PAGES

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THE CANADIAN ENGINEER
An Engineering Weekly.

IRON AND STEEL BOUNTIES.

Statement showing bounties paid to the various iron and steel companies of Canada on iron, steel, etc., during the fiscal year ended March 31st, 1910.

These bounties are for 740,244 tons of pig-iron, 695,752 tons of steel, and 538,812 tons wire.

Company.	Pig-iron.	Steel	Wire Rods.	Totals.
Algoma Steel Co., Ltd., Sault Ste. Marie, Ont.	$136,068.40	$182,746.37	$..........	$318,814.77
Dominion Iron and Steel Co., Ltd., Sydney, N.S.	174,442.96	316,248.59	538,812.30	1,029,503.85
Nova Scotia Steel and Coal Co., Ltd., Sydney Mines, N.S.	36,075.60	61,270.19	....	97,345.79
Hamilton Steel and Iron Co., Ltd., Hamilton, Ont.	162,013.64	76,394.71	....	238,408.35
Canada Iron Corporation, Midland, Ont.	31,935.79	....	....	31,935.79
Canada Iron Corporation, Radnor Forges, Que.	7,691.71	....	....	7,691.71
Canada Iron Corporation, Drummondville, Que.	520.56	....	....	520.56
Lake Superior Iron & Steel Co., Sault Ste. Marie, Ont.	....	54,628.56	....	54,628.56
Ontario Iron & Steel Co., Welland, Ont.	....	4,463.73	....	4,463.73
Atikokan Iron Co., Pt. Arthur, Ont.	15,099.76	....	....	15,099.76
Standard Chemical Co., Deseronto, Ont.	10,120.46	....	....	10,120.46
	$573,968.88	$695,752.15	$538,812.30	$1,808,533.33

DENSITY OF POPULATION.

The density of the cities of the old world has been frequently referred to and reliable data is readily secured. The density of population in America is becoming a study and the increase in density will call for increased attention to health and conveniences.

The American cities, with a population of over three millions, or an average of 338,838 each, have a total area of 195,168 acres, or 21,685⅓ acres per city, equivalent to 2,788 square feet per capita.

City.	Area Acres.	Per Capita Sq. Feet.
Buffalo	26,880	2,918
Cincinnati	27,840	2,526
Detroit	23,040	2,221
Indianapolis	19,840	3,485
Jersey City	12,288	3,091
Kansas City	16,640	2,396
Los Angeles	19,840	2,875
Minneapolis	34,080	4,791
Newark	14,720	2,004
Toronto	17,920	2,399

Toronto, with 2,399, is 389 square feet per capita behind the average of these nine cities of the United States, all of which are thickly populated.

The eighteen cities of Ontario aggregated, cover a total area of 80,341 acres. This is equivalent to 4,813 sq. feet per head of population, including streets, parks and open spaces. The proportion of streets, parks, public buildings, churches, etc., has been variously estimated at from ¼ to ⅓ of the total area. The latter figure is doubtless the more accurate, being based on the opinions of about 20 city engineers furnished the writer some time ago. On this basis the eighteen cities have a net area of 53,561 acres.

The position of Toronto, last in the table, is more or less problematical. With 44.76 per cent. of the population of all the cities of Ontario, only 22.3 per cent. of the total area is at her credit, as assessed in 1910. If the area should be doubled the "Queen City" would still be 120 acres short of the average standards, a serious situation, requiring attention. Apart from the street car imbroglio, this overcrowding may not be apparent to the individual observer, but nevertheless it is a real, vital fact. Even London, England, has 358 square feet per capita more than Toronto.

CANADIAN RAILWAY STATISTICS.

The annual report of the Comptroller of Railway Statistics, Mr. J. L. Payne, presented to Parliament on December 16th, gives some illuminative figures as to the marked railway development of the Dominion during the twelve months ending with June 30th last.

The total railway mileage increased from 24,104 in 1909 to 24,731 in 1910, an addition of 627 miles. Of this increase, 519 miles were in the four Western provinces. These figures do not include any mileage attaching to the Grand Trunk Pacific, which is officially regarded as "under construction," although over 1,000 miles were in actual operation during 1910. It is estimated that 4,500 miles of railway were under construction on June 30th last. During the past four years there has been an increase of 2,279 miles of main line track, 476 miles of second track and 1,063 miles of yard track, a total of 3,818 miles.

During the year $101,816,271 was added to capital liability, bringing the total up to $1,410,297,687, of which $687,557,387 was represented in stocks and $722,740,300 in bonds. The actual outstanding liability on June 30th last, after eliminating duplications, was equal to $52,361 per mile of line.

Cash subsidies during the year amounted to $1,789,723, bringing up the total to $146,932,180 by the Dominion, $65,837,060 by the Provinces, and $17,983,823 by the municipalities. In addition, 55,292,321 acres of land have been granted, of which 32,040,378 were alienated by the Dominion. The guarantees to June 30th amounted to $127,336,357.

The public service of Canadian railways was represented in the carrying of 35,894,575 passengers and 74,482,866 tons of freight, an increase over 1909 of 3,211,267 passengers and 7,640,608 tons of freight. The average number of passengers per train was 59, and the average passenger journey 69 miles. The average freight train consisted of 311 tons, and the average haul was 211 miles. The average passenger journey and average freight haul in Canada are the longest in the world.

The gross earnings for 1910 were $175,956,217, a gain of $28,899,881 over 1909, or 19.9 per cent. Operating expenses amounted to $120,405,440, an increase of $15,805,356. The net earnings were $53,550,777, or 32.3 per cent. better than for preceding years.

Railway fatalities numbered 615, and 2,139 were injured. Of these, 524 were killed and 1,441 injured from the movement of trains. The killed included 60 passengers and 214 employees. One passenger in every 598,243 was killed, and one in every 132,943 injured. One trainman in every 199 was killed, and one in every 33 injured.. In 1909 there were 36 passengers killed and 281 injured. The accidents at highway crossings during the year resulted in 63 persons being killed and 61 injured.

The 123,768 employees involved a wages and salary bill of $67,167,793, as compared with $63,216,662 in 1909. In addition, 16,709 employees were engaged in outside operations at a cost of $5,169,923. The wages bill for all railways four years ago amounted to $58,719,493.

The mileage for electric railways grew from 989 in 1909 to 1,049 in 1910. Capital liability increased from $91,604,989 to $102,044,979. Gross earnings reached $17,100,789, a betterment of $2,275,853. Net earnings amounted to $5,383,276, after making a deduction of $2,953,759 for taxes, interest on funded debt, etc. The electric railways of Canada carried 360,964,876 passengers in 1910 and 853,294 tons of freight. The employees numbered 11,390, and the wage bill was $6,316,777.

Accidents led to the death of 95 persons and the injury of 2,538.

ADVANTAGES, OPERATING CONDITIONS AND APPLICATIONS OF SMALL EXHAUST STEAM TURBINES.

A. Eugene Michel.

Increasing the power of a plant where the requirements have outgrown its original capacity, but are not great enough to justify scrapping the old and replacing with new units is a trying problem that is often made easy by means of the exhaust steam turbine. This is well illustrated, for instance, in a mill deriving its power from a simple non-condensing engine and in which the addition of machinery from time to time has increased the load on the engine beyond a practical limit. The owner can secure more power in three different ways:

First—He can install a larger or additional engine which is an expensive proposition at best, requiring additional boiler capacity, perhaps involving expense for enlarging the buildings, and increasing labor and upkeep costs materially. Seldom can over 20 per cent. of the new expenditure be netted from the sale of the old apparatus, taking into consideration the installation costs, etc. Further, the power needs, unless the increase is large, do not usually warrant big expenditure.

Second—More power may be secured by running the old engine condensing, but a condensing engine either simple or compound and even when operating at the most economical point of cut off and otherwise under the best conditions can hardly deliver 20 to 25% more power than when running non-condensing. The increase obtainable and practical will hardly be greater with a compound than with a simple engine and in either case the change may subject the engine to a constant load, greater than that for which it was designed. Where this is true the overload is in time bound to prove injurious and the economy improvement and power increase are partially counterbalanced by deterioration of the unit.

The Third Method—that of changing the engine to condensing and utilizing the additional range of pressure drop to drive an exhaust steam turbine—is far more logical. In this way it is possible not only to almost double the amount of power previously secured from the engine, but this is done without increasing the duty on the engine and without using more steam than before. Such an installation is illustrated in Figure 1. The initial cost of the turbine and condenser per horsepower is less than for additional boiler and engine capacity, but there is not the compulsion to buy more than may be required.

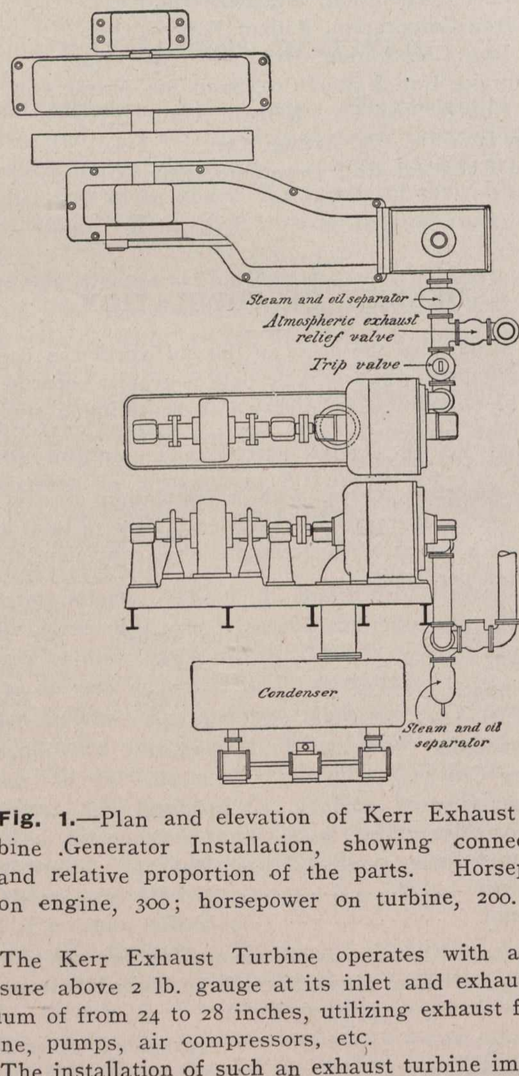

Fig. 1.—Plan and elevation of Kerr Exhaust Turbine Generator Installation, showing connections and relative proportion of the parts. Horsepower on engine, 300; horsepower on turbine, 200.

The Kerr Exhaust Turbine operates with any steam pressure above 2 lb. gauge at its inlet and exhausts into a vacuum of from 24 to 28 inches, utilizing exhaust from main engine, pumps, air compressors, etc.

The installation of such an exhaust turbine improves the economy most and offers the greatest capacity increase where the turbine and a suitable condenser are added to a simple non-condensing engine. For the smaller sizes the ordinary jet codenser maintaining 24 to 26 inches vacuum may be used with satisfaction. In larger units condensing apparatus maintaining higher vacuum is justified. A substantial improvement in economy and increase in capacity also result from the addition of an exhaust turbine to a simple condensing engine and from the addition of turbine and condenser to a compound non-condensing engine. The exhaust turbine can also be utilized to advantage with compound or even triple expansion engines where increased capacity is important.

In general, the steam economy of a simple engine and exhaust steam turbine together is always an improvement over that which would be obtained by compounding and adding a condenser. The plant capacity is increased from 50 to 100 per cent. by exhausting through an exhaust turbine to condenser on a non-condensing engine, while the increase by adding the turbine to a condensing outfit is from one and one-half to three times that which could be secured from the condenser alone.

As a engine and exhaust turbine installation takes no more steam than would the engine alone and under the same conditions as before, there is not an additional penny of expenditure necessary for boilers, chimneys, draft, coal handling apparatus, buildings and steam piping. The turbine and condenser, or turbine alone in a condensing plant, can be cut into the exhaust line without interfering with the engine and usually without otherwise altering the layout of the plant. The installation of the turbine hardly affects plant operating costs as the turbine is adjusted at the factory and seldom requires other attention than occasional lubrication and repacking of stuffing boxes. The oiler, who has previously been taking care of the engine, can look after the turbine too, without any serious drain on his time, for the turbine should run constantly for months without shutdown.

An engine that has previously been running non-condensing, continues to exhaust at about the same pressure and carries the same load after the turbine is put into the exhaust line. A condensing engine can be adjusted to exhaust at atmospheric pressure or thereabouts and will be relieved of that part of the load assumed between atmospheric pressure and the vacuum while the turbine is being operated. The water of condensation will be discharged from the condenser at a temperature within two or three degrees of the theoretical and can be utilized in the usual ways.

In short, the increase in output obtained from a condensing reciprocating engine and exhaust turbine set is greater by about 25 per cent. than obtainable with any condensing engine alone while the installation of turbine ad condenser upon a non-condensing engine increases the output from about 40 to 100 per cent.

Power developed by an exhaust steam turbine is available for driving a generator, centrifugal or air pump, fan or any high speed machine or for belt or silent chain driving, and under much the same conditions as that obtainable from high pressure turbines. Rigged up for belt or chain drive, the exhaust turbine delivers into the same line or jack shaft as the engine, in which case the turbine assumes an almost fixed proportion of the load. Figure 2 is a typical installation of this kind. The output of the turbine may be delivered entirely independent of the engine to drive belted auxiliaries or machinery of any kind, the speed requirements of the driven machine being perfectly met by a conforming pulley ratio.

An exhaust steam turbine may be arranged to carry a uniform or fluctuating load regardless of whether the load upon the engine, and consequently the source of steam supply to the turbine is constant, fluctuating or even entirely cut off for short intervals.

When operating in connection with an engine which is under constant load the turbine will, of course, receive its steam supply quite uniformly, save for the pulsations at the exhaust period. These in no way interefere with the action of the turbine. Under this condition of practically constant steam supply, the turbine will carry any or fluctuating load up to its maximum without governing device save an over-speed governor, which merely keeps the speed below a predetermined maximum and prevents racing in case the turbine is suddenly relieved of its load. The steam supply of the turbine may be throttled where the load is uniformly light and the surplus exhaust steam from the engine can be discharged into an exhaust stack or sent to the feed-water heaters. As a rule, however, the exhaust from the auxiliaries in an ordinary plant furnishes all the steam required for heating the feed water, thus leaving the entire exhaust of the main engine available for use as required by the turbine. The matter of steam supply for the turbine is therefore very simple where the main engine is under constant load.

It usually happens, however, that the load upon the engines and consequently the steam supply for the turbine varies greatly at different times as in electric lighting or railway plants. In this instance there are several practical methods of maintaining steam supply to keep the turbine up to desired constant or maximum capacity.

The maximum output desired from the turbine may be small so that the steam supply from the engine exhaust is always ample, even at points of lowest engine load. The condition then, as far as the turbine is concerned, is about the same as previously explained in that the turbine may draw its supply from the exhaust stack, or direct from the engine, the surplus exhaust being discharged to atmosphere without affecting the operation of the turbine.

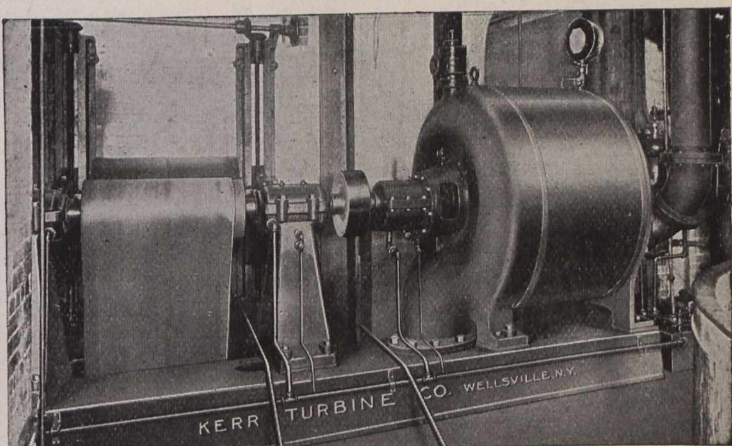

Fig. 2.—Kerr Exhaust Steam Turbine in the plant of the Wanaque River (N.J.) Paper Co. This turbine develops 200 h.p. at 1,500 r.p.m., when supplied with steam at 3 pounds gauge and exhausting into a 26-inch vacuum. It is receiving the exhaust steam from a 20-in. by 42-in. Corliss engine and is belted to deliver into the same line shaft as does the engine. This engine, when operating condensing, delivered approximately 415 h.p., but with the exhaust turbine the outfit now develops 575 h.p. while using the same amount of steam.

If, on the other hand, the turbine at times demands more steam than is available from the engine exhaust, as where the peak load of the turbine comes at the period of lightest engine load, the deficiency can be temporarily supplied by supplementing the live steam.

In many plants, such for instance as condenser installations, where the low pressure turbines are driving centrifugal pumps for circulating water, it is often desirable to start the condenser and produce the vacuum before the exhaust steam is available for the low pressure turbine, or that the vacuum be produced to enable the operation of the turbine with steam at atmospheric pressure. For such installations a mixed pressure machine lends itself equally to high pressure non-condensing, high pressure condensing, low pressure condensing, or mixed pressure condensing. Where a greater increase of plant capacity is desired than that brought about by using the exhaust steam available, a mixed pressure turbine solves the problem of utilizing the full amount of exhaust steam and automatically taking high pressure steam only in such quantity as is necessary to care for the load on the turbine.

Many industrial plants having engine-driven rope or belting desire additional power at some remote part of the mill. The mixed pressure turbine with a generator attached offers an easy solution. The turbine utilizes the exhaust of the main engine while the latter is operating and while requiring not a pound more fuel and no more labor, gives from 60 to 100 per cent. increased capacity. If it is desired to operate the electrical portion of the mill only, the turbine is then operated purely as a high-pressure machine.

Where a high-pressure Corliss engine has been installed with a view to later compounding when capacity must be increased, a mixed pressure turbine for belt drive can be more profitably installed than the low pressure side of the engine. First cost, economy of floor space and the ease with which the turbine and engine can be operated together or independently make such an installation attractive.

Where the turbine takes the intermittent exhaust from a number of pumps or engines a constant flow to the turbine can be maintained by putting a regenerator between engine and turbine. The regenerator acts as a receiver during the periods of excess supply, condensing the steam, and storing its heat to be utilized later in re-evaporating and producing a supply for the turbine during the period of deficiency. The regenerator thus cushions the engine pulsations and keeps a reserve steam supply right at the turbine ready to meet sudden demands.

An exhaust steam turbine is readily adaptable to driving an electrical unit in connection with either an engine-driven generating set or a reciprocating engine in other service.

It is quite practical, for instance, to utilize the exhaust from the engines of an electrical railway plant to drive turbines directly connected to generators that deliver into a lighting system, even if the peak load on the power generator comes at the same time as the minimum load on the lighting circuit or vice versa.

It is frequently desirable to arrange generators on both engine and exhaust turbine to deliver into the same bus bars, in which case each of the generators assume a practically fixed proportion of the load regardless of the total load variations. The advantage of this arrangement in providing an enormously increased capacity at the peak load is especially apparent in a lighting or railway plant. Remembering that the capacity of the turbine can be made to increase as the load on the engine increases, the total peak load capacity can be made at least from 50 to 70 per cent. greater than with the one generator alone and the engine running non-condensing.

Wherever the engine-driven unit and the turbo-generator deliver to the same system, the turbine should be kept in use as much as possible, for best steam economy is found during the time that both are working, although the turbo-generator or engine may be thrown out of service while the load is light or repairs are necessary.

Plants containing a number of engine-driven units can be equipped with an exhaust turbine for each engine and the additional power thus secured will carry the load with about one-half to one-third less steam, fewer engines in operation and the rest in reserve. A greatly increased output is possible with all engines in service, but without using more steam. Several engines may be made to exhaust into a large receiver separator, which in turn may supply the exhaust turbines and thus reduce the number of boilers under steam.

THE SANITARY REVIEW

SOME COMMENTS UPON WATERWORKS MANAGEMENT SUGGESTED BY THE RECENT SPECIAL REPORTS OF THE UNITED STATES COMMERCE AND LABOR DEPARTMENT.*

By Leonard Metcalfe, of Metcalfe & Eddy, Consulting Civil Engineers, Boston, Mass.

When your secretary asked me to address you upon some subject that might be of interest to water works managers, it occurred to me that the recent "Special Reports" of the United States Commerce and Labor Department, Bureau of the Census, upon "Statistics of Cities having a Population of Over 30,000," to which I had recently given serious study, and which I found to contain some valuable information relating to the financial condition of municipal water works,—though fragmentary and in some respects inconclusive,—might be of some interest to you. If you have not already seen them they are worthy of your attention.

The first report of this kind published by the United States Government covered, I believe, the operations of the year 1905, and there are now available such reports for the years 1905, 1906, and 1907, and later ones will doubtless follow. I shall limit my remarks to the water works statistics contained in the report for the year 1907, published in 1910, since this report is the most up-to-date and contains the greatest amount of information. I might also add that some of the bases of comparison were slightly improved by the assumption made in the 1907 report as compared with those of the 1905 report.

Incomparability of Certain Data.—It is necessary at this point to call your attention to the danger of attempting to compare certain of the figures submitted, and to discriminate between those data which should be reliable for purposes of comparison and those which are likely to be incomparable on account of the difference in the accounting methods used in different cities, and the bases or assumptions upon which the information collected by this bureau have been based. The Department itself calls particular attention to this danger of attempting to compare the results in certian lines, especially those relating to net cost and present value of system, inasmuch as,

> "Among such differences the following are conspicuous: (1) many cities make no distinction between cost and present value; (2) in cities that have purchased water-supply systems, the value of the franchise is included in the reported cost in some cases, and in both reported cost and present value in

*Paper read at the annual meeting of the Pennsylvania Water Works Association at Atlantic City, N.J., October 20th, 1910.

other cases; (3) the allowance for depreciation, overlooked in the great majority of cities, is excessive in a few cities; similarly the appreciation of real property values is usually ignored, but in a few cities furnishes an important addition to the present value."

