 300 seconds for three revolutions with the Osborne adhesive machines, when the oil is tested at a temperature of 77 degrees Fahrenheit, the load being 3 kilograms.

This test is the measure of the oil's power to prevent relative motion of two concentric cylinders which the oil acts as a binder between the surfaces of the two cylinders. The inner cylinder is 1.995 in. in diameter, the outer cylinder is 2 in. in diameter, the outer cylinder being in the form of a loose collar 2 in. wide. Its inner surface is coated with the oil to be tested. The outer surface of the inner cylinder is coated with oil and the collar then forced on the inner cylinder, which is maintained in a stationary position.

The outer collar is wound with cord to which a three-kilogram weight is attached; the pull of this weight causes the collar to revolve; the thin film of road oil between the two cylinder surfaces offers a resistance to this turning. The temperature of the oil being tested is maintained at 77° F. by means of water circulating in the inner cylinder. The measurement of the adhesive value of the oil is the length of time required for three complete revolutions of the collar.

Oils containing the same percentage of asphaltum will often show the greatest difference in their binding properties. Oils possessing the same viscosity will likewise often show a wide difference in adhesiveness.

As an example, one oil may be largely made up of heavy lubricating grease, another may be very free from lubricating material but they may both flow through a given-sized orifice at the same rate, when heated to the same temperature, that is, they have the same viscosity. The lubricating oil would lack binding power and be unsatisfactory for road construction; the other would be desirable. The adhesive specification would prevent the use of the unsatisfactory lubricating oil.

The asphalt contained in a road oil is required by some road builders to possess a certain ductility.

(11) The ductility of the asphalt which has been reduced to a penetration between 75 and 85 shall not be less than 110 centimeters.

This test is made with asphalt maintained at 77° F. and the pulling shall be at the rate of 5 cm. per minute, using the Dow ductility machine.

There is a woeful lack of uniform specifications for road oil and uniform methods of performing the tests. In the determination of the asphaltic content of an oil, the temperature for the asphalt oven is specified sometimes at 325° F., and from that to as high as 500° F.

The dish containing the road oil during the reduction is in some laboratories as small as a thimble, and in others, large enough to hold 500 grams; sometimes cylindrical, and others times semispherical in shape. Some tests require the use of an oven, others require heating in the open air. As has been shown, the "asphaltic content of an oil" is, at best, a rather indefinite term, and when we have added to this the different methods used and the wide range of equipment used, the "asphaltic content" becomes even more of a vague description.

The asphaltic road oils are, for the most part, a by-product of the oil refineries. They are a relatively cheap material. This cheapness saves the road oils from being adulterated with other material. It is expensive to add anything to the oil. The natural oil itself rarely carries undesirable material. The tests for water and sediment will take care of foreign materials brought in by the crude oil.

Some road engineers have regarded oil containing sulphur as dangerous to use because the sulphur is supposed to make the product unstable. Many oils and asphalts carrying sulphur have given good service for long periods of time and if sulphur does tend to make the oil unstable, this action is too slow to be of importance in the life of the oil used in the road construction.

MANY EUROPEAN NATIONS TO BE REPRESENTED AT PANAMA EXPOSITION.

In answer to numerous inquiries, President Charles C. Moore of the Panama-Pacific International Exposition, to open in San Francisco on February 20, 1915, has issued the following statement:

"One month ago, the decision of the Panama-Pacific International Exposition management not to postpone was first published. At the time the decision was made no word had been received from any foreign nation as to the effect on its plans caused by the European war, but it was hoped that at least those nations not fighting would go on with their plans. Later developments have proven that hope well founded; in addition, we have definite assurances from France, from Italy, from Turkey and from Japan that their intentions are unchanged. Holland has added $300,000 to her original appropriation. Italy has ordered work on her building and exhibits rushed. Japan has asked for and received an increase of space. The Argentine Republic has increased its appropriation from $1,250,000 to $1,750,000.

"We shall undoubtedly lose some of the promised exhibits from Europe, but not by any means all of them and not by any means the most important of them. Both Germany and Great Britain will be represented by individual exhibitors or by associations thereof.

Another evidence of the growing demand for American steel for South America was shown when orders were received at Pittsburg, Pa., for 100 miles of 80-pound steel rails. The order is the largest that has reached Pittsburg rail mills since the trend of the business to this country from South America began. The contract was placed with the United States Steel Products Company, the export department of the United States Steel Corporation.