The outstanding debt, of course, furnished no criterion of cost or value of the works, though it should, taken in conjunction with the latter, (were the latter correct), furnish a criterion of the extent to which past generations had been taxed for the benefit of the present and future generations in the liquidation of the water debt.

In many, perhaps most, cities no charge is made for water used for municipal purposes. An estimate has therefore been made by the Bureau of the "value of services to the city computed on the basis of 44 cents per capita for all cities of Group I, 46 cents for Group II, 48 cents for Group III, and 50 cents for Group IV."

The annual depreciation has been estimated on a basis of 2 per cent. of the present value, as shown in the tabulations. Here again it will be noted that owing to the uncertainty concerning the accuracy of the estimate of the present value of these works the allowance for depreciation is also approximate only. Engineers are in the habit of basing depreciation upon reproduction cost rather than present value of the works, for the reason that the depreciation takes place upon the physical structure rather than upon the so-called intangible values, such as going value or franchise value of the plant. It should also be noted that this depreciation allowance is based upon the so-called straight line method under which the depreciation fund is not assumed to enjoy any accretions from interest or earnings upon it from year to year, the 2 per cent. allowance corresponding to a 50-year assumed length of life.

The taxes for the works reported have been based upon the assumption of the reported "present value of system," and the basis of taxation in force, and rate of tax in the cities served by these works, reported elsewhere in this special report.

The interest on present value of system is based upon the "present value of system," a rate of interest being used corresponding to the average rate paid upon the water debt in the several cities, which must vary therefore with the credit of the city and is not uniform throughout the tabulation.

The relation between earnings and costs of services is therefore open to the same doubts as to accuracy, so far as certain items go, as apply in the data reported upon earnings and costs of services. The unit "Earnings," "Expenses of Operation," and "Interest" are approximate only in character, owing to the fact that the earnings include an estimate of value of services to the city (in free water for municipal purposes) in addition to the actual gross income; the expenses of operation include allowances estimated for depreciation and taxes; the interest is based upon a present valuation, of doubtful accuracy, and a rate corresponding to the credit of the city or of its water department.

Comparable Facts.—While the unreliability of certain of the information contained in these reports is apparent and is well recognized and commented upon by the Government officials,—who have done a very valuable work in bringing to the public's attention the urgent need of more rational methods of accounting and of compiling and reporting data upon such bases as to make them strictly reasonable or capable of comparison—some other facts are comparable and of value to you as operators.

It is to certain of the latter facts,—the actual earnings and operating expenses of the public water works, reported in this Government report,—that I desire to call your attention, as bearing upon the danger of direct comparison of water rates without careful study of the "reasonable rate" based upon the real value of the particular works under question, the character of service rendered by them, etc.

The facts relating to physical plant should be reliable, as should be the "collections for services to the public" which correspond to gross actual income; the "payments for salaries, wages and miscellaneous objects" which correspond to the ordinary operation and maintenance expenses **exclusive** of taxes, depreciation, fixed charges, or profits; the "excess of collections for services to the public, over payments for salaries, wages, and miscellaneous objects," meaning thereby the difference between gross actual income and operation and maintenance expenses as defined above.

Description of Tables.—With this preamble I submit for your consideration certain tabulations taken from the Government report for the year 1907, above referred to, and others based upon them.

TABLE A.

United States Commerce and Labor Bureau Special Report of 1907.

Estimated Earnings, (gross income plus allowance for public service),* **Expenses of Operation,** (including allowance for taxes and depreciation), and **Interest,** (upon estimated present value, with rate of interest corresponding to rate paid upon water debt), per capita and per million gallons of water supplied, for cities having a population of upwards of 30,000.

Group.	No. of cities.	Cities having population of	Per capita. Earnings.	Per capita. Expenses of operation.	Per capita. Interest.†	Average per million gallons supplied. Earnings.	Average per million gallons supplied. Expenses of operation.	Average per million gallons supplied. Interest.
I.	14	Above 300,000	$2.79	$1.96	$1.07	$50.59	$35.47	$19.34
II.	24	100,000-300,000	2.68	1.69	1.18	86.37	54.62	38.18
III.	34	50,000-100,000	2.38	1.71	1.04	75.89	54.56	33.18
IV.	45	30,000-50,000	2.17	1.47	0.90	73.59	49.84	30.58
	117		$2.64	$1.82	$1.07	$59.63	$41.01	$24.08

*The assumed allowances are for Group I, 44c. per capita; Group II, 46c. per capita; Group III, 48c. per capita; Group IV, 50c. per capita.

†The present value of the system, upon which the interest charge is based, is of doubtful accuracy, probably consid rably less than the actual present value.

Table A is abstracted directly from the Government report. It shows in substance the gross earnings (including an allowance for public water service), the expenses of operation, (including operation and maintenance expenses, and allowances for taxes and depreciation, but excluding fixed charges and profit), interest (computed at a rate corresponding to that paid upon the water debt, based upon the reported, probably inaccurate, "present value of system"), all per capita and per million gallons of water pumped or supplied, and for each of the 4 groups into which the cities have been divided,—comprising cities having a population,

1st above 300,000,
2nd between 100,000 and 300,000,
3rd between 50,000 and 100,000,
4th between 30,000 and 50,000.

TABLE B.

Based upon United States Commerce and Labor Bureau, Special Report of 1907 omitting cities for which the data is incomplete as below‡

Estimated Earnings, (gross income plus allowance for public service),* **Expenses of Operation,** (including allowance for taxes and depreciation), and **Interest,** (upon estimated present value, with rate of interest corresponding to rate paid upon water debt), per capita and per million gallons of water supplied, for cities having a population of upwards of 30,000.

Group.	No. of cities.	Cities having population of	Per capita. Earnings.	Per capita. Expenses of operation.	Per capita. Interest.†	Average per million gallons supplied. Earnings.	Expenses of operation.	Interest.
I.	13	Above 300,000	$2.91	$2.22	$1.19	$55.96	$43.39	$24.24
II.	20	100,000-300,000	3.07	2.07	1.45	86.69	58.28	39.85
III.	33	50,000-100,000	3.16	2.30	1.39	87.50	63.25	37.25
IV.	39	30,000-50,000	3.03	2.09	1.23	90.51	60.12	37.36
	105		$3.06	$2.17	$1.34	$84.56	$58.68	$36.17

*The assumed allowances are for Group I, 44c. per capita; Group II, 46c. per capita; Group III, 48c. per capita; Group IV, 50c. per capita.

†The present value of the system, upon which the interest charge is based, is of doubtful accuracy, probably considerably less than the actual present value.

‡Omissions in Group I, New Orleans; Group II, Indianapolis and Denver; Group III, Tacoma; Group IV, Spokane, Binghamton, Springfield, Ill., Kalamazoo, Sacramento, and Fort Worth.

Note.—The averages in this table have been obtained by finding the mean, or average, of the average values for the individual cities.

In **Table B** is shown a similar tabulation, differing from Table A only in the omission of certain cities from which the data furnished in the Government report was incomplete. The omissions were as follows:—

In Group I. New Orleans.
Group II. Indianapolis and Denver.
Group. III. Tacoma.
Group IV. Spokane, Binghamton, Springfield, Ill., Kalamazoo, Sacramento, and Fort Worth.

Metcalf's Table C, Based Upon United States Government Report.

Public water works: Actual gross income and operating expenses (including estimated taxes, excluding depreciation, fixed charges, and profit), omitting cities for which data are incomplete.*

Group.	No. of cities.*	Cities having population of	Actual gross income per capita.† Max.	Min.	Mean.	Operating and maintenance costs per capita, including U.S. Govt. estimation for taxes, excluding depreciation, fixed charges and profit. Max.	Min.	Mean.	Net income per capita, including estimated taxes but excluding allowance for depreciation and fixed charges. Max.	Min.	Mean.
I.	13	Above 300,000	$4.31	$1.64	$2.43	$2.17	$0.85	$1.58	$2.37	—$0.16	$0.85
II.	20	100,000-300,000 ..	4.95	1.18	2.61	2.56	0.77	1.38	3.72	0.28	1.23
III.	33	50,000-100,000....	3.85	1.64	2.68	3.44	0.77	1.62	2.27	—0.25	1.06
IV.	39	30,000-50,000	6.35	0.92	2.52	4.07	0.66	1.49	2.97	—0.47	1.03
Grand Total	105		$6.35	$0.92	$2.58	$4.07	$0.66	$1.52	$3.72	—$0.47	$1.06

*Note omissions,—Group I, New Orleans; Group II, Indianapolis and Denver, Los Angeles and Seattle; Group III, Tacoma; Group IV, Spokane, Binghamton, Springfield, (Ill.), Kalamazoo, Sacramento, Fort Worth.

†Found by averaging the per capita figures for each of the cities in the several groups.

In **Table C,** based upon the Government report, are shown the maximum, minimum, and mean values in each of the four groups cited, of the actual gross income (earnings, without allowance for water used for public service) per capita, and operation and maintenance costs per capita, (including the Government's estimate for taxes, but excluding allowance for depreciation, fixed charges, and profit). The omissions noted in Table B apply also in this table, for the same reason.

(Continued on Page 809).

CONCRETE SECTION

REINFORCED CONCRETE PIER CONSTRUCTION.*

By Eugene Klapp, M. Am. Soc. C.E.

A private yacht pier, built near Glen Cove, Long Island, has brought out a few points which may be of interest. It is an example of a small engineering structure, which, though of no great moment in itself, illustrates the adoption of means to an end that may be capable of very great extension.

The problem, as submitted to the writer, was to construct a yacht landing at East Island, on the exposed south shore of Long Island Sound, in connection with the construction at that point of an elaborate country residence. The slope of the beach at this point is very gradual, and it was specified that there should be a depth of at least 4 ft. of water at low tide. Soundings indicated that this necessitated a pier 300 ft. long. It was further specified that the pier should be to some extent in keeping with the scale of the place being created there, and that a wooden pile structure would not be acceptable. Besides these æsthetic conditions, wooden piles were rejected because the teredo, in this part of the Sound, is very active. At the same time, the owner did not care to incur the expense of a masonry pier of the size involved. Also, it was desired to unload on the pier all material for the house and grounds during construction, and coal and other supplies thereafter, thus necessitating a pier wide enough to allow access for a cart and horse and to provide room for turning at the pier head.

Comparative designs and estimates were prepared for (a) a pier of ordinary construction, but with creosoted piles; (b) a concrete pier on concrete piles; and (c) for a series of concrete piers with wooden bridge connections. The latter plan was very much the best in appearance, and the calculated cost was less than that of the pier of concrete piles, and only slightly more than that of creosoted piles, the latter being only of a temporary nature in any case, as it has been found that the protection afforded by creosote against the teredo is not permanent.

At this point on the Sound the mean range of the tide is about 8 ft., and it was determined that at least 5 ft. above mean high water would be required to make the under side of the dock safe from wave action. There is a north-east exposure, with a long reach across the Sound, and the seas at times become quite heavy. These considerations, together with 4 ft. of water at low tide and from 2 to 3 ft. of toe-hold in the beach, required the outer caissons to be at least 20 ft. high.

To construct such piers in the ordinary manner behind coffer-dams, and in such an exposed location, was to involve expenditure far beyond that which the owner cared to incur. The writer's attention had shortly before been called to the successful use of reinforced concrete caissons on the Great Lakes for breakwater construction, by Major W. V. Judson, M. Am. Soc. C.E., and under patents held by that officer. It seemed that here was a solution of the problem. These caissons are constructed on the shore, preferably immediately adjoining the work. After thorough inspection and seasoning they are usually launched in a manner somewhat similar to a boat, are towed into position, sunk in place, and then filled with rip-rap.

In this case what was needed was a structure that could be constructed safely and cheaply in the air, could then be allowed to harden thoroughly, and could finally be placed in accurate position. The weights to be supported were not great, the beach was good gravel and sand, fairly level, and, under favorable circumstances of good weather, the placing of the caissons promised to be a simple matter. Therefore, detailed plans were prepared for this structure.

An effort was made to preserve some element of the yachting idea in the design, and bow-string trusses, being merely enlarged gang planks, were used to connect the caissons.

The pier was originally laid out as a letter "L," with a main leg of 300 ft. and a short leg of 36 ft. The pier head consisted of eight caissons in close contact, and was intended to form a breakwater, in the angle of which, and protected from the wave action, was to be moored the float and boat-landing. After the first bids were received, the

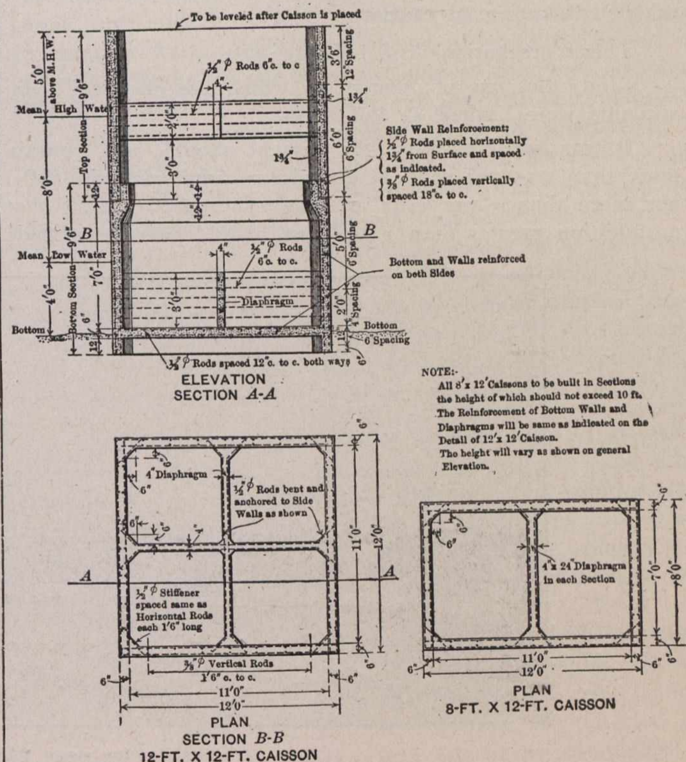

Fig. 1.

owner wished to reduce the cost, and every other caisson in the pier head was omitted, so that, as built, the pier contains eight caissons and five 53-ft. trusses. The caissons supporting the trusses are 8 ft. wide and 12 ft. long, and those in the pier head are 12 by 12 ft. On account of the shoal water and the great height of the outer caissons in comparison with their cross-section, it seemed advisable to mould them in two sections. The reinforcement in the side walls consisted of round ½-in. rods horizontally and ⅜-in. rods vertically, spaced as shown on Fig. 1, together with cross-diaphragms as indicated.

The caissons were reinforced for exterior pressures, which were to be expected during the launching and towing into position, and also for interior pressures, which were to be expected at low tide, when the water pressure would be nothing, but the filling of the caissons would be effective. The corners were reinforced and enlarged. In order to secure a proper bedding into the sand foundation, a 12-in. lip was allowed to project all around the caisson below the bottom. In the bottom there was cast a 3-in. hole, and this was closed by a plug while the lower section was being towed into place.

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* Presented to the American Society of Civil Engineers, and published in their May proceedings.

The question of the effect of sea water on the concrete was given much thought. The writer is unable to find any authoritative opinions on this subject which are not directly controverted by equally authoritative opinions of a diametrically opposite nature. He thinks it is a question that this society might well undertake to investigate promptly and water and frost on concrete, and that many able and experienced engineers in charge of the engineering departments of the great transportation companies have simply crossed concrete off their list of available materials when it comes to marine construction. It is a subject too large in itself to be discussed as subsidiary to a minor structure like the one herein described, and, though many have rejected concrete under these conditions, other engineers, equally conservative, are using it freely and without fear.

The writer consulted with his partner and others at some length, and, considering all the advantages to accrue by the use of these concrete caissons, decided to do so after taking all known precautions.

These precautions consisted in:—

First, the use of cement in which the chemical constituents were limited as follows:—

It was specified that the cement should not contain more than 1.75 per cent. of anhydrous sulphuric acid (SO_3) nor more than 3 per cent. of magnesia (MgO; also, that no addition greater than 3 per cent. should have been made to the ingredients making up the cement subsequent to calcination.

Secondly, to secure by careful inspection the most completely homogeneous mixture possible, with especial care in the density of the outer skin of the caissons.

Thirdly, a prolonged seasoning process before the new concrete should be immersed in the sea water.

In addition to these well-known precautions, it was decided to try the addition to the cement of a chemical element that should make with the free lime in the cement a more stable and indissoluble chemical combination than is offered by the ordinary form of Portland cement. This was furnished by the patent compound known as "Toxement," which is claimed by the inventor to be a resinate of calcium and silicate of alumina, which generates a resinate of lime and a silicate of alumina in crystalline form. It is further claimed that each of these materials is insoluble in sodium chloride and sodium sulphate, 3 per cent. solution. It was used in all the caissons, excepting Nos. 1 and 2, in the proportions of 2 pounds of Toxement to each 100 pounds of cement. The first two caissons were not thus treated, and will be held under close observation and comparison with the others, which were treated with this compound.

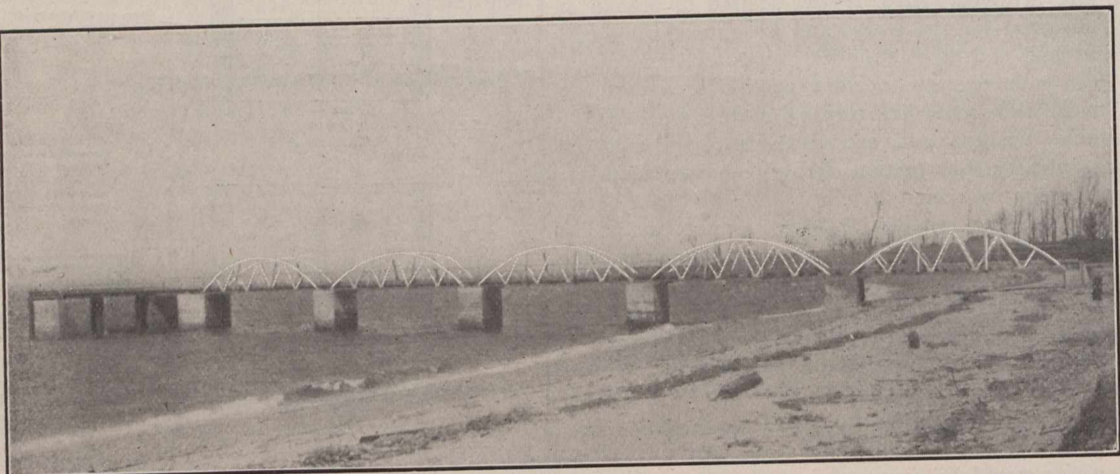
The mixture used was one of cement (Pennsylvania brand), two of sand, and four of gravel. The sand and gravel were from the nearby Cow Bay supply, and screened and washed. None of the gravel was larger than ½ in., grading down from that to very coarse sand. The sand was also run-of-bank, and very well graded.

The caissons, after being placed, were filled with sand and gravel from the adjoining beach up to about mean high-water mark, and the edges outside all around were protected from tidal and wave scour by rip-rap of "one man" stone.

The trusses were constructed on a radius of 34 ft., with 8 by 8-in. chords, 6 by 6-in. posts, and 1-in. rods. The loading was figured as a loaded coal cart plus 100 pounds per foot. All lumber was clear yellow pine, except the floor, which was clear white oak. The pipe-rail and all bolts below the roadway level, and thus subject to frequent wettings by salt water, were of galvanized iron. The trusses were set 9 ft. 9 in. apart on centres, giving a clear opening of 8 ft. between the wheel-guards under the hand-rails. The fender piles were creosoted. The float was 18 ft. long and 12 ft. wide.

A contract was let to the Snare and Triest Company, and work was commenced early in August, 1909. The first caisson was poured early in September, and the last about the beginning of October,

The caissons were all cast standing on parallel skids at about mean high water. It was first intended to construct a small marine railroad and launch the caissons in that manner, rolling them along the skids to the head of the marine railway. This plan was abandoned, however, and by sending in at high tide a powerful derrick scow, many of the caissons were lifted bodily from their position and set down in the water, towed to place and sunk in position, while the others, mostly the upper sections, were lifted to the deck of the scow and placed directly from there in their final position. There was not much difficulty in getting them to settle down to a proper bearing. Provision had been made for jetting, if necessary, but it was not used. In setting Caisson No. 2 a nest of boulders was encountered, and a diver was employed to clear away and level up the foundation. The spacing was accomplished by a float consisting of two 12 by 12-in. timbers, latticed apart, and of just sufficient length to cover the clear distance between the caissons. The first caissons being properly set inshore, the float was sent out, guyed back to the shore, and brought up against the outer edge of the set caisson. The next caisson was then towed out, set against the floating spacer,



Yacht Pier near Glen Grove Cove, N.Y.

and sunk in position. There was some little trouble in plumbing the caissons, but, by excavating with an orange-peel bucket close to the high side and depositing the material against the low side, they were all readily brought to a sufficiently vertical and level position to be unnoticed by sighting along the edge from the shore.

The trusses were all constructed in the contractor's yard at Bridgeport, and were towed across the Sound on a scow. They were set up and braced temporarily by the derrick boat, and then the floor and deck were constructed in place.

On December 26th, 1909, a storm of unusual violence—unequalled, in fact, for many years—swept over the Sound from the north-east; the waves beat over the pier and broke loose some floor planks which had been only tacked in position, but otherwise did no damage, and did not shift the caissons in the least. The same storm partly destroyed a pier of substantial construction less than a mile from the one in question.

Unfortunately, the work was let so late in the summer, and the restrictions as to seasoning the concrete were enforced so strictly, that the work of setting the caissons could not be commenced until November 11th, thus the entire construction was forced into the very bad weather of the late fall and early winter. As this involved very rough water and much snow and wind, the work was greatly delayed and was not completed until the middle of January. The cost of the entire dock was about $14,000.

The writer believes that the cost was much less than for masonry piers by any other method of construction, under the existing circumstances of wind, tide, and exposure.

It would seem that for many highway bridges of short span, causeways, and similar structures, the use of similar caissons would prove economical and permanent, and that they might be used very largely to the exclusion of cribwork, which, after a decade or so, becomes a source of constant maintenance charges, besides never presenting an attractive appearance. Finally, in bridges requiring the most rigid foundations, these caissons might readily be used as substitutes for open wooden caissons, sunk on a prepared foundation of whatever nature, and still be capable of incorporation into the finished structure.

CONCRETE BARGES.

To those interested in transportation, lumbering, dredging, or contracting, the recent development in the use of reinforced concrete for barges, pontoons and scows is of especial interest, and the following has been compiled with a view to presenting what has been, and is being, accomplished along that line in a concise and accurate form.

The history of concrete boats dates back to 1850, when a Frenchman named Lambot constructed one, exhibiting it five years later at the Paris Exposition. This is supposed to be the first reinforced concrete structure of any kind. Lambot patented the invention, believing that the material was well adapted to boat building. From that date, however, no further development took place until in 1907, the Signori Gabellini, an Italian firm, took the matter up on a large scale, and constructed a concrete barge of 150 tons for use on the Tiber and the Coast. This boat has been in continuous service ever since and proved thoroughly satisfactory in every way. Since then concrete boatbuilding has made rapid progress in Italy and France, and there are now large numbers of barges and pontoons, of this construction and of all sizes, in use in these countries.

As an illustration of the adaptability of this material for marine floating structures, it may be stated that the Italian firm mentioned above have built six car ferries for the Italian State Railways, each 158 feet long, and each capable of transporting six freight cars.

Concrete boatbuilding, therefore, is a novelty no longer, nor an experiment, but a well defined industry in the two countries already named, and signs are not wanting of its adoption in other countries. During the past year three barges for dredging purposes have been built at Panama for work on the canal there, and have fulfilled every requirement. These boats were 64 feet long by 24 feet wide, and about 5 feet 8 inches deep, and each carried a dredging pump and other machinery of some 30 tons.

The advantages of boats of this construction are many, and, in the light of past experience, assured. While a concrete boat is somewhat heavier than a wooden one, it is far more economical to maintain, and, being capable of taking on a very smooth surface, presents less resistance to propulsion in water than either wood or steel. Further, as marine growths do not adhere readily to concrete, no painting is required for the top-side, nor anti-fouling composition for the bottom. The maintenance costs of concrete boats are practically nil, and they last forever; in the event of any damage to the hull, any necessary repairs can be cheaply and quickly effected, as some filling-in with cement or concrete is all that is required. Comparative estimates have been made of the first cost and maintenance of boats of wood and concrete, and it has been found that whereas a wooden barge, after five years work, requires repairs involving an expenditure of about 30 per cent. of the first cost, the concrete barge, after eight years' service, is in perfect condition.

With regard to the capability of such boats to withstand severe shocks, such as bumping against piers and other vessels, it may be said that they will stand very rough usage. An interesting experiment to test this point was carried out by the Italian Government some years ago, in which a concrete boat of 1,000 tons was rammed by a much larger steel boat, with the result that the concrete boat suffered less damage than the steel vessel. Another advantage the boats have over wood or steel ones, especially interesting to those engaged in transportation is: that as the concrete is non-absorbent, impermeable to humidity, and not affected by ordinary chemical reactions, there can be no complaints of losses in cargoes caused by such agencies during transportation. Further, from a hygienic point of view, they can be very easily maintained in a perfectly sanitary condition. No fire insurance for the hull is necessary. Of special interest to those engaged in contracting, lumbering, or dredging is the point that no expensive plant, special material, or expert workmen are required to build boats of this construction. Wherever there is sufficient water for launching, and wherever cement, sand, rock and reinforcing material can be got together, there the barge, pontoon, or scow can be built by unskilled labor under the supervision of any intelligent man, and they are easily and quickly constructed.

In any class of work necessitating the use of barges, pontoons and scows, and where low first cost and maintenance charges are the primary considerations, reinforced concrete boats will be found to be the most economical and satisfactory. This form of construction is worthy of attention, and those engaged in transportation, lumbering, dredging, or contracting would be well advised to give it their best consideration before placing orders for new craft in wood or steel.

ROADS AND PAVEMENTS

NOTES ON ROAD CONSTRUCTION.*

By W. Calder, Assoc.M.Inst.C.E., City Surveyor, Prahran, Victoria.

The Road Problem and its concomitant, "The Dust Problem," have of late years been so prominently before road engineers and the general public, and so much has been written on this question, that any attempt to deal with the subject in a necessarily short paper will appear presumptuous, but as your honorary secretary expressed a wish that your Society be supplied with some particulars regarding the methods employed in road construction in the Prahran Municipality, the writer has been induced to communicate some data and particulars of the methods employed there, and though no method can be laid down as the best under all conditions of locality, traffic and climate, there are certain general principles in road construction which may be observed with some modification to suit local circumstances.

The few remarks here noted, which are specially applicable to city and suburban streets, are the result of the writer's experience as a municipal engineer, confirmed by observation of methods employed in other lands.

Within the past five or six years, owing to the ever-increasing number of rapidly moving self-propelled vehicles, the conditions of traffic have undergone a radical alteration. The ordinary dry or water-bound macadamized road, which, if well constructed and efficiently maintained, has hitherto been found economical and sufficiently good for the best country roads and suburban streets of medium or light traffic, no longer meets the newer conditions.

For slow moving, horse-drawn vehicles small inequalities of surface were of little consequence, and the dust produced from the wear of their surfaces was taken as a matter of course. Now all is changed. The public has become more exacting; the drivers of motor cars, with good reason, demand a smooth and even surface, as rough or rutty roads are destructive to their costly vehicles. We have likewise reached a sanitary age when the general public will no longer tolerate the nuisance and discomfort experienced through the clouds of dust raised by motor cars. The dust existed before, but it was only noticed when raised by the winds. Since the advent of the motor car the dust is raised in dry weather even when calm.

Those who do not use the motors blame them for making the dust, and though they are undoubtedly most efficient dust raisers, the writer is of opinion that on well constructed roads with smooth, even and impervious surfaces, they cause far less damage than iron-tyred vehicles drawn by iron-shod horses, and that the dust raised by the cars is mainly produced by the disintegrating action of the former, combined with the influence of the weather. Metal studs and other non-skidding devices on the tyres of motor cars should, however, be prohibited.

The motor car has come to stay; so, it is to be hoped, has the sanitarian; and in the future self-propelled vehicles of one form or another will surely, to a great extent, take the place of others for traction, haulage of merchandise, and many purposes where the horse is now the motive power.

Nor is this to be altogether regretted, for, apart from the pounding and screwing action of the shod feet of the horse on the road-surface, he is responsible for another fount of discomfort and expense. Mr. W. E. Higgins, an English engineer, has estimated that a horse will produce from 7 to 8 tons of manure per annum, a considerable portion of which is distributed about the streets. During dry weather this manure becomes pulverized under traffic and is added to the dust produced from other sources. To satisfactorily meet present-day requirements roads must possess the following qualities:—

(1) Sufficient stability and durability to withstand the weights passing over them.

(2) A smooth and even surface offering the minimum of tractive resistance and facilitating cleansing.

(3) Comparative noiselessness under traffic.

(4) Fair foothold for horses.

(5) A surface impervious to moisture. This latter quality has an important bearing on the life of the road.

The problem before road engineers is to provide roads possessing these desiderata at a reasonable cost, taking local conditions into consideration.

Of all known forms of pavement, asphalte and wood on a foundation of cement-concrete most nearly comply with the above ideal conditions, but, owing to their high initial cost, their adoption in this young country, with growing towns and rapidly extending suburbs, must be restricted to the most important city and suburban streets, where the volume and nature of the traffic, class of residence or premises in the street, and the funds at disposal warrant their use.

Wood Pavements.

The examples of wood pavements as laid with close joints in the city of Melbourne are equal to any to be seen in other parts of the world, and this method of construction is so familiar that brief reference only will be made here.

The earlier pavements were laid with red gum blocks, but as the supply of this excellent timber has practically ceased we are mainly dependent upon jarrah from Western Australia, spotted gum, black-butt, and tallow-wood from New South Wales, and to a lesser extent, Tasmanian blue gum. Jarrah blocks are supplied in Melbourne at a cost of about £7 10s. per 1,000, the hardwood blocks from New South Wales cost here about £11 10s. per 1,000.

The cost of jarrah blocks is about 8s. 3d. per square yard, or laid complete with a 6-in. concrete base, 17s. to 18s. per square yard, which, strange to say, is slightly more than the cost of the same pavement laid in Great Britain.

The life is variously estimated at from ten to twenty years, according to the volume and nature of traffic. Pavements of red gum blocks laid in Toorak Road and Chapel Street, Prahran, in 1889, are still in use, and when some of the blocks were removed for repairs in 1907 the actual wear was found to be only ½-in. They are now failing from wet rot at the bottom where they rest on the concrete.

Well maintained, with a dressing of distilled tar and sand, it is a sanitary pavement and comparatively easily cleansed, can be laid on gradients up to 1 in 25, and as a sanitary and non-dust-producing pavement it ranks next to asphalte, but the discomfort of the necessary annual tar dressing is strongly objected to by the public.

Wood is still one of the most popular pavements in England, but Australian hardwoods are in many cases being supplanted by pine, Memel deal, and other soft woods in a number of cities, particularly in London and Sheffield, the reason being that it is difficult to obtain large supplies of hardwood blocks of uniform quality and texture; conse-

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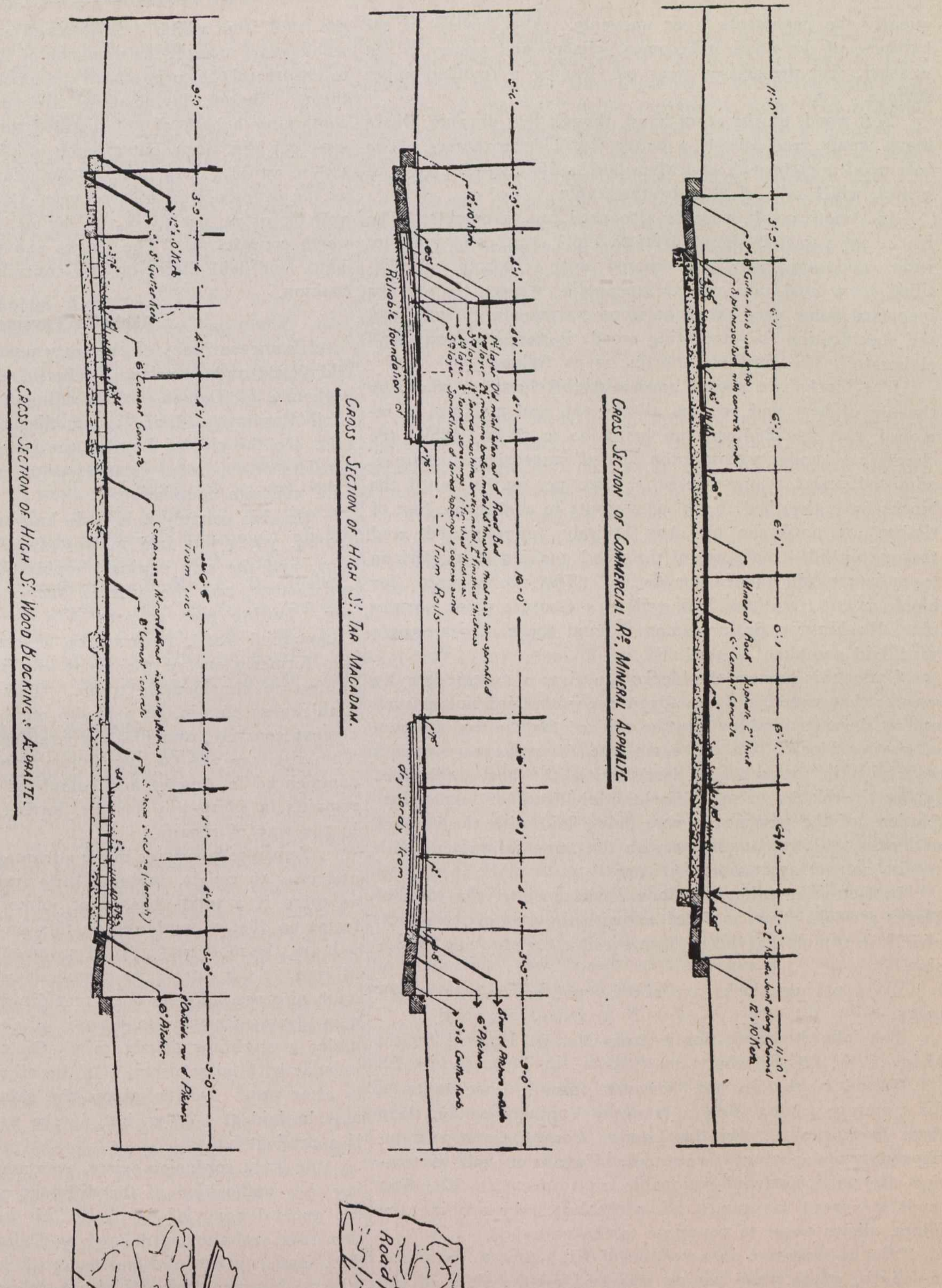
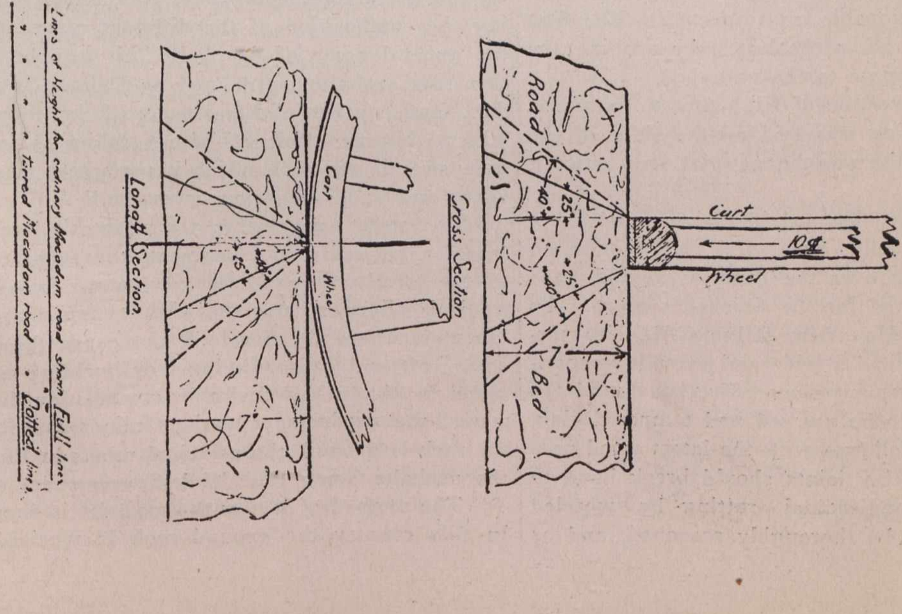
*Paper read before the Melbourne University Engineering Society.


Cross Section of High St. Wood Blocking & Asphalt.
Cross Section of High St. Tar Macadam.
Cross Section of Commercial Rd. Mineral Asphalte


Long'l Section
Cross Section
Cart
Wheel
Road
Bed
Lines of Weight for ordinary Macadam road shown Full lines
" " " Tarred Macadam road " Dotted lines

quently the pavements wear unevenly. Also, owing to the hardness of the wood, it becomes polished and greasy in wet weather, and the arrises wear off, leaving a rounded upper surface.

Soft wood, on the other hand, though less durable, wears more evenly, and affords a better foothold for horses. The soft wood is creosoted, and when laid is liberally covered with gravel, which is worked in by the traffic.

In America soft wood is also used for pavements. The blocks are 5 to 10-in. long (average 8-in.), 4-in. deep and 4-in. wide, and are heavily creosoted with creosote oil distilled from coal tar. In Minneapolis, where the writer inspected some very excellent wood pavements during 1906, the specification for creosoting wood is very stringent and elaborate. The process, shortly, is as follows:—

The blocks are placed in an airtight chamber, where by the use of heat and vacuum all the sap and moisture is removed, the specified vacuum being 20 to 26-in. While the chamber is under vacuum the heated creosoting mixture is admitted under a pressure of 125-lbs. per sq. in. until the blocks have absorbed 16 lbs. of creosote to each cubic foot of timber, or until the oil has entirely impregnated and thoroughly filled the pores of the wood, making it impervious to moisture and preventing decay. The timber used for blocks is cut from long leaf, yellow or Georgia pine, Norway pine, Washington fir, or tamarack, and the cost per square yard laid complete is 12s.

Under this process the blocks are given a specific gravity greater than water, and one advantage is that inferior or even otherwise waste timbers may be utilized for the manufacture of paving blocks. In the same city extensive experiments were also in progress for ascertaining the best method of laying the blocks to neutralize the ill-effects of expansion. Sections of the pavements were being laid with the courses of blocks at different angles with the street alignment with results not yet ascertained.

In Detroit, another populous American city, the rows of blocks are laid at an angle of 40° with the axis of the street, and little trouble has been experienced there through expansion.

Wood paving blocks are not favored by tramway engineers.

The following quotation is from Mr. W. Howard Smith, M.Inst.C.E., F.G.S., who states that:—

"Wood blocks do not, however, form a good material for tramway paving, and a tramway engineer seldom lays them from choice. On the London County Council tramways no wood paving is admitted. Expansion and contraction are particularly objectionable on tramways. The first tends to spread the gauge, while the latter, by opening the joints, allows water to penetrate to the underbed.

"For this reason, in a section of High Street, 500 yards in length, where wood paving was laid on the sides of the road, compressed rock asphalte was the material used between the tramway rails.

"The main points to be observed in laying wood pavements are: To ensure a solid, even, and true foundation for the blocks; the floating over the concrete should have the same convexity as desired for the finished surface. To provide for expansion Mr. Mountain, M.Inst.C.E., city surveyor, Melbourne, who has had a wide and extended experience with this class of pavement since 1880, has found the most satisfactory material to be pugged and tempered clay, and this practice has been followed with the latest wood paving laid in Prahran. The clay joints should break bond to prevent the tendency to longitudinal rutting by wheeled traffic. The timber should be thoroughly seasoned, and as the trees from which it is obtained are felled throughout the whole year, to meet the demands of the market, the only way to ensure this is to purchase the blocks in advance and store them. Before laying they are run through a machine containing a bath of hot distilled tar. Formerly the blocks were cut 6-in. deep, but a depth of 5-in. is now the standard. 4½-in. would be sufficient, as the actual wear is so slight, but as the difference in cost between 4½-in. and 5-in. blocks is only 6s. or 7s. per 1,000, the saving in the timber is scarcely worth considering. The blocks should be cut to a uniform depth and laid direct on the concrete bed, without a sand cushion.

Asphalte Pavements.

"Immense areas of this pavement have been laid in the Old World and America. In Berlin alone it is stated on the authority of Delano ("Proceedings" of the Institution of Civil Engineers, June, 1903), that 2,500,000 sq. yards are laid. In the city of London the greater part of the paving consists of 2¼-in. of compressed natural rock asphalte on a 6-in. concrete foundation.

"In this country it is little known. A sample section of 500 sq. yards was laid in Newcastle, New South Wales, in 1907, and the city engineer reports that it has been found satisfactory, and the area is likely to be extended in that city. During 1908 an area of 3,500 sq. yards was laid in Commercial Road, Prahran, on a section of the road which was formerly one of the worst in this city, and which was subject to considerable traffic. This pavement consists of a thickness of 2-in. of asphalte on a foundation of 6-in. of cement concrete, and has a guaranteed life of twenty years. The cost was 19s. 6d. per square yard. The pavement was commenced in August and completed in October, 1908, and remains in every way perfect, having required no attention in the way of repairs.

"Asphalte possesses many advantages. It is very durable and easy to repair, presents little tractional resistance, and as there is a total absence of joints, it is easily cleansed, forms no dust or mud, and on this account is, in the writer's opinion, the most perfect road pavement from a sanitary point of view. As it retains its camber it can be laid with a minimum of cross-fall. Its one great disadvantage is its slipperiness during certain conditions of the weather, especially under a slight or drizzly rain. On this account it is not popular with horse users. On the other hand, it dries quickly after rain. Delano places the safe gradient at which it may be laid at 1 in 30, but, in the writer's opinion, 1 in 50 is a prudent limit.

"As great confusion exists, even among engineers, regarding the composition of the different materials known under the general name of "asphalte," it may be here mentioned that true asphalte, as defined by Delano, is "a natural product, and consists of limestone rock impregnated with pure mineral bitumen (mineral pitch), which is only found in its pure state in the rock which it permeates when in a state of vapor and under enormous pressure."