Coast to Coast

Edmonton, Alta.—The 3-story structure being erected by the Bank of British North America has been completed at a cost in all of approximately $160,000.

Collingwood, Ont.—The corner-stone of the new Federal building, which is being erected at Collingwood by the Dominion Department of Public Works, was laid on September 10th.

Hamilton, Ont.—Much satisfaction is being expressed by citizens of Hamilton with the work being done on new civic roadways this year under the supervision of Mr. Eugene Whitley, assistant city engineer.

Regina, Sask.—The operation returns of the Regina Street Railway Department for the week ending September 5th showed a revenue of $3,322.60; while for the week ending August 29th, the revenue shown was $3,378.05.

Oakville, Ont.—Repairs to the piers at Oakville harbor are in progress. The wall has been raised at the east side, the floor has been levelled, and new sleepers have been installed. When the east pier has been fully repaired, the west pier will also receive attention.

Saskatoon, Sask.—The Dominion Interior Elevator at Saskatoon was to be ready for operations about 15th September. The structure is considered to be one of the finest pieces of construction of the kind on the American continent. The capacity of the present initial unit is 5,000,000 bushels, and its cost is about two million dollars.

Windsor, Ont.—On September 12th, Sir Adam Beck, chairman of the Ontario Hydro-Electric Commission, performed the inauguratory function of releasing to public service in the entire business section and many of the principal residential districts of Windsor electric light and power generated at Niagara Falls, 250 miles from the former city.

Winnipeg, Man.—During August the steam and electric pumps at Winnipeg handled 328,697,210 gallons of water as compared with 342,426,000 gallons in the corresponding month of 1913, a decrease of 13,545,390 gallons. The rate per 24 hours for August this year was 10,603,135 gallons, as compared with 11,040,083 gallons in 1913, a daily decrease for August this year of 436,948 gallons.

Fort William, Ont.—The financial report of the utilities of Fort William for the first six months of 1914 shows a total profit on the operation of all utilities of $20,954.34. Water shows a surplus of $5,463.97 above maintenance and fixed charges, the revenue being $47,653.44; light, a surplus of $14,245.55, and revenue of $59,912.80; and telephone, surplus, $1,244.82, revenue $31.565.16.

Regina, Sask.—A recent report made by the superintendent of the Regina street railway department to the utilities committee of the city council showed that expenses on that department are being steadily curtailed. Receipts for this year compared favorably with corresponding periods of 1913; and the operating expenses showed a decrease over last year, current figures being 92.9 per cent. as against 115.7 per cent. in 1913.

Regina, Sask.—A report upon the work being done by the provincial public works department on a large reinforced concrete culvert near Clark's Crossing, announces that this work is well under way and will be completed within a few days. Announcement is also made that the concrete bridge and dam being undertaken by the department near McTaggart E. 3-10-15 w. 2 are now under way and will be carried to completion.

Peterborough, Ont.—Work to proceed and be completed at Peterborough this autumn includes street paving and sewer construction, and the reconstruction by the G.T.R. of 50 miles of roadbed between Lindsay and Hastings. Moreover, it is understood that the Utilities Commission has under contemplation the extension of its mains, and that the Peterborough Radial Railway Company is prepared to rebuild immediately a portion of its Charlotte street line if the city will decide to pave the same section at the same time.

Fort William, Ont.—The depression caused by the outbreak of the war at Fort William was of short duration. About two weeks ago work was recommenced with a rush by the three transcontinental roads which make that city their lake terminus. The C.P.R., C.N.R., and G.T.P. doubled their rolling stock and equipment to provide for the shipping of grain into the city; and it is expected that this state of affairs will last well on into the winter, since rail shipments to west St. John this year will doubtless be the heaviest in history.

Victoria, B.C.—The tunnel at Macaulay point for the Northwest sewer at Victoria has been pierced after over 5 months' work, and is the first of 4 to be completed on this project. A second, that at Gore street, will be finished in about six or seven weeks, as there is only another 180 feet to complete. The other tunnels will not be finished this year. About 450 feet of the 1,800 feet in the Sunnyside tunnel has been pierced; while the other long tunnel of 2,700 feet will not be finished till the new year. The tunnel between Thomas and Robert streets, which is now opened, will be cleaned up and finished shortly, and the sewer pipe will be laid.