For street pavements the desirable percentage of the bitumen varies from 9 per cent. to 12 per cent., according to the locality, the lower percentage being suitable for tropical climates and the higher for temperate or cold climates, where the heat will not cause the bitumen to become soft and cause waviness or buckling in the road. In order to obtain the desirable composition for different climates, the products of various mines are blended before the rock is ground, the principal mines in Europe producing the asphalte being the Val-de-Travers, Seyssel and Servas.

The method of laying the asphalte is shortly as follows: In this country the ground rock is received in bags, the material being heated in special drying furnaces until it falls to powder. It is then conveyed to the road in carts, covered to prevent loss of heat, and spread on the prepared concrete bed, which should be dry, to the desired thickness 1½ in. for light and 2 in. for heavy traffic. The powder is then beaten with heated rammers and rolled with a light roller also heated, rammed again, rolled with a heavier roller and finally smoothed with hot irons. The pavement is ready for traffic as soon as it has cooled. A mastic joint, 2 in. in thickness, consisting of a mixture of bitumen and clean grit, is laid on both sides of the roadway next to the paving to provide for any possible expansion and contraction of the material.

Artificial Asphalte.

In Germany, America, and elsewhere pavements are laid consisting, not of the natural rock, but of a mixture of bitumen, sand and pulverized limestone in varying proportions, according to the locality and the practice of the paving company which lays them. The best known of these is Trinidad asphalte, which consists of from 10 to 15 per cent. of asphaltic cement, consisting of refined asphalte and flux, 63 to 80 per cent. of sand, and from 3 to 30 per cent. of finely powdered mineral matter known in America as filler. In America the asphalte pavements are almost wholly composed of this artificial substitute for rock asphalte, in which country, on the authority of Mr. E. P. Hooley, M. Inst. C.E., no less a quantity than 38,000,000 square yards of this pavement are in existence. The same authority states that Trinidad is not as hard or durable as European standard asphalte, but is slightly cheaper and less slippery.

Mastic Asphalte.

This is artificially compounded of powdered calcareous rock asphalte and a proportion of refined natural bitumen, or sometimes of bitumen and powdered stone or grit in varying proportions. This material is mainly used for footpaths. In this city several varieties of mastic asphalte laid by different firms may be seen in Collins Street; also in Commercial and Toorak Roads, Prahran, these latter consisting of ¾ in. of the mastic asphalte on a 3-in. foundation of concrete, which has proved quite a satisfactory pavement. The bitumen used in the composition of the artificial as distinguished from the natural rock asphalte is mainly obtained from the Island of Trinidad. It should not be confounded with tar pitch, from which it is easily distinguished by the smell when burnt.

Stone Pavements.

Stone pavements are the noisiest, and at the same time the most unsanitary, of pavements, owing to their rough surfaces and many joints, which prevent efficient sweeping and cleaning. On this account they are unsuitable for city and residential streets. In this city bluestone cubes or pitchers are mainly used for the construction of rights-of-way and on roads of steep gradient where wood or asphalte pavements would offer insufficient foothold for horses.

In the manufacturing towns of Great Britain and Europe stone still forms the principal pavements for heavy-traffic streets, owing to its durability and comparatively low first cost. The setts are usually of granite, 6 in. by 3 in. on the surface, with a 6-in. concrete foundation, the average price in Great Britain being 14s. to 15s. per square yard. The granites in general use are from Aberdeen, Guernsey, Norway, Enderby and Wales, the latter being the hardest and most durable. Welsh granite from Carnarvon on a foundation of cement concrete 8 in. deep is the material used for paving the Dock Road at Liverpool, which thoroughfare probably carries the heaviest traffic of any road in the world. Mr. John A. Brodie, the distinguished engineer for that city, states that on this road "the average two-horse load on four wheels amounts to from 7 to 10 tons, and where a common load behind a traction engine may be taken as 35 tons, and where an exceptional load up to 100 tons on four wheels may be at any time expected." The writer witnessed a section of this road being repaved in 1906. The mineral used for the jointing between the setts was a mixture of pitch, tar, oil and sand, with a small percentage of lime or cement. The jointing material is most carefully selected, the pitch and oil used for flux being required to pass a certain standard determined by analysis. Occasionally, especially in Rome and some other Continental towns, the setts consisted of 4-in. granite cubes. These pavements are less noisy than those constructed of larger-surfaced stones, especially if the joints are filled with some bituminous or other mastic material.

Tar-Macadam Roads.

Considerable diversity of opinion exists regarding the merits of roads constructed of tar-macadam, and by some municipal engineers its use is not recommended on the ground that it is expensive and fit for light traffic only.

The writer's opinion is that it is an excellent material for use in residential streets of the best class, and in business streets of medium or even of moderately heavy traffic. This opinion is shared by some of the leading road engineers of Great Britain, and many excellent roads of tar-macadam or Tarmac (tarred furnace slag) may be seen all over that country, notably in Edinburgh, Liverpool, Sheffield and Nottingham. In the two latter cities this form of road construction has been practised for a period of between forty and fifty years, and in Nottingham particularly many miles of tarred-macadam roads have been, and are still being, constructed. It has, therefore, stood the test of time in the Old Land, where the climatic conditions are much less favorable to its preservation than in this country.

Considerable areas of tar-macadam have been laid in the city of Melbourne, with satisfactory results. and in his evidence before the Dust Conference, held in Melbourne last year, Mr. Mountain, the city surveyor, stated that it could be laid at a cost of 2s. 6d. per square yard, which, for a fairly durable and comparatively dustless road, must be considered exceedingly moderate.

In the municipality of Prahran we have 1¾ miles, with a total area of 27,400 square yards of tarred macadam of different grades and methods of construction, and, as all have proved more or less satisfactory, it is proposed to extend this class of work in the future.

The advantages of tarred macadam, as compared with ordinary dry or water-bound macadam, or surface-painted macadam:—

(1) Increased durability.
(2) Ease of cleansing.
(3) Economy in maintenance and watering.
(4) Comparative absence of dust and mud.
(5) It is a sanitary pavement.
(6) Is noiseless.
(7) Offers good foothold for horses, and its tractive resistance is less.
(8) It may be laid on almost any gradient, with variations in the surface treatment.

One great disadvantage is that when the pavement has to be broken up by plumbers for attention to gas or water services it cannot be made good without making a patch which causes a disfigurement, and for this reason the water mains in High Street were moved from the centre of the road and relaid beneath the side gutters before the pavement was laid.

With regard to its durability. A section of ¼ mile was laid in Commercial Road, east of Chapel Street, in 1902, and has during eight years required but little attention save for minor patching and tar-painting of portions that appeared rough on the surface. Formerly this was one of the worst roads in the municipality. It required recoating with metal every third year, and in wet weather the road-scrapers and mud carts were familiar objects in the street. To all appearance this road is as sound as when first laid, the only defect noticeable being a somewhat uneven and wavy surface. The cost of reconstruction of this road was high, namely, 6s. per square yard, the reason being that the road-bed had to be excavated to obtain the desired convexity, and as the foundation was wet the sub-bed was drained by means of stoneware-pipe drains. The depth of the coat consisted of 6 in. of tarred 2½-in. metal, with a binding of about 1½ in. thick of ¾-in. tarred chippings, and sealed with a light coat of tarred toppings, sufficient only to fill all surface interstices, laid on a foundation of 4 in. of cinders and 6 in. of ordinary dry metal. It is estimated that the increased economy in maintenance and cleansing in this road has been 75 per cent., and the expense and inconvenience of the mud cart has no longer to be borne. This street carried what may be termed fairly heavy traffic.

In 1903 Greville Street, for a distance of 19½ chains, was re-coated with ordinary dry metal, the binding being composed of tarred chippings, sealed with a light coat of tarred toppings, the additional cost of the tarred material and rolling being 1s. 4d. per square yard. Only nominal repairs have been necessary in this road since the work was done. This street carries light traffic only.

In 1907 a section of Toorak Road, between Chapel and River Streets, was re-coated with ordinary macadam. Trouble was experienced here formerly, as the road has a somewhat steep gradient, and the metal continually became disintegrated by the feet of horses, particularly adjoining the strip of paving along the tramway track. An improved method of treatment was adopted in this section. The dry 2½-in. metal was first sprinkled with distilled tar, then a coating of tarred chippings spread over the larger metal before rolling. The surface was then sealed with tarred toppings. The reason for this method is obvious. The tarred chippings wedged between the stones by the roller filled the interstices, and made the mass more homogeneous, thus preventing the moving and consequent abrasion of the stone under traffic. The only object of the surface dressing of toppings is to prevent the penetration of surface water to the body of the road, and on gradients steeper than, say, 1 in 18 or 1 in 20, it is inadvisable to make the surface too smooth, a surface dressing of dry toppings being sufficient. Recently, when the construction of the Prahran-Malvern tramway rendered it necessary to reconstruct High Street, the sides of the road for a total length of 83 chains between the Avenue and the Armadale Railway Station were constructed of tarred macadam by a method which the writer has not before seen followed, and which, in his opinion, is a great improvement on the former methods described.

QUEBEC'S UTILITY COMMISSION.

Colonel Hibbard, chairman of the Public Utilities Commission of Quebec, has been cautious in exercising the powers of that commission. The other day it was necessary to define the authorities of the commission. The contention of the Montreal Light, Heat and Power Company that Mr. H. F. Gribble had no right to make the complaint he did against what he alleged to be excess rates for electric light and gas, as he had no interest in the matter, was dismissed by the Public Utilities Commission in a decision regarding the point, given at the court house Saturday morning.

In defining the powers of the commission Colonel Hibbard, the chairman, pointed out that while the board had no authority to order a discriminatory rate for Mr. Gribble against other consumers, it could order another tariff of charges to be made if investigation proved that the present tariff was excessive. There were three points, the chairman said, filed by the counsel of the company in appealing against Mr. Gribble's charge.

These were, firstly, that the Public Utilities Commission had no jurisdiction regarding the matter which had been given to them to investigate; secondly, the appeal of Mr. Gribble had no grounds for the exercise of any jurisdiction; and thirdly, Mr. Gribble, having no interest in the matter, had no right to make the complaint regarding the price of electric light and gas.

The company claimed that Mr. Gribble should have approached them first before he had gone to the city council. The chairman, however, quoted a precedent from the records of the Wisconsin Public Utilities Commission in which it was stated that a commission of that kind could investigate the complaint of a body of not less than twenty-five citizens. The resolution of the city council to refer Mr. Gribble's complaint before the Public Utilities Commission for investigation was then read, it being held that an investigation was entirely within the authority of the board.

The commission in this respect, the chairman declared, had no limitations as in the Criminal Court, where the facts and matters and the persons most directly concerned therein were alone considered and dealt with.

From present appearances it looks as though much time of the Quebec Public Utilities Commission will be occupied by deciding questions as to the commission's authority.

To some extent, we are in the experimental stage with public utilities commissions. Broadly speaking, they seek to give fair play to the public and the consumer, corporations meanwhile resisting the growing tendency of commissions to probe to the last figure. Questions of jurisdiction are cropping in all parts of the continent. The Trenton Board of Public Utility Commissioners the other day decided that under the Act of last winter it is without jurisdiction to regulate the issuance of stock or securities of holding companies formed under the general corporation Act with the object of acquiring the stock and other securities of public utilities. The question was raised during the recent hearings in the case of the Trenton Street Railway Company, whose system has been leased by another corporation.

It is suggested by the board that should legislation be enacted, as contemplated, regulating and providing for the supervision of the issuance of stock and other securities by corporations in general, the situation would be met. If, however, such legislation is not enacted an amendment is urged to the Act of 1910 bringing holding companies under the same supervision as the corporations now defined in the Act as public utilities.

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CONTENTS OF THIS ISSUE.

CONCRETE SURFACES.

The appearance of concrete surfaces has been oftentimes marred by stains appearing on the surface, caused in many cases by chemical action in its component parts. The presence of iron frequently makes itself apparent by the brown stains upon the surface. As this is always present in good Portland cement, and as the presence of iron is also sometimes very marked in the water used in the mixing of the concrete there is constant danger of discoloration of surfaces. To prevent the undesirable gloss and shine of surface, and also to avoid efflorescence and consequent discoloring becomes at once a matter of some import in concrete construction work. While surface defects do not seriously affect the strength of a concrete structure, barring those due to imperfect forms and poorly laid concrete, they do affect the final general appearance and hinder the growing popularity of concrete work. Many plans have been resorted to to overcome the surface imperfections of concrete structures, and it is possible to make a concrete surface attractive, and even preferable to another form of structure merely from the standpoint of appearance. One means of surface finishing has been the rough, uneven effect produced by dashing a mortar mixture against the surface. This produces an exceedingly rough effect, but none the less attractive if properly carried out. Etching with an acid is also a treatment resorted to for producing a more attractive surface. The concrete is brushed shortly after the form has been removed, and is treated by a dilute acid solution—hydrochloric is a good acid—applied with a brush. This tends to remove the outward cement covering, exposing the aggregate, and producing a rougher effect. Artificial color stains are used, and they have rather more in their favor than concrete paints, since they are cheaper and can be more rapidly applied to concrete surfaces.

A surface appearance may be considered when the form is erected, and slats or small pieces of wood nailed upon the interior will allow of a desired form of finish to give the effect of cut granite blocks. It often happens that a natural cement finish is desired, and, in fact, this is oftentimes fully as attractive as artificial cut stone effects. A successful method of finishing now used to overcome the aforesaid surface defects of concrete structures is the application to the surface of sand. A cement wash is first applied to the surface of the concrete, and, while this is still wet, a fine grade of sand, which has been dried, is blown against the surface. The result is that a rough surface, not unlike the surface of a natural sandstone, is obtained. This does not change the natural color of the concrete structure, but it gives a desirable surface appearance, and seems to be effective in covering stains.

REGULATION OF STREET TRAFFIC.

With the growth of Toronto one of her new problems has been the regulation of street traffic. The traffic on the street has increased, and the street railway occupy more of the street than they did formerly, and in addition, building operations every block or so narrow the street again.

The Legislation Committee of the City Council have been struggling with the question, and recently Chief of Police Grasett submitted the following set of regulations as suitable for present conditions.

In addition to these regulations he suggests that the Police Commissioner be given full control of the street traffic:—

Keep to the right and as near kerb as weather and circumstances permit, according to discretion of police.

Meeting, pass to the right.

Overtaking, pass to left.

Stop with right side to kerb.

Crossing street, take same direction as traffic.

Vehicles going north and south to have right-of-way over those going east and west.

Police, fire, mail, and ambulance vehicles to have right-of-way over all others.

Reduce speed at crossing.

Vehicles not needing license to carry owner's name for identification.

Vehicles used for advertising purposes, or for carrying coal, bricks, lumber, earth, etc., whether loaded or empty, to keep off Yonge between Melinda and Albert, King between Church and York, and Queen between Victoria and York, unless consigned thereto.

No drivers to be under 16.

Drivers to stop at police signal.

A COURSE IN CERAMICS.

During the past week there met in the city of Toronto the Canadian Clay Products Association. This association represents the manufacturers of clay products from one end of Canada to the other, and when the new ideas in architecture that are now being displayed on many of the structures there can be little doubt but that the clay beds and the shale formations of Canada will be worked to an extent hitherto unthought of.

The Provincial Governments annually set aside a large amount of money for education and for exploration work, and we think that at this particular period in the industrial development of Canada each province should make special appropriations for the study of practical ceramics.

The brickmakers in the past have developed the drain tile, the common brick, and a few have done pioneer work with terra cotta and fireproofing. This work has been for their personal profit, and we congratulate them that they have been successful in a business way, but it is to the interest of almost every resident of Canada that further development work be done, and as in the past the Departments of Mines have located several of our clay deposits, we feel that it is incumbent upon the Government to go farther, and through our educational institutions indicate what may be done in the working of these clay deposits.

ELECTROLYSIS.

The injury of pipe lines by electrolysis from stray electric currents is a matter that is engaging the attention of several of our railway companies, the telephone companies and the waterworks officials. Usually the water pipes have been in place first, and the street railway systems undoubtedly bear this in mind during construction.

The area in which damage occurs is not usually large, and, while the street railway companies and electric distributing companies are usually most to blame, where considerable trouble occurs they should bear the greater part of the expense, yet the water companies and the waterworks officials should do what they can to assist in the minimizing of this trouble.

EDITORIAL NOTES.

A Happy and Prosperous New Year.

* * * *

The year just ending was a good year for business, but 1911 has greater possibilities.

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The Canadian Society of Civil Engineers meet in Winnipeg, January 24th, 25th, 26th and 27th, 1911.

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The Index of Volume 19 will be found on page 82 of this issue.

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The Canadian Cement and Concrete Association will hold their annual Convention and Exhibition at Toronto, Ont., March 6th to 11th, 1911.

* * * *

The launching at Collingwood on December the 17th of a ship 525 feet in length with a 56-foot beam made a new record in ship-building, as this vessel will be the largest vessel built in the British Empire outside of the British Isles.

* * * *

The Conservation Committee of the Canadian Society of Civil Engineers has undertaken to collect information respecting the developed and undeveloped water power of Canada. They have recently distributed forms which, when properly filled out and returned, will place at the disposal of this committee some of the most interesting and valuable information that has yet been sought in connection with the industrial possibilities in Canada. It is hoped that all those communicated with it will do what they can to supply the desired information. The usefulness of the society depends largely on the efforts put forth by the individual members to make the work of the society interesting and practical.

* * * *

During Christmas week the Canadian Institute have arranged for a series of lectures by Prof. J. C. McLennan, Ph.D. These lectures will be given in the Physics Building, University of Toronto, and will cover four subjects: The Properties and Forms of Matter; Energy and its Transmission; the Formation of Cloud-drops and Soap Bubbles; Radium and Radiation. The object of the Canadian Institute in presenting these lectures is to offer to the young people of the city an interesting course of scientific lectures, couched in language which will appeal especially to them. The lectures, while intended primarily for juvenile audience, will be of interest to the general public. Activity in behalf of the general public is commended, and it is pleasing to notice the readiness with which the University assists in the matter.

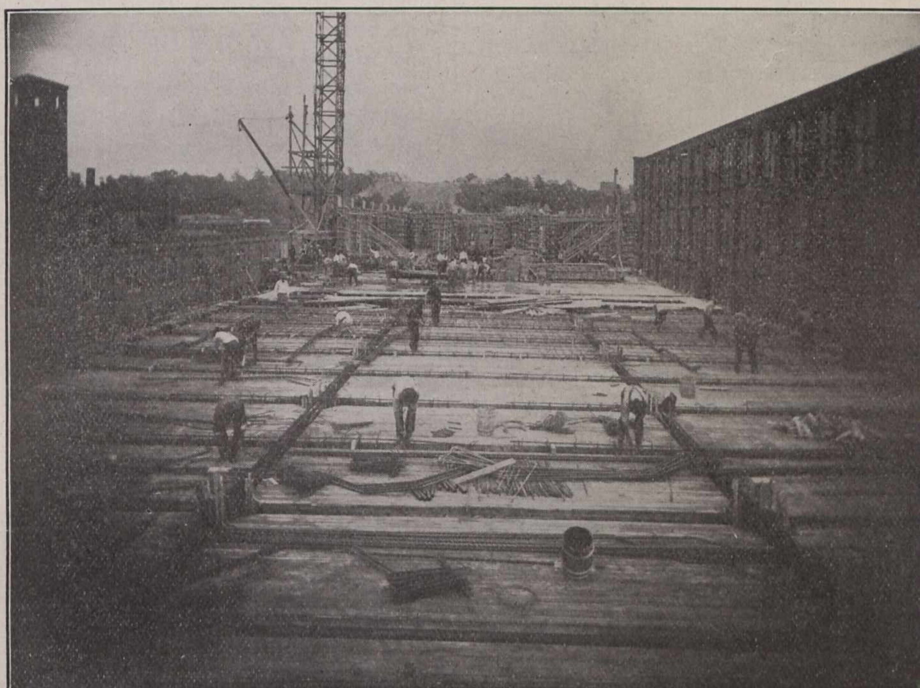
INFLUENCE OF DESIGN ON THE COST AND SPEED OF ERECTING CONCRETE BUILDINGS.

Obviously the standardization of parts can be made a great factor in reducing the cost and increasing the speed of assembling or erecting either machinery or buildings regardless of their general type of construction. The two large reinforced concrete factory buildings, a machine shop and a store house designed by the Stone and Webster Engineering Corporation of Boston, and recently added to the plant of the General Electric Company, at Schenectady, are striking examples of the extent to which standardization of parts can be carried in this type of construction. The designing engineers being thoroughly familiar with actual operations in the field were enabled to combine the requirements of the owners as regards size and purpose of the buildings with a maximum economy of material and labor in erection. These buildings are known respectively as Nos. 40 and 46. The former is 83 ft. x 403 ft., with two adjacent towers 32 ft. 8 in. wide, having a combined length of 134 feet, and with a two-story lean to 192 feet long between the towers.

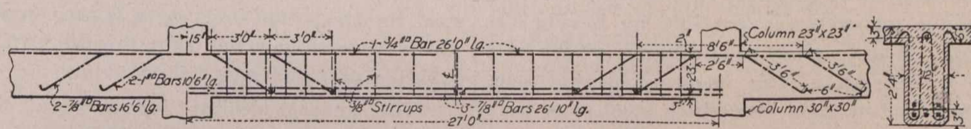
A distinguishing feature in the design of these buildings is the fact that story heights and spans are greater than in the average factory building. Both buildings are five storeys high, the first story height being 24 ft., and the ones above 17 ft. 8 in. Provision is made for an additional story in the future on both buildings, the roof being flat and the slope for the drainage obtained by a cinder fill. In the machine shop the floor loads throughout are 200 pounds per square foot, but in the store-house the second floor is designed for a live load of 400 pounds per square foot, the third and fourth floors for 300 pounds, and the fifth floor and roof for 200 pounds.

In the erection of building No. 46 a really remarkable speed record was made. The piling which is of the Raymond modified type of concrete pile was completed during July. In the latter part of this month the actual erection of the superstructure was commenced. A railroad siding extended along one side of the building and the construction plant so arranged that stone and sand could be readily unloaded and hoisted into bins by means of belt conveyers. The mixer was located between and below these bins so that the aggregate was delivered into the mixer through chutes. After mixing the concrete was discharged from the mixer directly into automatic dump buckets in the elevator tower. It was then hoisted to the proper floor and dumped into concrete carts and wheeled to the point of placement.

In designing the beams all the stems below the slab were made the same size, 12-in. wide by 23-in. deep. Variations in the loading and span were provided for by varying the area of steel. This arrangement greatly facilitated the form work and effected a big economy in same. The general procedure was to erect the forms and follow along closely with the fabrication of the steel and the concreting. By the time the forms were erected for one floor the concrete at the other end of the building had set sufficiently to permit the stripping of the forms which were then erected on the floor above. Hence it was only necessary to purchase sufficient lumber for forms for one floor.

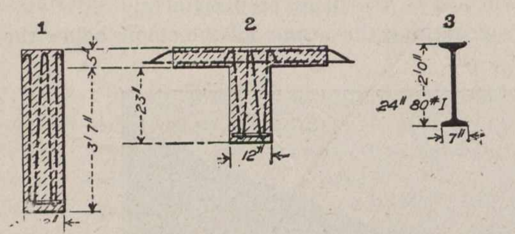


Fabricating Steel, Concreting Floors and Erecting Forms.

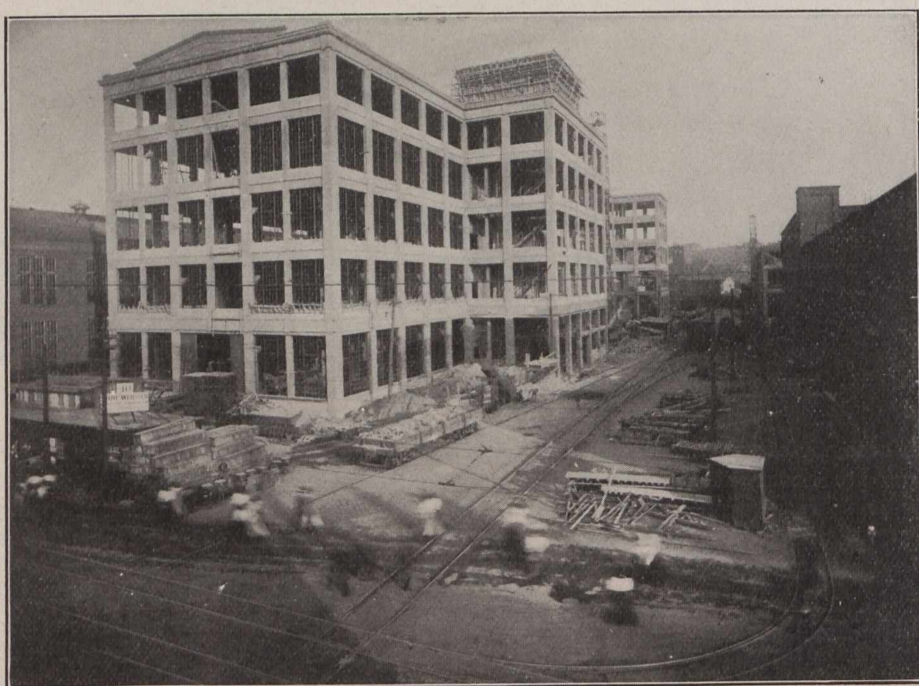


Perhaps the greatest economy effected, however, was in the designing of the steel reinforcement. In regard to this the engineers developed a system which provided for the fewest sizes of bars and bent shapes, and devised a method which insured the proper placing of steel and prevented displacement during the pouring and ramming of the concrete.

The cheapest type of bar available of any of the form bars on the market is the square cold twisted bar. This does not have the projecting lugs and webs possessed by other bars which adds to the tonnage without increasing the effective tensile strength. Furthermore, the elastic limit of the bars used was increased from 36,000 to 55,000 pounds per square inch by the twisting; thus giving the bare the advantage of a high elastic limit without the brittleness of a high carbon steel. In the beams and girders the heavy main reinforcing bars located in the bottom were designed to extend from end to end without being bent. The negative bending over the support was provided for by bent bars, the lower



ends of which were hooked around short cross rods placed between the two layers of main reinforcing bars. These bent bars were reduced to the fewest types possible, and a variation in the length of the beams or girders merely required a change in length of the straight unbent bars in the bottom.



Reinforced Concrete Machine Shop.

An independent adjustment of the steel to take care of sheer and negative bending moment was possible by having the loose negative bars. The bending of the heavy girder bars was accomplished on a bending table made up of two ⅜-in. plates with holes punched in them into which steel pegs were placed at any desired distance apart and at any angle.

The stirrups which were all of the double loop type of ⅜-in. square twisted stock were bent on a machine consisting of a slide which was operated by a lever attached to one end. At the other end of the slide a slot was cut the exact width of the desired bend, and the rods were bent by placing them across the slotted end of the slide, and being forced into the slot by a peg when the slide was moved forward.

For the slab rods a uniform set was designed, a typical bar of which was straight at one end, campered at the centre over a beam, and also at the other end. These were bent by means of a special double bending machine designed by Lewis F. Brayton, of the Stone and Webster Engineering Corporation. This machine will offset a bar parallel to itself and put in two bends at one pull of the lever. The accompanying photograph shows one of these machines in operation. It was found that with labor at eighteen cents per hour bending the ⅜-in. square bars used in the slab ran about seven cents per hundred bends approximately one-third the cost by other methods.

The actual time consumed in erecting Building No. 46 from footings to roof was 39 working days. In that time one million one hundred and eighty thousand pounds (1,180,000 lbs.), and six thousand one hundred (6,100) cubic yards of concrete were placed. The steel contained in the neighborhood of one-third of a million bends, and the bending was done at the average rate of fifteen to the minute. In the two buildings something over 1,400 tons of steel reinforcing was handled at a cost slightly less than $6.25 per ton. This included the entire cost of bending, handling and placing, including the making of the rectangular and spiral column cages.

The exterior columns are of the Hennibeque type, but in order to save floor space the interior columns were designed of the spirally hooped type which have considerably greater strength for an equal area of cross section. In placing the steel for the latter four 1¾ x ¼-inch spacer bars were used which were so punched that the pitch of the spiral winding could be perfectly maintained.

The general design for the two buildings was very similar, the longitudinal bays being 16 ft., while across each building there were three bays 23 ft. wide in No. 46, and 27 ft. wide in No. 40. Each longitudinal line of columns supports a continuous girder into which are framed the transverse floor beams, which are spaced 8 ft. on centres.

The arrangement of the steel for the girders and the manner of transferring the web stress out into the flange of the Tee section were interesting. The accompanying cut shows the detail of the reinforcement in one of the girders, the main features of which are the straight loop bar which extends the entire length of the girder placed at the centre near the top and the short negative bending bars over the supports which bend down and hook under short cross bars

(Continued on Page 810).

SOME COMMENTS UPON WATER WORKS MANAGEMENT SUGGESTED BY THE RECENT SPECIAL REPORTS OF THE UNITED STATES COMMERCE AND LABOR DEPARTMENT.

(Continued from Page 796).

TABLE D.

Statistics of Public W_ter Supply Systems.

Computed from Report of United States Department of Commerce and Labor, Bureau of the Census—upon "Statistics of Cities having a Population of over 30,000—1907," by Metcalf & Eddy, omitting cities for which data are incomplete.†

Cities having population of	No. of cities.	Actual gross income. Per capita.	Per mile of pipe.	Per mg.	Operation and maintenance (including estimated taxes excluding depreciation and fixed charges). Per capita.	Per mile of pipe.	Per. mg.	% of gross income.	Net income excluding allowance for depreciation and fixed charges). Per capita.	Per mile of pipe.	Per mg.	% of gross income.
Over 300,000 ..	13	$2.43	$2,098.21	$46.16	$1.58	$1,323.74	$30.47	66.8	$0.85	$774.47	$15.69	33.2
{ 100,000-300,000	22	....	1,779.23	73.89	....					856.15	36.34	46.9
{ 100,000-300,000	20*	2.61	1,791.99	72.80	1.38	969.83	39.00	55.6	1.23	822.16	33.80	44.4
50,000-100,000 ..	33	2.68	2,044.82	73.72	1.62	1,286.68	45.01	61.5	1.06	758.14	28.71	38.5
30,000-50,000 ..	39	2.52	1,466.69	75.88	1.49	887.31	43.30	62.3	1.03	579.38	32.58	37.7
Grand average..	107	....	$1,785.98	$71.19	....	$1,070.86	$41.08	60.7	....	$715.12	$30.11	39.3
Grand average..	105	$2.58	$1,788.54	$70.94	$1.52	$1,082.58	$41.43	61.3	$1.06	$705.96	$29.51	38.7

*Excludes Seattle and Los Angeles.

†Note omissions,—Group I, New Orleans; Group II, Indianapolis and Denver; Group III, Tacoma; Group IV, Spokane, Binghamton, Springfield, (Ill.), Kalamazoo, Sacramento, and Fort Worth.

In **Table D** are shown, for the four groups cited, the actual gross income, the operation and maintenance expenses, (including estimated taxes, but excluding depreciation, fixed charges, and profit), and the net income, (being the difference between the actual gross income and the operation and maintenance charges, including in the latter taxes, but excluding allowances for depreciation, fixed charges, and profit) per capita, per mile of pipe, and per million gallons of water pumped.

As I inertpret them it is this. Under the prevailing rates is the significance of the results shown in Tables C and D which give the actual gross income, the operation and maintenance expenses (including estimate for taxes but excluding allowances for depreciation, fixed charges, and profit) per capita per mile of pipe, and per million gallons of water pumped or "supplied to the pipes"?

As I interpret them it is this. Under the prevailing rates the public water works in this country have gross actual annual incomes (without allowance, in the majority of cases, for water used for municipal purposes) of approximately

$2.58 per capita of population.
$1,800.00 per mile of pipe,
$71.00 per million gallons of water supplied,

and operating and maintenance expenses (including allowance for taxes, but excluding allowances for depreciation, fixed charges, and profit) of

$1.52 per capita of population,
$1,100.00 per mile of pipe,
$41.00 per million gallons of water supplied, corresponding to 61 per cent. of gross actual income,

and net annual income of approximately

$1.06 per capita of population,
$700.00 per mile of pipe,
$30.00 per million gallons of water supplied, corresponding to 39 per cent. of gross actual income.

The question arises, is this so-called net income sufficient to provide a reasonable allowance for depreciation and for fixed charges? Let us see.

The Government statistics of "net cost of system" and "present value of system" are admittedly neither reliable nor comparable, as reported for the different cities, and obviously the "outstanding debt" is of no significance except as indicating the extent to which past generations have contributed to the liquidation of the water works debt, and thus have been taxed for the benefit of the present and future generations. Moreover, for our purposes here the Government's method of computing the interest is unsatisfactory, as it involves the relative credit of the several cities and the probably erroneous estimate of present value of the works. Therefore we are forced to base our conclusions upon certain assumptions.

If we assume a "per capita value of the works" of $25, an annual depreciation allowance of 1 per cent., based upon value, not upon reproduction cost of the works, and fixed charges of 4 per cent., corresponding to best city credit conditions, we should require for,

Depreciation ......1% of $25 = $0.25 per capita,
Fixed charges ......4% of $25 = $1.00 " "

Total .... = $1.25

If we assume a per capita value of works of $50, an annual depreciation allowance of 2 per cent. of the value of the works, fixed charges of 4 per cent., we should require for,

Depreciation ......2% of $50 = $1.00 per capita,
Fixed charges ......4% of $50 = $2.00 " "

Total .... = $3.00 " "

or if we assume, as reasonable for average conditions, a per capita value of $35, a depreciation allowance of 1 per cent., (based upon the value not the reproduction cost of the works), and fixed charges corresponding to city conditions of 4 per cent., we should require for,

Depreciation	......1% of $35 =	$0.35 per capita.
Fixed charges	......4% of $35 =	$1.40 " "
Total	.... =	$1.75 " "

As against these depreciation and fixed charge requirements we have seen above that the Government report indicates an average net income, applicable to these uses, of approximately $1.06 per capita of population.

Broadly speaking, therefore, it appears that the net income of our public water supplies, upon prevailing rates and existing methods of supplying free water for municipal uses, is **not** sufficient to meet a proper depreciation allowance and fixed charges corresponding to the value of these works. Obviously no water company could do business upon such a basis. Moreover, the rate (4 per cent.) upon which the fixed charges have been figured, is entirely inadequate for such works, if privately owned.

I do not appear before you as an exponent either of municipal or of private ownership of water works. Whether the present method of operating these public works is desirable, or not, is not at issue here, nor whether it is wiser to pay the cost of public water service by charging higher rates for domestic and manufacturing service than by direct tax for water used for municipal purposes, nor yet whether it is desirable, in the interest of a conservative public policy, and to assist the city to meet such possible emergencies as conflagration or earthquake, to charge off the water debt at a more rapid rate than depreciation requirements alone would make necessary.

The significant point which I desire to call to your attention is one well-known to you already,—that it is not safe to compare water rates found in different cities, without full knowledge of all existing conditions, including the value of the works and the character of the service rendered. Therefore if the attempt is made to compare your water rates directly with those charged in neighboring cities, you should inquire immediately what the conditions of operation and allowances for depreciation and fixed charges may be, or in other words what the financial policy in the operation of these work is.

Were you in the position implied by the Government statistics, with an average net annual income of $1.06 per capita applicable to depreciation, fixed charges, and profit, you might well find yourself with an annual deficit of between $1.25 and $1.75 per capita, derived as follows:—

Average per capita net income, applicable to depreciation, fixed charges and profit (as per United States Government Report)..........			$1.06
Depreciation	............1¼% on $35 =	$0.43	
Fixed charges	.... 5% on $35 =	$1.75	
Profit	.................1½% on $35 =	$0.52	
		$2.70	2.70
Deficit per capita	....		$1.64

While these figures are only approximate, as the operating cost under private ownership is probably considerably less than that shown for public ownership, they serve to bring home the lesson to be drawn from these Government statistics, which has already been pointed out,—that water rates cannot be compared equitably at their face value, without due allowance for difference in value of the works, character of service rendered, and any other important factors; and they show that upon the Government's average figures for gross and net annual income for municipal water works, under prevailing rates, these works are not earning a reasonable depreciation allowance and fixed charges corresponding to the probable present value of these works, and that private works or corporations could not earn a reasonable return upon the value of their plants upon water rates yielding such an average net income as that reported by the Government.

INFLUENCE OF DESIGN ON THE COST AND SPEED OF ERECTING CONCRETE BUILDINGS.

(Continued from Page 808).

which keep the layers of tension steel in the bottom separated.

The loop bar is supported on blocks resting on the slab form at either side of the girder. The bottom reinforcing bars are hung from this loop bar by means of ⅜-in. stirrups bent in the form of a "W." These stirrups in combination with the negative bars are designed to keep the sheer on the concrete down to 35 pounds per square inch. Alternate slab bars pass underneath the loop bar which serves to transfer the web stresses into the flange. The accompanying cut shows an interesting comparison of three different types of beams which were designed for this building. There is a great deal of variation in the allowable width of flange according to different opinions, but the width of 42-in. allowed in this case seems to be conservative practice.

The construction work proceeded as follows;—the column forms were erected, plumbed and squared, and securely braced. The girder forms made up in units were then put in place and finally the sheathing for the floor slab. The construction tower for hoisting the concrete was located about one-quarter the length of the building from one end so that when the sheathing reached this point it was possible to commence wheeling the concrete over the forms and placing same at one end of the building. Fabrication of the steel followed very closely after the erection of the forms. The following summary indicates the rapidity with which building No. 46 was erected. On July 29th the column forms on the first floor were all in place, the girder forms for half the second floor were erected and the sheathing for the second floor slab had been laid as far as the construction tower. The actual concreting for the superstructure commenced about August 1st. Three weeks later the concreting for the first floor and about half the second floor had been completed. The forms for the entire second floor were erected and the column forms for four bays on the third floor were in place. By September 7th, the concreting of the first three floors had been entirely completed, and the forms stripped while the forms for the fourth floor were practically all in place. On September 26th, the concreting had been practically finished and the forms were stripped from the entire building with the exception of the fifth floor columns and the roof. As indicated before the erection of the entire frame work of the superstructure occupied a period of but 39 working days. The system of reinforcement worked out admirably for construction, and the various details fulfil perfectly the purpose for which they were intended.

Great assistance was rendered the contractors by the transportation department of the General Electric Company whose co-operation made possible the handling of 407 carloads of material between August 21 and September 24th, without incurring a dollar's worth of demurrage.

The ease and rapidity with which this building was erected is surely a striking example of the large extent to which the proper design of a building may influence the cost and the speed of erection.

DETECTORS.*

By A. H. Johnson.

"Detection" is one of the several functions into which railway signalling is arbitrarily divided. Broadly speaking, the whole interlocking system is a detection system; but, in speaking of "Detection," we mean the method and means by which we prevent the signals of any route from showing

FIG. 1.

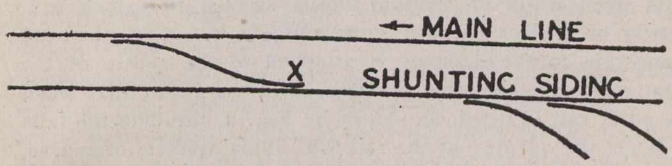
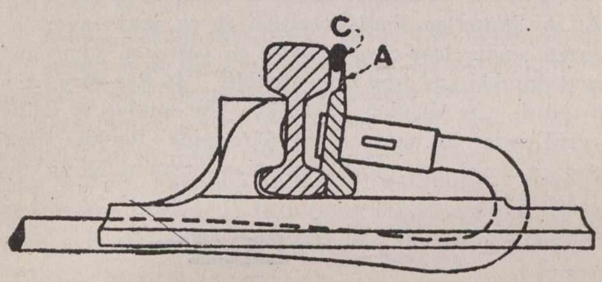


FIG. 2



false security in the event of switch points failing properly to correspond with the movement of the levers at the signal cabin.

In the early days of railway working the need for detection was not fully proved, in fact, facing points were not even protected by a facing point lock. On the introduction of the facing point lock it was thought that detection would be sufficiently performed by the bolt, and we all know that many failures of the points have been, and are now, often detected by the facing point lock. The point lock, however, is far from being a good detector, for the points have sometimes remained completely over in the wrong position, and the point lock has plunged them in that position. Many trailing points are at present devoid of a facing point lock, and this fact, taken in conjunction with the spread of the indiscriminate and unfortunate practice of using one ground signal to answer for several routes, makes detection in such cases a matter of great difficulty attempted by ordinary mechanical means, where several pairs of points are involved, indeed, so much so, that in many cases the detection has been omitted. The danger to be anticipated from the lack of detection is not confined to points over which passenger trains run in a facing direction. On the contrary, a great risk attends trailing points in some cases, especially those over which shunting takes place. This is due to the fact that a shunt made over a misplaced trailing point would, in many cases, be nearly sure to foul the main lines. For instance, such a case in connection with points x, Fig. 1, might easily prove disastrous to a fast train.

After practical experience had proved the need of detection, the first dectectors installed consisted of bolt locks connected in the run of the signal wire. Now, in cases where the signal could be fixed near the points, this device proved fairly efficient as a detector, and it is largely in use to-day, but signals have been held in the "off" position owing to the bolt lock binding in the point connection. In a complicated group of points, this method has been attempted, but with very poor results, owing to the difficulty connected with varying temperature. The use of a wire-adjusting screw is very apt in such cases to pull the nearer bolts into the gap in the point connection. There is also the extra chance of the sticking of the signal connection, when it has to thread, so to speak, through a group of points. In this method, in common with all systems of detection, there is the difficulty of keeping the detector bolt accurately adjusted to the ever-broadening gauge. This gradual broadening of the gauge takes place even when half-inch tie-plates are used, and it is a very real difficulty affecting accurate detection. It should be remembered that a point tongue cannot always be protected by a set in the stock rail, and an opening of one quarter-inch has derailed engines having worn flanges. The flange simply uses the point as a ramp, and climbs up and off.

There have been many patterns of detector bolt lock, some detecting both point tongues and others only one. Other patterns have detected both tongues and the bolt of the facing point lock. Some bolts have been counterweighted as a sort of antidote for temperature troubles.

From about thirty years ago till quite recently numerous attempts have been made to meet the detection of facing points by what is known as the "Facing Point Lock Detector" method. In this method the facing point lock itself is so designed as to become fixed and immovable should the point tongues fail to correspond correctly with the point levers.

There are several designs of this apparatus, and the means employed consist generally of a duplex bolt and gearing for causing the reversal of the bolt action when the point lever is reversed. The various designs are well-known to those whose experience goes back, say, fifteen years. They can be found in the old catalogues of McKenzie and Holland and Saxby and Farmer. In one of the later designs a single

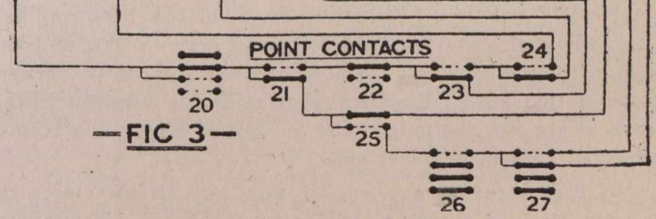


FIG 3

action bolt is so geared that it requires a complete reversal of the points after each withdrawal from the stretcher bar. It is ingenious and simple, but the necessity of reversing the switch points each time after unlocking would preclude its use in many cases.