Regina, Sask.—Considerable work has been undertaken by the board of highway commissioners in Saskatchewan, arrangements having been made for an expenditure of $500,000 in road and bridge work. At the beginning of the current month, 150 road gangs, with crews of from 15 to 20 men each, and using 10 to 12 teams, commenced work. According to the recent statement of F. J. Robinson, chairman of the commission, these numbers will be considerably increased, since the commission is operating with the municipalities, using municipal equipment, and in general is seeking to turn municipal organization everywhere to the very best advantage.

Dunnville, Ont.—Satisfactory progress is reported at Dunnville on the Erie and Ontario Railway. The right-of-way for this road is 75 feet wide, and the grading now being done is 31 feet from one side, so that if later on the road is double-tracked the two tracks will be in the centre of the right-of-way. The grading is for single track, and the work is being advanced from 3 points,—Smithville, Attercliffe, and Dunnville. The switch from the Michigan Central to the Erie and Ontario has been graded; and the rails are laid on it for the greater part of the distance. Revised tenders for the stations and freight sheds were received recently, and it is expected that the contracts for these will soon be let.

London, Ont.—The major portion of the work on the London breakwater provides for a 3-foot by 2-foot concrete base toe line and a 26-foot natural slope front of embankment faced with reinforced concrete 11 inches thick at the base and 7 inches thick on the top of the slope, where provision is made for a substantial concrete cap and a 5-foot sidewalk with guard tubular iron railing. Short lengths of vertical retaining walls will be necessary at the Oxford and Blackfriars bridge ends of the breakwater. The proposition is to provide for a top area of embankment, giving provision for a driveway, and utilizing existing conditions without disturbing trees or making excessive filling necessary in fixing face line of embankment. The estimated expenditure, as authorized, is $25,000.

Empress, Alta.—The construction of the large bridge which the C.P.R. company is erecting across the Saskatchewan river 6 miles east of Empress is nearing completion. All of the 36 massive piers have been completed. The contract for the steel work on the structure is held by the Canada Bridge Company, and the steel material is arriving at the site. The company commenced work however, on August 31st; and it is expected that the bridge will be entirely complete by October 15th, and that the new C.P.R. line will be connected from Swift Current to Bassano. The ballasting of the line is nearly completed to the bridge, both from the east and west, and it is expected that a train service will be established at an early date the full length of the new line.

Montreal, Que.—A recent important announcement from the headquarters of the G.T.P. system is to the effect that a through passenger and freight service would be put in operation the third week of September between Fort William, Ont., and Price Rupert, the Pacific terminus of the line. The line from the head of the Great Lakes at Fort William to Winnipeg and Edmonton has been in operation for some time. Trains have also been operated westward from Edmonton to Prince George, a distance of 486 miles, and from Prince Rupert eastward to Priestly, a distance of 335 miles. A gap of 131 miles between Priestly and St. George remained unfinished. The laying of the steel was actually completed in April last; but aiming at absolute safety and efficiency, the opening of the system was delayed until the present time.

Fenelon Falls, Ont.—The new dam which has been under construction by the Dominion Government just below Fenelon Falls, and has been supervised by Mr. Alex. Spence and erected by Messrs. McPhee and Kehoe, of Brechin, is now almost complete, and will soon take the place of the old wooden structure which has served at that point for many years. The length of the new dam is 325 feet between the abutments; and consists of 12 large piers, with grooves in either side, for holding the stop-logs. A platform runs from end to end above the sluices connecting the piers; and both platform and piers are built entirely of reinforced concrete. On the platform a track is laid for the purpose of conveying the machinery necessary for adjusting the stop-logs. In the construction of the dam about 2,000 barrels of cement and 2,500 cubic yards of gravel were used. Altogether $47,000 has been granted for the work by the Government; but with the improvements on the original plans and other necessary expenditures above the estimates the total cost will doubtless be $55,000.

PERSONAL.

Lieut.-Col. Hon. J. S. HENDRIE, of Hamilton, has been appointed Lieutenant-Governor of the Province of Ontario, succeeding Sir John Gibson.

R. M. MILAN, of Saskatoon, has been appointed electrical superintendent of the Dominion Government interior storage elevator at Moose Jaw. He will have charge of both installation and operation.

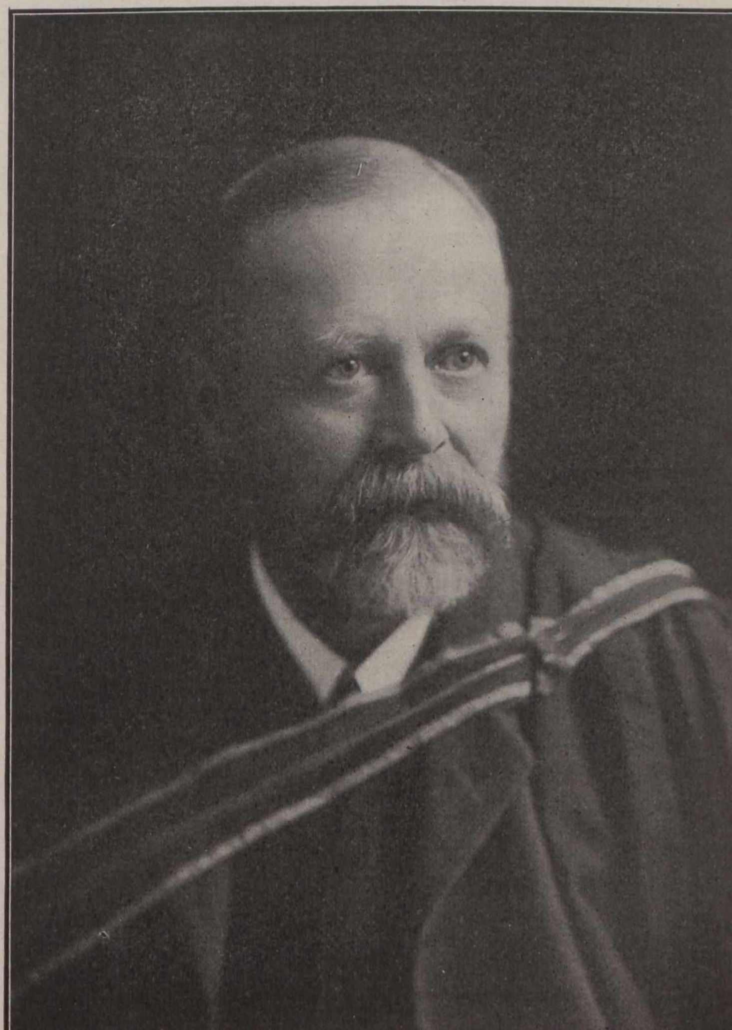
DR. G. G. NASMITH, director of the civic laboratories at Toronto, Ont., has been appointed advisory officer on sanitation to the Canadian expeditionary force, and is leaving Valcartier this week with the first contingent.

BOARD OF HEALTH APPROVES.

During the week ending Sept. 19th the Provincial Board of Health of Ontario approved of the waterworks extensions for the town of Smith's Falls, and of the construction of sewers in Smith's Falls and York Township.

W. H. ELLIS, M.A., M.B., ACTING DEAN OF ENGINEERING, UNIVERSITY OF TORONTO.

The Faculty of Applied Science and Engineering of the University of Toronto resumes activities this week under the direction of William Hodgson Ellis, M.A., M.B., as acting Dean, thereby temporarily filling the vacancy occasioned by the death of Dr. John Galbraith on July 22nd. Dr. Ellis' appointment to the head of the faculty council comes after a maximum period of connection with the institution, which, until 1906, had been known, since its organization in 1878, as the School of Practical Science. In fact, in the earlier seventies he was a member of the staff of the College of



W. Hodgson Ellis, M.A., M.B.

Technology, the prototype of the institution. In 1878 he became assistant to the Professor of Chemistry, Dr. H. H. Croft. Later, he assumed the professorship in Applied Chemistry.

VICTORIA BRANCH, CANADIAN SOCIETY CIVIL ENGINEERS.

The Victoria branch of the Canadian Society of Civil Engineers recommenced its activities by a meeting on Sept. 17th. Committees were appointed and a program for the season's work discussed. On Sept. 19th the members of the Branch paid a visit to the works of the Pacific Lock Joint Pipe Company at Cooper's Cove, where pipe is being manufactured for the Sooke Lake water supply system.

BURRARD TUNNEL AND BRIDGE COMPANY.