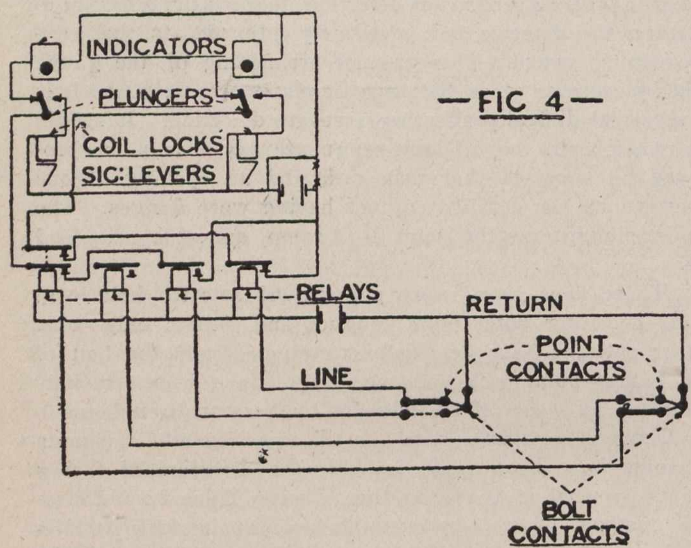
It may be mentioned, in passing, that the facing point lock detector method is used in some of the power signalling systems.

*Paper read before the Institution of Signal Engineers (Incorporated).

Another scheme which was tried on the Lancashire and Yorkshire Railway, about 29 years ago, consisted of springs applied to the point tongues to throw them half-cock should the point connection fail. Needless to say, the signal engineer removed them after a short trial.

Those who have not had close touch with the upkeep of railway signalling are apt to think that the "F. P. L. Detector" method of detection is efficient enough, but experience proves that nothing short of direct detection of the point tongues themselves by means separate from the facing point

—FIG 4—



lock should be used, owing to the growing importance of this feature of signalling by reason of the ever-increasing traffic. The risk is thought to bear some relation to the number of train movements.

Some of the more recent power-signalling schemes embody direct detection of both point tongues, and some go further and provide what may be termed, "Continual Detection," inasmuch as the detector serves to detect any displacement of the points, at any time subsequent to the regular check-lock detection, performed when the signalman uses his operating lever. This "Continual Detection" is a most valuable feature, and in the opinion of the author it will, in course of time, become standard.

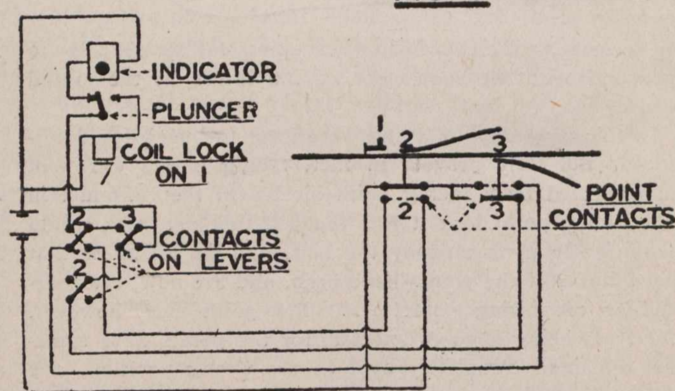
Some of the difficulties connected with the practical upkeep of detection performed by ordinary mechanical means have been mentioned. Those drawbacks have induced some signal engineers to try electrical detection in connection with manual plants. Some difficulties are thereby removed. For instance, varying temperature is no longer an obstacle, and there are no parts which may hold the signal in the "off" position. Electrical detection has been applied to the whole of Waterloo Yard for about seven years, and we have thereby remarkably reduced the services of the heavy lifters at that yard. Electrical detection has, however, difficulties of its own, although they are not so hopeless as those connected with mechanical ones.

At first sight it may appear that any circuit closer or electric switch, designed to withstand the heavy vibration in the vicinity of railway rails would, in connection with an electric circuit and an electric lock at signal lever, be all that is required. But, as a matter of fact, every electrical contact requires a definite margin of movement after actual touch is established. The result is that those which have been tried by the author cannot be set to detect the points quite so finely as a mechanical bolt. Then, again, there is generally a sinuous movement of the rails, in a horizontal direction, under the wheels of a train at many switch points, which rapidly wears the contact surfaces of the detector. The author found that to counteract these weaknesses requires constant care at a busy yard. It must be admitted, however, that as much care is needed in the adjustment and renewal of mechanical bolt detectors, at equally busy places, if they are really kept efficient.

There is one part of the point tongue that is of vital importance, as regards safety, in its relation to the stock rail. This is the portion A, Fig. 2. When the point stretcher bars and fittings become slightly worn, it is found that an obstacle such as shown at C will cause the top of tongue to remain open while the bottom closes against the stock rail. A twig or a piece of hard snow will do it. Now, the rod connection to the detector is attached to the centre of the point rail or to the base of same, with the result that when the point rail is tilted, as shown by Fig. 2, the detector fails to detect the opening at the rail top. This applies, of course, to both mechanical and electrical means of detection.

Another question calling for serious consideration is that of providing good underground wire work at a moderate cast. At the Waterloo Yard detection seven years ago, the author used single lead-covered wire in cast-iron pipe, and it is found durable and free from trouble. It was very carefully installed. At Clapham Junction, the author is using lead-covered wire, in bitumenized fibre pipe, for the main runs, and in iron pipe, for connections transverse to the rails.

—FIG 5—



There are two principal methods of laying out the wiring for electrical detection, viz.:—

1. Taking the circuit of the signal lever lock through a contact box at every pair of points affected.
   This method needs multiple contact boxes, which is objectionable.
   Fig. 3 shows diagrammatically this method as applied to Waterloo.
   The diagram shows a small portion of the detection at this yard. Attention is drawn to the multiple contacts at points 20, 26 and 27.
   In some cases there are twice as many contacts as at 26.
2. The provision of a two-way contact box at each pair of points; wires from each to the signal cabin; a multiple point relay worked by that circuit and the governing of the various signal lever locks locally therefrom.
   Fig. 4 shows the method as applied by the author.
   Instead of two line wires and two relays serving each pair of switch points, the author sometimes uses a single line wire and a polarized relay.

A combination of schemes 1 and 2 can be used for sake of economy. In that case, scheme 2 is used only for those switch points at which scheme 1 would necessitate more than a two-way contact.

The electrical detection method for Power Signalling is substantially the same as scheme 2 in most cases, although No. 1 has been used.

The reasons which lead the author to prefer the second of these methods are that the contact box at the points is simplified down to a uniformity of two circuit closers, and the multiplication of the circuits takes place at the signal cabin, where they are less liable to give trouble than in ground work. Another great advantage is the uniform wiring to each pair of points.

Electrical detection has an additional advantage inasmuch as with a single signal answering for several routes, the actual route corresponding to the point lever positions can be detected. This is done by simply passing the detector circuit through circuit closers working with the point levers as shown by Fig. 5. If the lever circuit closers are omitted, of course the exact route is not detected.

Before closing this paper, the author would like to draw the attention of the Permanent Way Department to the very practical need there is for improved switch point fittings, such as gauge plates which will really keep the rails to gauge, and stretcher bars which will stand for a reasonable time without attention from a blacksmith. The present fittings are little better than those used when the rolling loads were half what they are now and the train movements far less.

THE STEAM TURBINE CENTRIFUGAL PUMP.*

C. H. Hurd.

There has been considerable discussion at various times during the last three or four years, in the engineering societies and water-works associations, as to the possibilities of the steam turbine centrifugal pump compared with the reciprocating pump or pumping engine for water-works use. The same sort of discussion preceded this a few years in reference to the steam turbine generator, and the general use of which in the modern plant is evidence that these units can compete with the reciprocating type of prime mover for power-house use.

In considering the economical advantages of the various types of engines or pumps, it is necessary to take into account not only the first cost or interest upon invested capital, but the depreciation and maintenance as well as the operating expense, and unless all of these items are considered it is not possible to come to a proper conclusion as to which would be the most economical type.

In the discussion at the meeting of the American Water-Works Association three years ago, the statement that the centrifugal pump could show an economy, when everything is considered, against the crank and fly-wheel type, was challenged by representatives of some of the large engine builders. It is a noticeable fact, however, that some of these same builders are now offering on the market turbine driven centrifugal pumps and guaranteeing duties between 95,000,000 and 100,000,000-foot pounds per 1,000 pounds of steam.

*Read at Fourteenth Annual Convention Central States Water-Works Association.

One of the features which is often overlooked in the purchase or designing of a pumping plant, is the fact that the machinery may or may not be in continuous operation, also that it may not always be operated at its full-load condition. The specifications for large pumping engines almost invariably specify that the duty trial shall be made under full-load, whereas, in practical operations, particularly in towns having a direct-pressure system, it is almost impossible to reproduce these test conditions for any considerable period, and it often occurs that the machinery is operated during the greater portion of the time at from one-half to three-fourths of its capacity rating.

It is well known to engineers, superintendents, and those familiar with water-works service, that the total capacity of a pumping equipment must be largely in excess of the average requirement; provision must not only be made for peak loads in times of extraordinary demands, but there must also be spare units to be brought into service at times of repairs, and it is for such service that the turbine centrifugal, on account of its first low cost, makes a very favorable showing in net economy during the annual period.

In comparing these two types of pumps, it is necessary not only to consider the cost of the units themselves, but also the cost of foundations, buildings and boiler plant, as it will be readily seen that the total cost of delivering water will include both the fixed charges and operating expenses of the entire plant, as it is obvious that a high fixed charge may mean a low cost of operation, or a small investment in the pumping equipment, and correspondingly lower duty, a higher boiler room expense and additional boiler capacity.

In making the comparisons, a plant has been selected with an average pumpage of 10,000,000 gallons per 24 hours, which is perhaps slightly larger than the average water-works plant in the United States. In designing an equipment to take care of the service for the average city, it would be considered poor judgment to make the pumping capacity less than twice the average consumption. While perhaps it would be better to divide the installation into three or four units, particularly if the plant is to operate against a direct pressure system, for the purpose of this paper, we assume that the city has a reservoir of such capacity that two 10,000,000-gallon units would be sufficient.

As to the cost of such a plant, it is understood that the figures can only be approximate, and that they will vary in both cases according to the conditions and demands. In assuming the operating conditions, we will consider the price of coal at $2.50 per ton, fired into the boilers, and the head pumped against to be 200 feet. The cost of such a pumping plant, using vertical triple expansion pumping engines, for 20,000,000 total capacity, would be about $180,000, with interest and depreciation at 9 per cent., the fixed charge would amount to $16,200 per year, or $4.33 per 1,000,000 gallons pumped. It would be fair to assume that the centrifugal pumping plant to do like service, including boilers as above, would not cost more than $90,000, making a fixed charge per 1,000,000 gallons of $2.16.

In the case of the triple expansion engines under most favorable conditions, the station duty would not exceed 150,000,000-foot pounds per 1,000 pounds of steam. With the centrifugals, it would be fair to assume a duty of 80,000,000-foot pounds per 1,000 pounds of steam, and in both cases that the water evaporated to be six pounds per pound of coal. One hundred and fifty million-foot pounds duty is equivalent to 13.2 pounds of steam per water horse-power hour; 80,000,000 duty is equivalent to 24.75 pounds per water horse-power

(Continued on Page 816).

PAGE OF COSTS

COST OF CONCRETE BLOCKS FOR SEWERS.

During 1909 Halifax laid some 6,000 feet of concrete sewers. Considerable of these sewers were lain with concrete blocks, the cost of which are given below:—

20" x 30" Sewer, 84 tops = 126 cu. ft.

14" x 21" " 559 " = 1,263.34 cu. ft., 952 sides = 1,066.24 cu. ft.

12" x 18" Sewer, 805 tops = 909.65 cu. ft., 1,968 sides = 1,633.44 cu. ft.

Small Inverts, 1,665 = 1,681.65 cu. ft.

Catch Pit Covers, 18 = 37.08 cu. ft.

Number of batches mixed, 939 = 6,739.46 cubic feet = 7.18 cu. ft. per batch.

Cost:—

Labor	............4,888 hours at .18* cost	$882.26 = .1309	per cubic foot =	.94 per batch.
Cement	............1,174 bushels at .80 "	939.20 = .1391	" " " =	1.00 " "
Sand	..............1,878 bushels at .04½ "	84.51 = .0126	" " " =	.09 " "
Gravel	............1,878 bushels at .05 "	93.90 = .0140	" " " =	.10 " "
Stone	............3,756 bushels at 0.8 "	300.48 = .0446	" " " =	.32 " "
Paper	...........1,025 pounds at .03¼ "	33.32 = .0050	" " " =	.04 " "
Soap	.... 196 pounds at .06½ "	12.74 = .0019	" " " =	.01 " "
Coal	.... 8 tons at $7.25 "	58.00 = .0086	" " " =	.06 " "
Tools	............interest and depreciation,	10.00 = .0015	" " " =	.01 " "
Total Cost	....	$2,414.41 .3582	" " "	$2.50 " "
				$9.67 per cubic yard.

*First month various rates.

The above includes the cost of cleaning moulds, moving and storing blocks, and every expense incident to the cost of manufacture except the cost of water used and interest and depreciation of the moulds.

COST OF WATER MAINS.

From the report of the City Engineer of Halifax, N.S., we secured the following costs. These costs refer to mains laid during 1909.

Cast Iron Main Pipe.							Hydrants.				Cost per Foot in Cents.						
4-in. Pipe—feet.	6-in. Pipe—feet.	9-in. Pipe—feet.	12-in. Pipe—feet.	Joints.	No. of Valves.	Length of Pipe—feet.	Size of Pipe—inches.	Number.	Number of Valves.	Percentage of Rock.	Pipes and Specials.	Valves and Hydrants.	Labor and Cartage.	Lead and Gasket.	Dynamite and Fuse.	Total.	Total Cost.
...	155	.....	...	T & B	1	..	..	..	..	5	60.0	12.9	98.2	.9	2.2	174.2	$ 270.06
...	...	700	...	"	1	9	..	1	1	20	92.3	15.7	107.5	1.7	1.6	218.8	1,551.69
...	1,007	...	...	"	2	31	6	2	2	..	60.9	20.5	12.8	1.8	.2	96.2	998.56
...	600	...	...	"	1	..	..	..	..	..	61.1	3.3	35.4	.5	..	100.3	601.80
...	728	...	...	"	3	34	6	2	2	100	62.6	30.6	178.5	3.0	5.6	280.3	2,136.88
...	360	...	...	"	.	..	..	..	..	...	60.0	....	38.7	...	...	98.7	355.29
...	872	...	...	"	1	19	6	1	1	5	60.7	12.1	62.1	1.7	.3	136.9	1,219.90
...	96	...	...	"	.	..	..	..	..	...	60.0	....	27.8	...	...	87.8	84.29
...	...	...	...	"	1	..	..	..	.	100	65.1	6.9	172.0	1.7	5.6	251.3	733.79
...	500	...	...	"	1	..	..	..	..	...	60.0	4.0	53.3	.8	...	118.1	590.47
...	973	...	...	"	2	13	6	1	1	...	63.2	13.0	48.4	1.7	.1	126.4	1,229.86
...	175	...	...	"	1	..	..	..	..	10	60.0	11.4	109.0	1.0	...	181.4	317.45
...	196	...	...	"	1	..	..	..	..	90	62.4	10.2	171.2	1.4	9.7	254.9	499.60
...	...	*486	...	"	1	14	6	2	2	50	95.4	39.7	120.0	4.4	2.5	262.0	1,310.00
...	...	...	387	"	.	..	..	..	..	100	121.2	....	233.8	.5	8.4	363.9	1,408.29
...	228	...	...	"	1	11	6	1	1	...	61.9	44.5	45.3	3.8	...	155.5	371.65
290	...	...	...	"	1	..	..	..	.	5	43.1	5.5	39.6	.7	.3	89.2	258.62
...	516	...	...	"	1	12	6	1	1	20	62.1	21.2	61.3	.1	.7	145.4	767.71
473	6,698	1,232	387	....	20	143	..	11	11	...	....	....	....	...	...	.....	....

*270 ft. of 6-in. pipe taken up and replaced with 9-in.

PIPE-CLEANING BY MECHANICAL SCRAPERS.

Many water mains do not do the work for which they are designed because of growths and formations in the pipe. There are several mechanical scrapers designed for this work, and the cost for pipe cleaning in Halifax, N.S., is given herewith:—

Diameter of pipe—inches.	Length cleaned in feet.	Cost.	Remarks.
6	1,430	$ 9.92	Recleaned.
20	6,712	19.44	"
15	29,628		
20	6,712	21.32	"
15	29,628		
..	74,110	$50.68	

REINFORCED CONCRETE AND MACHINERY MAINTENANCE COSTS.

More important elements than the comparative cost of different building materials may have to be considered in deciding upon the type of construction for a factory. The relation of maintenance outlay to the net profits from a business has in recent years played an important part in the calculations of mill architects and engineers. The engineer has paid more and more attention to operating questions, and this more comprehensive view of the effect of particular types of construction on repairs and depreciation has greatly influenced his functions as designer and constructor.

The use of reinforced concrete in the new Maverick Cotton Mill, at East Boston, illustrates rather strikingly the way in which the operating knowledge of the engineer influences this construction practice. The chief interest of the Maverick Mill is not the fact that it is the largest cotton mill built of reinforced concrete, but that concrete was adopted by the engineers, Lockwood, Greene & Company, of Boston, because their experience with the relation of types of construction to operating cost had convinced them that a reinforced concrete cotton mill was in the long run less expensive than the ordinary type of mill construction. Concrete costs more than wood, or wood and brick, even in the north where lumber is more costly than in the region of the southern cotton mills. A concrete mill, therefore, costs more at the outset than one of wood. But the wooden mill sways and vibrates incessantly under the running of textile machinery, and this vibration of the whole building adds a good deal to the inevitable minimum of wear and tear on the machinery. At the textile schools the repairing of machines is a very important course of study. In the agent's office the cost of repairs to the machinery is one of the large items of expense of a textile mill. Hence the importance of lessening the cost, in time and money, of repairs to machinery.

A reinforced concrete mill properly designed and constructed is monolithic, rigid, free from vibration. This rigidity means an important reduction in the cost of repairs to machinery. For some types of machines, and in some industries, reinforced concrete would not be worth while solely on this point of its rigidity; but for the textile mill, rigidity is worth while, and means a saving which very soon overbalances the greater initial cost of concrete over ordinary mill construction.

As an example both for construction and operation considerations, the Maverick Mill is full of suggestion. The main mill, 550 ft. long by 130 ft. wide, has been built two storeys in height, but the columns and wall members have been designed to carry two additional storeys which may be built some time in the future. The one-storey weave shed, 340 ft. by 231 ft., is novel in the management of the construction of its saw-tooth roof, in which the usual horizontal tie-rods and tie-girders are absent. Each bay throughout its entire length is absolutely free of any obstruction to the light from the window. The 995 looms in this weave shed are driven by belts passing through slots in the concrete floor from motors in the basement. The room is indeed an extraordinarily perfect example of space and light used to the very highest advantage.

Having satisfied the operating requirements of rigid floors and framework, the designers of the Maverick Mill showed their readiness to save money in non-essentials by building the outer walls of both mill and weave shed of hollow concrete tile. This tile is fire-proof, and it costs, labor of laying included, even less than brick; it is also better than brick because of the insulation provided by its contained air spaces.

In regard to the installation of machinery the difficulties which many mill men associate with the idea of concrete construction were easily overcome in the Maverick Mill. In the spinning mill the motors which drive the machinery are suspended from channel beam frames bolted to the girder beams of the floor above. Proper engineering foresight has provided in the various portions of the concrete structure the margin of strength, and the arrangement of reinforcement, necessary for the carrying of all the necessary motors. The attaching of the various machines to the concrete floors,—a job that somewhat terrifies the mechanic accustomed only to wood construction,—has proved a vanishing difficulty. A small power drill has bored holes in the concrete almost as quickly as they could be driven in wood, and an expansion bolt in each hole gives a perfect anchorage. In the case of the spinning frames, the friction of the frame on the concrete floor adds so much to the stability of the machines under the pull of the driving belts that six bolts give an adequate anchorage where it is customary in fastening the frames to a wood floor to use twenty-two bolts. The absence of vibration of the building as a whole also removes the tendency of the machines to shift or "walk" on the floor from this cause. These details are referred to only by way of pointing out the fact that the supposed mechanical difficulties attending concrete mill construction are very easily met, and constitute no real problem. Meanwhile, the responsibility of Lockwood, Greene & Company for the planning and construction of large cotton mills which have proved economical in production expenses makes the example of the Maverick Mill particularly worth study.

COST OF HORSE KEEP.

Many engineers and contractors are interested in the daily and annual cost of a work horse. Recently the Property Commissioner of Toronto suggested that the city could more cheaply own and feed horses than hire. In the Farmer's Advocate, Mr. D. Caughell, of Yarmouth Centre, Ont., gives figures in support of the statement that the annual cost for feed and bedding is $147.35.

Supposing the horses keep stabled from the first of November till the first of June, and after that, out to pasture when not in use, but get their grain rations pretty regularly, the cost of keeping one horse will be as follows:—

Month.	Hay, Lbs.	Grain, Lbs.	Pasture, Value.	Straw for bedding, Lbs.
January	775	400	......	200
February	770	360	......	200
March	775	400	......	200
April	750	390	......	200
May	750	400	......	200
June	100	300	$1.50	...
July	200	400	1.50	...
August	200	400	1.50	...
September	200	400	1.50	...
October	300	400	1.50	...
November	700	400	....	200
December	775	400	....	200
	6,295	4,650	$7.50	1,400

Value of horse at five years old, $180.

Interest on money invested	$ 9.00
Decrease in value per year	12.00
Risk on horse per year	5.00
Four sets of new shoes	5.50
Extra setting	5.00
Wear and interest on harness	3.00
Clipping in the spring	1.25
Grooming and care for year	35.00
Pasture	7.50
Straw for bedding	2.80
Grain, 4,650 lbs., at $1.25 per cwt.	58.12
Hay, 6,295 lbs., at $8 per ton	25.18
Cost of stable room per year	8.00
Gross cost for one year	$177.35
Value placed on manure	30.00
Net cost per year	$147.35

Net cost per day—40 cents.

Where a person did not have so much work for his horses to do, a cheaper horse would do. This would cut down the decrease in value per year a little; also, if not working, the grain ration could be reduced, and also blacksmith's and groom's account.

Cartage Horses.

Usually, in the cartage and transport service, the teams turn out to work at 6.45 a.m. Feeding is done in the morning from 4.30 to 5 o'clock, by the regular barn-men, whose duties are to attend to the feeding and the stables of from 25 to 30 horses, and in some cases as many as 48 animals. The teamsters reach the barn from 5.30 to 6 o'clock. They have nothing to do with the feeding of their horses, but each man has to care for his own team and harness, and everything is done by the companies to stimulate a pride on the part of the driver in the fitness and attractiveness of his hitch. Each man is supplied with brushes, combs, dressings, cloths, and whatever he can use in caring for his team and harness, and no questions are asked, no matter how often the brushes are worn out or the bottles emptied. The teams come in as near twelve o'clock as their work permits, and at night as near six as possible; in such haulage work, however, teams may be from two to three hours late.

Feeding is a most particular task with so many horses at hard work. At all the barns visited, the horses were fed in three equal feeds. The Shedden Cartage Company, of Montreal, feed from 7 to 8 pounds of concentrates three times a day, consisting principally of oats, with some bran and molasses added. Timothy hay is largely used, although a fair mixture of clover in the timothy is found to make a more palatable and more desirable hay. In the morning, the horses at this barn are watered as soon as the teamsters arrive at the barns, then are returned to the stalls to eat hay while being cleaned and harnessed. At noon and at night, unless the teams are too warm, they are watered as soon as unhitched. The same practice in watering pertains at the Dominion Transport Company's barns. This company feeds 18 pounds of mixed grain feed per day in three equal feeds; 20 pounds of hay is given each horse per day, most of it being given at night. The grain feed is made up of oats, bran and molasses, mixed in the following proportions: 70 pounds oats, 15 pounds bran, 15 pounds molasses, the molasses in this mixture being two-thirds water. This is found to be a most satisfactory ration, and has been used since the 13th of July.

THE STEAM TURBINE CENTRIFUGAL PUMP.*

(Continued from Page 813).

hour. It will be seen from the accompanying chart, by using 13.2 pounds per water horse-power hour and a total head of 200 feet, that the steam required is 11,232 pounds per 1,000,000 gallons pumped, and with six pounds evaporation, 1,872 pounds of coal will be used, which at $2.50 a ton would mean that the cost of fuel is $2.34 per 1,000,000 gallons pumped. Also for the equipment using 24.75 pounds per water horse-power hour, 20,800 pounds of steam are required per 1,000,000 gallons pumped, and with the same evaporation, 3,460 pounds of coal would be used at a cost of $4.33 per million gallons.

Assuming labor, depreciation and maintenance to be the same in both cases, this gives a difference of $8,100 per year in the fixed charges in favor of the centrifugal plant, and approximately $7,300 per year difference in operation in favor of the triple expansion installation, or a net balance of about $800 per year in favor of the less expensive plant. With an average pumpage of 10,000,000 gallons per day, this would represent a saving of 21 cents per 1,000,000 gallons pumped

These figures are not intended to be accurate in all the various details but are fairly approximate for the conditions assumed. The writer, in making estimates on cost of plants of this character, has come to the following conclusions: For large water-works plants, where the pumps will be in almost constant service, the high duty pumping engine is the better investment. This is particularly true in districts having a high cost of fuel. On the other hand, for smaller plants, and plants where the machinery is liable to be out of service more driven centrifugal will show a marked economy over the than half the time, and for auxiliary equipment, the turbine larger and more expensive unit.

NEW INCORPORATIONS.

British Columbia.—British Columbia Trading & Packing Co., $100,000. International Battery Co. Pacific May-Oatway Fire Alarms. Rainy River Gravel Co. Vancouver Sand & Gravel Co. Western Engine and Supply Co., $25,000.

Ottawa, Ont.—Canadian Electric Automatic Machines, $225,000; L. S. Macoun, J. B. Prendergast, N. G. Guthrie Oxygenator Company of Canada, $4,000; A. L. Higley, C. N. McMichael, E. L. Moses, Buffalo.

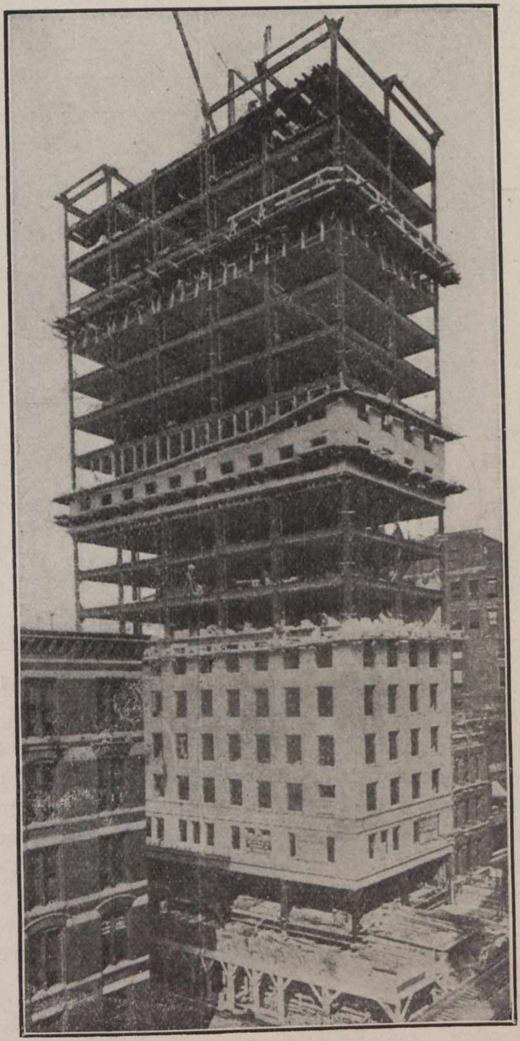
SCAFFOLDING FOR HIGH BUILDINGS.

The high building has brought its own problems, which are only now being solved in many instances. The erection of each of the modern skyscrapers has taken its toll in human lives, while masons and bricklayers were working on wooden scaffolds supported by horses and cantilevers. Abroad, particularly in France and Germany, a building being erected is surrounded by a forest of timbers supporting the scaffolding. In this country time is everything, and builders will not also go to the expense of such rather useless constructions, hence the dangerous if economical plan noted above. In five years in New York alone there were 660 deaths caused by falls from new buildings, while 177 deaths were caused by falls from scaffolds alone.

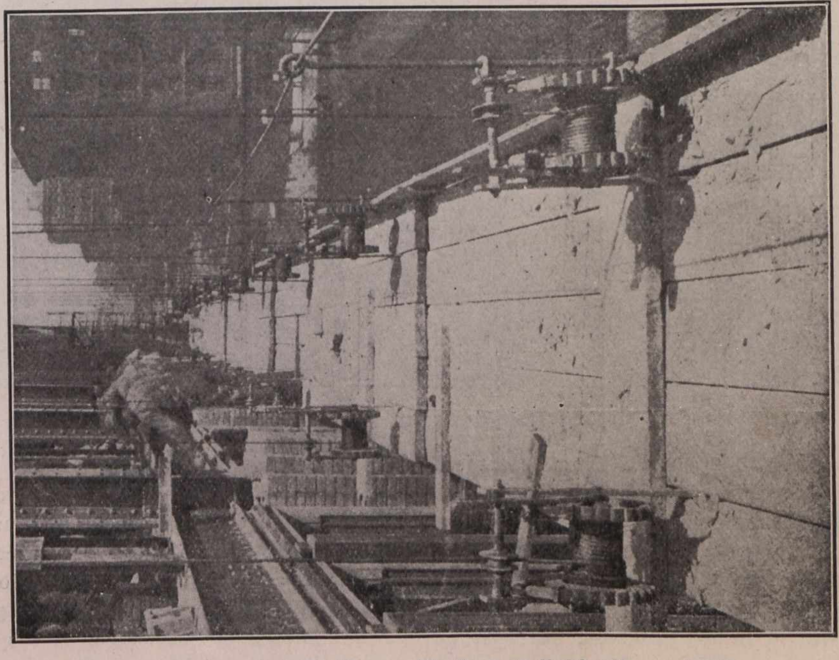
The presentation of the Scientific American gold medal to the Patent Scaffolding Company, of New York, brings to attention the practical device, which is being taken up by the Canadian Patent Scaffolding Company, in Canada.

Since the introduction of the new form of scaffold, there have been no fatal accidents where it is in use. In the last two years 319 buildings were erected with its aid, and 8,265 machines were employed, and the men were all unharmed.

The construction will readily be understood by reference to the engraving. The scaffold is interrupted so as to make sections ten feet long. At the ends of each section of planking are a pair of winches secured to a horizontal iron beam serving to support the planks. The winches are composed of a drum around which wire rope is roved, and the necessary supporting members. The upper end of the wire rope is secured to an outrigger by an anchor bolt, thus serving to support the scaffold. To the drums are secured ratchet wheels. A lever serves to actuate a pawl, which raises or lowers the scaffold by means of the ratchets, which serve to turn the drum, which winds up the cables. As the sections are small, one man can raise his section very quickly by a few strokes of the four levers at each corner. The speed is very considerable, and permits workmen to operate in sections, which is often important when material does not arrive, or where there are many openings. One of our engravings shows a building with part of the brickwork in place and a scaffold warped up at an angle. The great danger in scaffolding is in the use of imperfect and worn-out material, and for this reason with the present device inspections are constant, and all worn parts are replaced at the end of each job.



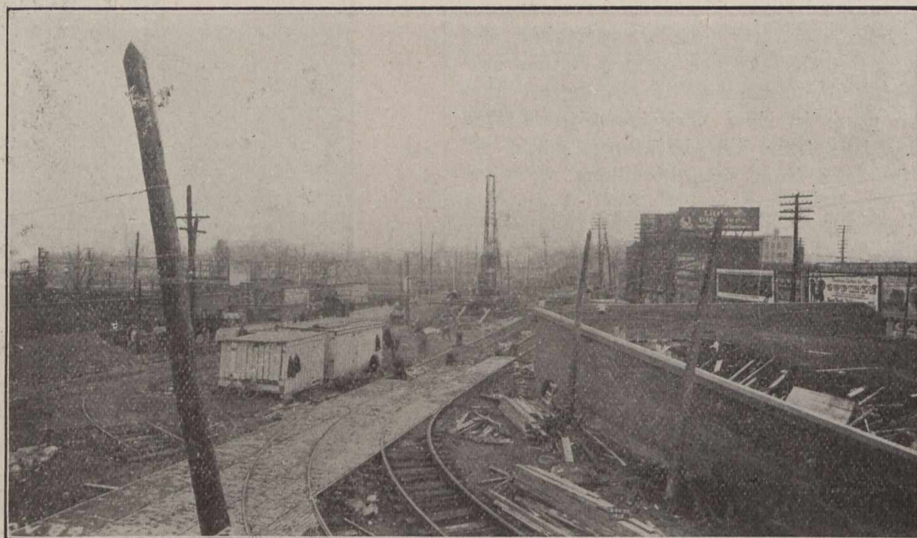
The Safety Scaffolding Enables Brick to be Laid at Any Storey.



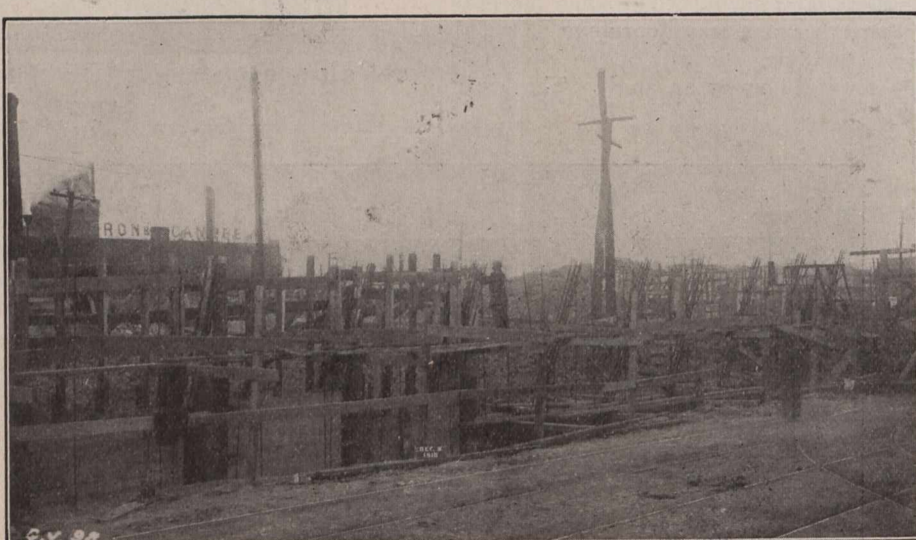
Masons' Suspended Platforms Worked Individually as Units.

QUEEN STREET BRIDGE, TORONTO.

At the Engineers' Club of Toronto, on December 15th, an interesting address upon the "Method of Construction of the Queen Street Bridge, Toronto," was given by Mr. R. E. Chadwick, Bridge Engineer, city of Toronto. Mr. Chadwick showed many interesting views of the work as it is at present. Mr. Chadwick said, although the alteration at Queen Street has been only recently undertaken, the change has been under consideration for a long time. The bridge is calculated to carry traffic of 30-ton cars. Some had stated that 40-ton cars should be here provided for, but at present in Toronto the heaviest loaded car is only about 25 tons. When the Grand Trunk Railway has completed its present city construction work, and this work is complete, all level crossings up to the Humber will be done away with. The first work on the bridge was on the west abutment. A reinforced concrete wall has been constructed upon the King Street side, and a similar wall is being constructed upon the Queen Street side of the approach. In this wall construction, square clutch bars were used as reinforcements. The concrete was a 1:2½:5 mixture. Broken stone was at first used, but it has now been substituted by a good grade of gravel. Concrete work below ground is still in rapid progress, but it is possible that serious difficulty will be encountered in the above ground work owing to the change in the weather. The great difficulty in this work has been the fact that it has had to be carried on in the midst of traffic, and furthermore, telegraph, telephone, car wires, car lines, and electric light wires have had to be moved about. Sewers have had to be temporarily supported, bridged, and underground difficulties have been met with which had not been at all reckoned on. In excavation, the abutments of an old bridge of which there seems to be no record was found near the Don's former course, 15 feet below the surface. A great deal of the earth in this section where excavation and pile driving was necessary, was a sort of muck land, in which if any depth of excavation was made the sides would speedily crumble in. In order to avoid this, the plan of excavating a few feet and then driving the pile, and thus continuing the process was followed. The most interesting feature of the alterations near the Don probably was the moving of the bridge. The plan proposed by Mr. McCuigan to move the bridge was the plan followed. In this falsework was used, piles were driven 12 feet. Three lines of rails were used, a bed of solid rail-road ties laid, and stringers were laid on top. Block and tackle were used, the bridge was moved parallel at first, then was swung around. The weight of the bridge is about 300 tons.

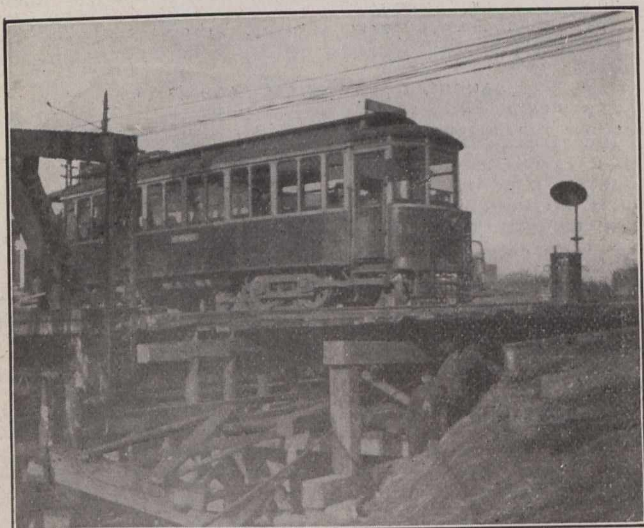


General View of Work Showing Diverted Traffic.



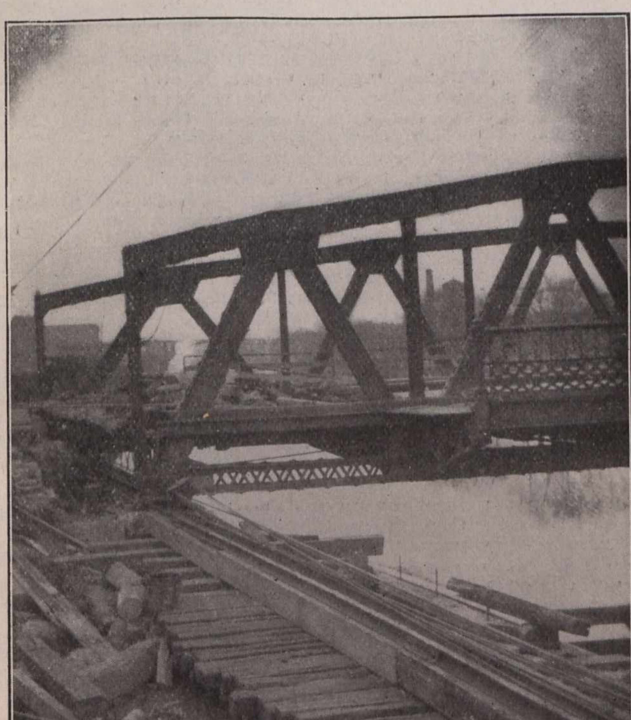
Placing Reinforcement for Retaining Walls.

This sliding of the bridge was very successful, two hitches in the process only occurring. An inch chain was broken by the pull and delayed work somewhat, and the south-west shoe refused to skid and did considerable grinding, which hindered the sliding. The movement of the bridge enables traffic to continue, and also leaves a clear space for work on the new structure.



Temporary Trestle at East End of Old Bridge.

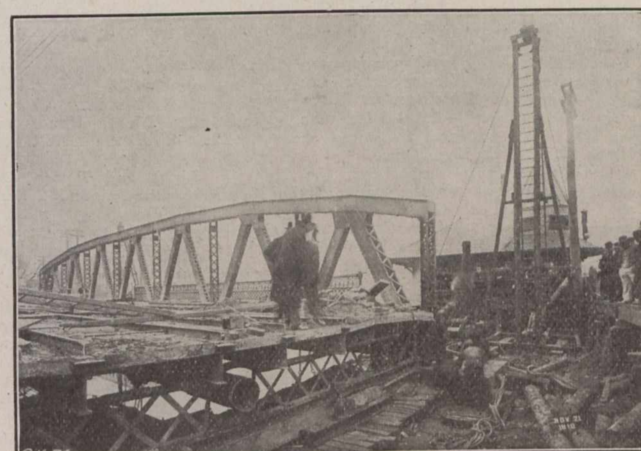
There are to be in all 55 pedestals; over 20 are now in, and work can continue on these as the top of the pedestals will be about 3 feet below ground-level. The structure will be carried on piles, supported by friction. All borings as much as 30 feet below water show sand, and none show solid rock, so 50-foot piles have been driven, with 3-foot centres. The



Skids for Moving Old Bridge, West End.

only other method would be to put in long spans and sink caissons, and this was not considered necessary. The river span will be carried on the present abutments. Great difficulty has been met with in bridging and supporting the sewers and water pipes, and the whole water service in this section will eventually have to be relaid.

The bridge will have a 42-foot roadway, 11-foot 4-inch sidewalks, and a 96-foot span. In the work there are 5,400 yards of ordinary excavation, and 2,300 yards of deep excavation. Considerable piling is to be done in the work, in all, 20,000 feet. The amount of concrete used totals 1,570 yards, and 104,000 pounds of reinforcement steel will be used. The refill will total about 24,000 yards, and 1,900,000 pounds of



Old Bridge Being Skidded Fifty Feet South.

structural steel will be used. Bridge railing to the amount of 1,650 feet will be used, and 1,700 lineal feet of pipe railing will go into the work. Concrete flooring will be used, and in all will amount to 880 yards. The floor will contain 122,000 pounds of reinforcing steel. The total cost of the bridge will be $250,000, of which the city pays 15 cent., the C.P.R. 30 per cent., the G.T.R. 10 per cent., the C.N.R. 30 per cent., and the Street Railway Company 15 per cent. The city is to pay 70 per cent. of the maintenance of the bridge.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

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

12473—December 7—Authorizing the C.P.R. Co. to construct an industrial spur for the Redcliffe Manufacturing Co., Ltd., in the townsite of Redcliffe.