At the annual meeting of the Burrard Tunnel and Bridge Company, of Vancouver, held early last month, officers of the previous year were re-elected. The standing committees are also the same as last year. The company was formed to undertake the construction of the Second Narrows Bridge across Burrard Inlet for details respecting this work the reader is referred to *The Canadian Engineer*, August 27th, 1914, issue. The board of directors of the company is as follows: President, Mr. F. Carter Cotton; vice-president, Reeve May, North Vancouver, and Messrs. Woodside, Loutet, Bridgeman and Vance, with the mayors of Vancouver city and North Vancouver, and the reeves of North Vancouver municipality and West Vancouver, members ex-officio.

CANADIAN GAS ASSOCIATION.

Last week the 7th annual convention of the Canadian Gas Association was held in Ottawa, about 150 representatives of gas plants throughout the Dominion being present. The following officers were elected for the ensuing year: President, H. E. Mann, Chief Engineer, Montreal Light, Heat and Power Company; first vice-president, R. A. Wallace, Manager Quebec Railway, Light, Heat and Power Company; second vice-president, J. M. H. Young, Manager London Gas Company. Executive Committee— A. A. Dion, General Superintendent Ottawa Gas Company; Arthur Hewitt, General manager Consumers' Gas Company, Toronto; Mayor Samuel Carter, Guelph; J. P. King, Manager Stratford Gas Company.

The next convention will be held in Montreal.

C.G.E. CORPS OF ENGINEERS.

In our issue of last week mention was made of the corps of engineers established by the Canadian General Electric Company for service at Quebec, Halifax and Esquimalt. We are able in this issue to reproduce from a photograph taken prior to their departure. Reading from the left, they are:—

Back Row, Standing—H. S. Elliott, Charles Stewart, C. Pink, W. J. Swanger, F. G. Jackson, H. Williams, E. S. Shill.

Front Row, Standing—Capt. Ritchie, A. T. McLean, W. S. Johnson, J. S. Dunlop, G. Hillier, C. Henry, George Monaghan, A. Hardie, J. C. Munro, C. C. Rous.

Front Row, Seated—P. Foster, E. Crockford, H. S. McKean, A. J. Palmer, R. W. Nurse, H. Calvin, R. Lethune, H. Bestard.

COMING MEETINGS.

MOTOR TRUCK CLUB OF AMERICA.—Annual Convention, Detroit, Mich., October 7th to 9th. President, George H. Duck, New York City.

GULF AND INTEROCEAN NATIONAL HIGHWAY ASSOCIATION.—October 8th, 9th, 10th; conference to be held at New Orleans, La. Secretary, Jno. B. Kent, Lake Charles, La.

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS.—Annual Convention, Grunewald Hotel, New Orleans, La. October 20th to 23rd. Secretary, Mr. McFall, Roanoke, Va.

ALABAMA GOOD ROADS ASSOCIATION. — Nineteenth Annual Convention will be held from October 21st to 23rd at Montgomery, Ala. Secretary, J. A. Rountree, 1021 Brown Marx Building, Birmingham, Ala.

NORTHWESTERN ROAD CONGRESS.—Annual Convention, to be held at Milwaukee, Wis., October 28th to 31st. Secretary, J. P. Keenan, Milwaukee.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—Charles Carroll Brown, Secretary, Indianapolis, Ind. Meets at Somerset Hotel, Boston, Mass., October 21st, 22nd and 23rd.

AMERICAN HIGHWAYS ASSOCIATION.—Fourth American Road Congress to be held in Atlanta, Ga., November 9th to 13th, 1914. I. S. Pennybacker, Executive Secretary, and Chas. P. Light, Business Manager, Colorado Building, Washington, D.C.

WASHINGTON STATE GOOD ROADS ASSOCIATION.—Convention to be held at Spokane, Wash., November 18th, 19th, and 20th. Secretary, M. D. Lechey, Alaska Building, Seattle, Wash.

ANNUAL MEETING, AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The annual meeting of the American Society of Mechanical Engineers will be held in New York, December 1st to 4th, 1914. Secretary, Calvin W. Rice, 29 West 39th Street, New York.

The Robert W. Hunt and Company, Limited, has removed its Vancouver, B.C., office and cement and physical testing laboratories from the Bank of Ottawa Building to the Standard Bank Building, 508 Hastings Street West.