12474—December 6—Rescinding Order of the Board No. 12209, dated November 7th, 1910, made upon the application of the C.P.R. Co., to construct an industrial spur for the Gres Falls Company, at mileage 2.22 from Piles Junction on said railway, in the Parish of Ste. Marie du Cap de la Madeleine, County of Champlain, Quebec.

12475—December 6—Authorizing the C.P.R. Co. to construct an industrial spur for the Canadian Tube & Iron Co., Ltd., in the city of Montreal, Que.

12476-77—December 7—Authorizing the James Bay & Eastern Ry. Co. to cross and divert the public road at Station 726.50, and at Station 605.63, in the Indian Reserve, County of Lake St. John.

12478—December 7—Authorizing the C.P.R. Co. to reconstruct Bridge No. 11.9, over the Assiniboine River at Headlingly, Man.

12479—December 7—Extending until June 1st, 1911, the time for the approval of the G.T.P. Telegraph Co.'s tolls for the transmission of telegraph messages.

12480—December 7—Authorizing the C.N.O.R. to cross and divert Broken Front Street, in Lot 1, Concession 1, Township of Sidney, County of Hastings, Ont.

12481—December 7—Approving road diversion in the south-east quarter of Section 14, Township 53, Range 5, west 5th Meridian, District of North Alberta, Province of Alberta.

12482—December 7—Dismissing application of the corporation of the city of Grand Forks, B.C., for an Order directing the Kettle River Valley Ry. Co. to carry out the terms and conditions of its agreement with the city, and forthwith to construct line of railway, so as to afford proper and adequate facilities for traffic from Grand Forks for 50 miles up north fork of the Kettle River.

12483—December 7—Authorizing the C.P.R. to construct an industrial spur for the Canadian Fairbanks Company, in the town of Saskatoon, Sask.

12484—December 7—Authorizing the C.P.R. to construct an industrial spur for the Outlook Saskatchewan Flour Mills Co., in the town of Outlook, Sask.

12485—December 7—Authorizing the Hydro-Electric Power Commission to use and operate its transmission wires at forty-seven different points in the Province of Ontario.

12486—December 6—Dismissing application of the corporation of the Township of Nepean, for leave to construct a crossing at Magee Avenue, Township of Nepean, across the Ottawa Electric Street Railway.

12487—December 6—Granting leave to the corporation of the Township of Nepean to construct a highway crossing over the Ottawa Electric Street Railway at Strathcona Avenue.

12488—December 6—Directing that the C.N.Q.R. Co. put the interlocking plant where its railway crosses the track of the Montreal Street Railway Co., near the intersection of Valois Avenue and Ontario Street, Montreal, in proper shape within ten days from the date of this Order.

12489—December 9—Authorizing the C.P.R. Co. to construct two industrial spurs for the city of Calgary, in Victoria Park, in the city of Calgary.

12490—December 9—Authorizing the C.N.O.R. Co. to construct its railway across the side road in Lot 35, Concession 1, Township of Sidney, County of Hastings.

12491—December 9—Authorizing the North Bay Light, Heat and Power Co., Ltd., to erect its wires across the track of the C.P.R. Co. at Ninth St., North Bay, Ont.

12492—December 9—Authorizing the Dufferin Light and Power Co. to erect its wires across the track of the Bolton to Owen Sound Branch of the C.P.R. Co. at Centre St., Orangeville, Quebec.

12493—December 9—Authorizing the Gres Falls Co. to erect its electric wires across the track of the C.P.R. Co. from the Shawinigan Water and Power transformer at Three Rivers, to its pulp mill at Cap Madeleine, Que.

12494—December 9—Authorizing the Dufferin Light & Power Co. to erect its wires across the track of the C.P.R. Co. (Bolton to Owen Sound Branch) at Town Line between Townships of East Garafraxa and Mono, one mile west of Orangeville, Ont.

12495—December 9—Authorizing the Stratford Light and Heat Commission to erect its wires across the track of the G.T.R. Co. at Ontario Street, Stratford, Ont.

12496-97—December 10—Authorizing the Ontario Water Company of Niagara Falls to erect its wires for the transmission of electrical energy across the tracks of the Niagara, St. Catharines and Toronto Ry. Co. at two different points in the city of St. Catharines, Ontario.

12498—December 10—Authorizing the corporation of the city of Winnipeg to lay a water main under the track of the C.P.R. Co. where it intersects Alfred Avenue in the city of Winnipeg.

12499—December 10—Authorizing the C.P.R. Co. to construct an industrial spur for the Great-West Felt Co., Ltd., in Elmira, Ontario.

12500—December 10—Authorizing the C.P.R. Co. to construct an industrial spur for the University of Saskatchewan, in the village of Sutherland, Sask.

12501—June 22—Dismissing application of the C.P.R. Co., and the Montreal Terminal Railway Co., for an Order interpreting certain provisions of the Order of the Board, No. 4988, dated July 8th, 1908.

12502—December 10—Authorizing the C.N.O.R. Co. to connect its lines and tracks with the lines and tracks of the Harwood Branch of the G.T.R. Co., in the town of Cobourg, Ontario.

12503—September 21—Refusing application of the Prudential Exchange Co., Ltd., of Lang, Sask., alleging discrimination by the C.P.R. Co., in rates on coal from Fort William and Port Arthur to Lang as against Moose Jaw and Regina.

SOCIETY NOTES.

Junior Gas Association, Toronto.—At the quarters of the association, 38 Toronto street, the opening meeting took place, when Hon. President Arthur Hewitt and President Armstrong addressed the members. A visit to B station on Saturday, December 10th, is the first of a syllabus of most beneficial outings, and everything points to a most successful and interesting session.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, Col. H. N. Ruttan; Secretary, Professor C. H. McLeod.

Chairman, A. E. Doucet; Secretary, P. E. Parent. Meetings held twice a month at Room 40, City Hall.

TORONTO BRANCH—

96 King Street West, Toronto. Chairman, A. W. Campbell; Secretary, P. Gillespie, Engineering Building, Toronto University, Toronto. Meets last Thursday of the month.

MANITOBA BRANCH—

Chairman, J. E. Schwitzer; Secretary, E. Brydone Jack. Meets first and third Fridays of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—

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

OTTAWA BRANCH—

Chairman, A. A. Dion, Ottawa; Secretary, H. Victor Brayley, N. T. Ry., Cory Bldg.

MUNICIPAL ASSOCIATIONS.

ONTARIO MUNICIPAL ASSOCIATION.—President, Mr. George Geddes, Mayor, St. Thomas, Ont; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

UNION OF ALBERTA MUNICIPALITIES.—President, H. H. Gaetz, Red Deer, Alta., Secretary-Treasurer, John T. Hall, Medicine Hat, Alta.

THE UNION OF CANADIAN MUNICIPALITIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Mayor Reilly, Moncton; Hon. Secretary-Treasurer, J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. E. McMahon, Warden, King s Co., Kentville, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Hopkins, Saskatoon, Secretary, Mr. J. Kelso Hunter, City Clerk, Regina, Sask.

CANADIAN TECHNICAL SOCIETIES.

ALBERTA ASSOCIATION OF ARCHITECTS.—President, E. C. Hopkins, Edmonton; Secretary, H. M. Widdington, Strathcona, Alberta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

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

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Vice-President, Gustave Kahn, Toronto; Secretary-Treasurer, R. E. W. Hagarty, 662 Euclid Ave., Toronto.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto.

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

CANADIAN FORESTRY ASSOCIATION.—President, Thomas Southworth, Toronto; Secretary, James Lawler, 11 Queen's Park, Toronto.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN GAS EXHIBITORS' ASSOCIATION.—Secretary-Treasurer, A. W. Smith, 52 Adelaide Street East, Toronto.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. Frank D. Adams, McGill University, Montreal; Secretary, H. Mortimer-Lamb, Montreal.

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

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 157 Bay Street, Toronto.

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

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

DOMINION LAND SURVEYORS.—President, Thos. Fawcett, Niagara Falls; Secretary-Treasurer, A. W. Ashton, Ottawa.

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

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, A. D. Campbell; Corresponding Secretary, A. H. Munroe.

ENGINEER'S CLUB OF TORONTO.—96 King Street West. President, C. M. Canniff; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian Members of Council:—Prof. F. D. Adams, J B. Porter, H. E. T. Haultain, and W. H. Miller, and Messrs. W H. Trewartha-James and J. B. Tyrrell.

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

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, H. W. Selby; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5 Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Alfred T. de Lury, Toronto; Secretary, J. R. Collins, Toronto.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, H. P. Ray; Secretary, J. P. McRae.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm. Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

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

CONSTRUCTION NEWS SECTION

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

TENDERS PENDING.

In addition to those in this issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Margaree Harbor, N.S., breakwater	Jan. 4.	Dec. 15.	52
North Vancouver, B.C., sewers	Jan. 3.	Dec. 15.	52
Ottawa, Ont., buoy steamer	Jan. 4.	Dec. 1.	698
Ottawa, Ont., railway	Jan.	Nov. 24.	42
Ottawa, Ont., tender for rails	Jan. 24.	Dec. 22.	66
Ottawa, Ont., tender for rail fastenings	Jan. 24.	Dec. 22.	66
Point Grey, B.C., steel pipe	Dec. 29.	Dec. 15.	68
Point Grey, B.C., castings	Dec. 29.	Dec. 15.	68
Point Grey, B.C., valves	Jan. 11.	Dec. 15.	66
Prince Rupert, B.C., buoy depot	Jan. 3.	Dec. 1.	698
Prince Rupert, B.C., wharf	Jan. 2.	Dec. 15.	52
Quebec Que., railway bridge	Jan. 9.	Dec. 22.	66
Sault Ste. Marie, Ont., construction of roadbed and structures on Manitoulin and North Shore Rivers	Jan. 2.	Dec. 8.	68
Sault Ste. Marie, railway	Jan. 2.	Dec. 15.	68
Souris, Man., water works supplies	Feb. 1.	Nov. 24.	54
St. John, N.B., main intercepting sewer	Dec. 30.	Dec. 1.	698
Stratford, Ont., cement supply for 1911	Dec. 30.	Dec. 22.	66
Vancouver, B.C., hospital	Dec. 30.	Dec. 15	52
Winnipeg, Man., steel cells	Jan. 6.	Dec. 15.	52

TENDERS.

Fredericton, N.B.—Tenders will be received until the 2nd day of January for the rebuilding of the Connor's Bridge, in the Parish of Chipman, Queen's County. Provincial Board of Works Department, Fredericton.

Fredericton, N.B.—Tenders will be received until the 5th day of January, 1911, for the construction of a retaining wall at Brick Yard Cove, on Little Lepreaux Road, Charlotte Co. Hon. John Morrissy, Chief Commissioner of Public Works.

Quebec, Que.—Tenders will be received until January 23rd, 1911, for restoration of and addition to Custom House, Quebec. R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

French River, Ont.—Tenders will be received until January 11th, 1911, for the construction of a dam and sluiceways across a channel in the French River, in the Indian Reserve, Province of Ontario. R. C. Desrochers, Secretary, Department of Public Works, Ottawa. (Advertised in The Canadian Engineer).

Gravenhurst, Ont.—Tenders will be received until January 16th, 1911, for the construction of a wharf and stone approach at Gravenhurst, Township of Muskoka, District of Muskoka, Ont. R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received until the 11th day of January, 1911, for the construction of 15-inch suction dredge for Maritime Provinces. R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received until the 18th day of January for the construction of an extension to wharf at Shigawake, Bonaventure County, Que. R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received until January 18th, 1911, for the delivery of Indian supplies during fiscal year ending March 31st, 1912. J. D. McLean, assistant Deputy and Secretary, Department of Indian Affairs, Ottawa.

Ottawa, Ont.—Tenders will be received until the 15th day of February, 1911, for the construction of a twin screw steel steamer. Alexander Johnston, Deputy Minister of Marine and Fisheries, Department of Marine and Fisheries, Ottawa.

Ottawa, Ont.—Tenders will be received until the 16th day of January for the construction of a wharf at Leitche's Creek, Cape Breton County, N.S. R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received until the 29th day of December for permits to locate mill in Riding Mountain Forest Reserve, Man. Perley G. Keyes, Secretary, Department of the Interior, Ottawa.

Ottawa, Ont.—Tenders for construction of a 15-inch suction dredge for Maritime Provinces will be received until 4 p.m., January 11th, 1911, at the office of the Department of Public Works. R. C. Desrochers, secretary.

Ottawa, Ont.—Tenders will be received until January 11th, 1911, for dredging, Port Hastings, N.S. R. C. Desrochers, Secretary, Dept. of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received until January 3rd, 1911, for the construction of a rifle range at Nelson, B.C. Eugene Fiset, Deputy Minister of Militia and Defence, Ottawa.

Pembroke, Ont.—Tenders are required by the 16th of January for either riveted or lapwelded steel piping. Mr. E. A. Dunlop, chairman of water committee. Pembroke. (Advertised in The Canadian Engineer.)

Pembroke, Ont.—Tenders will be received until the 16th of January for the delivery of cast iron water main. Mr. E. A. Dunlop, chairman of the water committee, Pembroke. (Adverised in The Canadian Engineer).

Peterboro', Ont.—Tenders will be received until the 5th day of January, 1911, for the construction of a power house, on the waterworks dam, near Peterborough, Ont., by the Canadian General Electric, 212 King Street West, Toronto.

Toronto, Ont.—Tenders will be received until December 30th, 1910, for the construction of that section of the Canadian Northern Pacific Railway from Victoria westerly twenty miles. Mackenzie, Mann & Co., Ltd., Toronto.

Winnipeg, Man.—Tenders will be received until Dec. 29th, 1910, for steel work substation 1. M. Peterson, Secretary, Office of the Board of Control, Winnipeg.

Winnipeg, Man.—Tenders will be received until December 28th for the supply of water meters, namely: ten 2-inch 22 one and one-half-inch and 43 one-inch. M. Peterson, Secretary, Board of Control Office, Winnipeg, Man.

Regina, Sask.—Tenders will be received until January 10th, 1911, for the supply of street railway materials. L. A. Thornton, city engineer, Regina.

Vancouver, B.C.—Tenders will be received until February 7th, 1911, for the supply of a new road roller. Wm. McQueen, city clerk, City Hall, Vancouver.

Edmonds, B.C.—Tenders will be received until January 9th, 1911, for the construction of a waterworks system for D. L. 186, in the Municipality of Burnaby. C. T. Saunders, C.M.C., Municipal Hall, Edmonds, B.C.

CONTRACTS AWARDED.

Ottawa, Ont.—A contract for a new steamer for lighthouse and buoy service on the Pacific coast has been awarded by the Government to the Collingwood Shipbuilding

Company. The contract price is $260,000. The new vessel is to be 200 feet long.

Collingwood, Ont.—Contract for a new steel steamer for lighthouse service on the Pacific coast has been awarded to the Collingwood Shipbuilding Company for $260,000. The vessel will be 200 feet long, and modern in every respect.

Winnipeg, Man.—C. W. Sharpe, of Winnipeg, has secured the contract for the new Canadian Pacific hotel at Balfour, near Nelson, B.C. The structure will be three storeys high, 205 feet by 105 feet, with a foundation of cement and stone. It is expected to be open for the tourist season of 1911.

RAILWAYS—STEAM AND ELECTRIC.

Montreal, Que.—It has been decided to extend the street railways of Calgary next spring. Tenders were gone into at a meeting of the city commissioners and it is stated that $100,000 will be expended on steel rails.

Montreal, Que.—J. H. Walsh, general manager of the Quebec Central Railway, stated that there was no truth in the report that the New York, New Haven and Hartford Railway would take over the Quebec Central. The English shareholders of the road were well satisfied with the future prospects of the company and the country, and would not dispose of their interests.

Montreal, Que.—Mr. E. J. Chamberlain, general manager of the G.T.P. was in Montreal recently, having just come back from a trip over the route of construction in British Columbia. He says now a stretch of only four hundred miles separates the Pacific and eastern ends of the G.T.P. He is confident that this will be finished in time for the opening of the line through to the coast early in 1913. The line from Fort George to Vancouver will be started as soon as the main line is finished.

Montreal, Que.—The completion of the Kootenay Central Railway, which has been taken over by the Canadian Pacific, and on which construction is now being pushed forward, will open a fertile stretch of land in the Columbia Valley. The railway will extend for 175 miles from Golden to Fort Steele, and will skirt the shores of Lake Windermere, in which the Kootenay and Columbia Rivers both have their rise. One of the difficult feats of engineering on the new line will be the diversion of Wild Horse Creek, but once this is done very little further trouble is anticipated.

Montreal, Que.—The Alberta Central Railway Company has entered into the field as one of the competitors for the construction of a line of railway to the Hudson Bay, and through its solicitors, Smith and Johnson, of Ottawa has given notice of application to parliament for an Act with power, among other things, to construct, operate, etc., a line of railway in common or as may be defined by the proposed Act from Saskatoon easterly to Hudson Bay, with terminals at both Fort Churchill and Fort Nelson. Alberta Central Railway Company is now constructing its line of railway 70 miles westerly of Red Deer, and forty miles easterly are under construction, while the route easterly has been approved to Moose Jaw. The company is authorized to build westerly as far as the Yellow Head Pass, and in addition to its line to Moose Jaw has power to build to Saskatoon or Warman. The present application is to obtain authority to build several branch lines, to project its line southerly to a point on the international boundary and to extend the Saskatoon branch to Hudson Bay, and if necessary to construct the latter by agreements with the government or other lines of railway to be the general road in common.

Montreal, Que.—Some interesting figures of the remarkable growth of the Canadian Northern in the past fourteen years were recently given out by Mr. D. B. Hanna, third vice-president and general manager. In 1896, said Mr. Hanna, the company operated only 100 miles of track. To-day the length of track under operation and in course of construction is 7,135 miles. This estimate does not include the British Columbia section of some 500 miles, or the gap of 600 miles still to be constructed between Sudbury and Port Arthur. But it does include all of the lines in Ontario, Quebec and Nova Scotia. It is hoped that by the end of 1914 all the gaps will be filled in and that the system will then be a transcontinental with 10,000 miles of line in operation. The pay roll has grown from $650 per month in 1897, to over $1,000,000 a month in 1910, and a gross revenue of $60,000 in 1897, to over $18,000,000 this year. In 1896 the staff included 13 men and a boy. To-day, the employees of the railway and its allied industries number 48,400. At the present time there are 535 cities, towns and towns in embryo on the Canadian Northern Railway. Sixty of these towns have a population of over 500, and 85 places have been given transportation facilities within the past four months.

Montreal, Que.—Although the American railway systems have a mileage 6 to 7 times larger than that of any other nation, yet the growth of railways in the Canadian prairie provinces is remarkable and is drawing the attention of the railroad world. Since 1903 Canada has increased its railway mileage by approximately 50 per cent. With the idea of opening up the wheat belt the Canadian Pacific and Canadian Northern instituted aggressive plans for reaching the new territory. Of course, in comparison with the 330,000 miles of road in the United States, this development is small. Nevertheless, within a few years, Canada will undoubtedly rank second among nations in extent of its railway mileage. Germany to-day ranks second and Russia third, and these nations have only between 35,000 and 36,000 miles. Canada has a tremendous capacity for further expansion. Even yet she has only 0.6 per cent. miles of railroad per 100 square miles of territory, or less than any other country in the world, except Brazil. Germany has 17.1 miles per unit of area, and the United States has 6.4 miles. Belgium, the most densely railroaded country in the world, has 40.9 miles per 100 square miles of territory. One the other hand, and notwithstanding an increase in population from 4,000,000 to 7,000,000 in a decade Canada has already expanded its railroads to a point where it has a smaller population per mile of trackage than any other country. She has now, in fact, only 300 people per mile of track, against 365 people per mile of track in the United States, 1,587 in Germany, and 10,000 per mile of track in British India, the most densely populated country per mile of road in the world. Grand Trunk, hitherto confined in its operations to the East, launched in the Grand Trunk Pacific transcontinental, the greatest railway project ever conceived as a single unit, to traverse a section far to the north of Canadian Pacific hitherto untouched. American roads, principally the Hill lines, also pushed into the new territory. As a result, railway mileage of the Dominion has been increased from 18,714 miles in 1903, to nearly 28,000 miles to-day, which, moreover, does not include over 6,000 miles of second track and sidings. The next four years should see even more rapid expansion. The Grand Trunk Pacific, which already has some 1,000 miles of road completed, will by 1913 have 3,600 miles of main track, besides numerous branches which it is pushing out through the rapidly populating areas. Canadian Northern has already 2,000 miles of road in operation, and will, when linked up with the East, comprise a transcontinental 4,000 miles in length. Canadian Pacific is also quietly stretching out north and west of its main highway, and has already double-tracked 595 miles of its main line to take care of present and prospective traffic from these areas.

Toronto, Ont.—The Canadian Pacific may shorten its Toronto-Winnipeg line by 50 miles by building a new line from Nepigon, 70 miles northeast of Fort William, to Savanne, 71 miles northwest of Fort William. The present main line now diverges to the south from Nepigon until it reaches Fort William, when it turns to the northwest, until it reaches Savanne, running from that point until it strikes Molson, when the line again runs south into Winnipeg. This will give the Canadian Pacific Railway the shortest route between the East and the West as far as Toronto is concerned. The distance from Toronto to Winnipeg by the new line will be 1,185 miles.

Toronto, Ont.—Five hundred men will be set to work on the Porcupine branch of the Temiskaming and Northern Ontario Railway early in January. Two hundred and fifty men are now rushing the construction work, but the number will be doubled as early next month as they can be secured and set to work. Half a mile of the roadbed has been laid and the T. & N. O. commission is pressing every portion of the road.

Guelph, Ont.—The plans provide for two subways and a foot passageway under the tracks. The main building will be 120 feet in length and 43 feet wide.