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The Canadian Engineer

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The Canadian Engineer.

ISSUED MONTHLY IN THE INTERESTS OF THE

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THE QUEEN.

God save the Queen! The hymn and prayer resounds throughout the world. It is echoed from a greater number of lips and hearts than any invocation or national cry since mankind began to band themselves into nations. Her name is beloved and revered, not only by her subjects, now numbering 350,000,000 people, but by millions in other nations, who, rightly reading the history of the time, know our Queen to be a lover of peace, and to be animated by the spirit of goodwill to all peoples. Millions of citizens of the United States, though owning the rule of an elected sovereign, will join the prayer for long life to the Queen, and are to-day almost as much interested as we ourselves in this jubilation for the longest reign in English history, and the longest reign of any noted sovereign of a nation prominent in the history of the world.

In the eloquent outpourings of love and devotion that will thrill through the tens of thousands of presses and pulpits this month, it is quite possible to exaggerate the personal power and the personal attributes of our Queen. Beloved though she is, we have to acknowledge that she is but human. She has no doubt made mistakes, and yet there has been no important crisis in the Empire's history where her judgment has not been guided by sound sense, and in no instance—God bless her!—has her record been tainted by an expression of cruelty or oppression. Those who have read her "Reminiscences of Life in the Highlands," or her other books, must see internal evidence of a pure mind and simple life. Her spontaneous utterance when, as a young girl, she received the announcement that she was Queen of Great Britain—"I will be good"—was the natural expression of her heart's desire.

Now the remarkable thing about Queen Victoria's call to the throne is this: that if it had been a case of election by the people she would inevitably have been passed over. The nation would have fixed on some more striking and dramatic figure—not an inexperienced maiden of negatively good qualities, but a lady of some pronounced mental qualities with something of the dash of Queen Elizabeth. Yet, as our young Queen grew into a woman, it was seen that the very absence of those dashing and brilliant qualities was the evidence of a truer greatness. It was her common sense and that excellent balance of intellect that was to make her reign far outshine the glories of the age of Elizabeth. Time alone, in the ordering of Providence, could develop the high nobility of her character, forged in the fire of personal affliction, by bereavement, widowhood and all the moulding "changes and chances of this mortal life," through which she has passed. Thus no plan of popular selection of a ruler could have brought about a reign so long and so glorious, or so abounding with mutual affection between ruler and people.

And so all hearts may join in the stirring anthem composed for this special occasion by a Canadian, the Rev. G. J. Low, of Almonte :—

A NEW NATIONAL ANTHEM.

O Lord, our God, to Thee
All praise and glory be,
Thy power we own.
For Thou hast heard our prayer,
Her life in health to spare,
For three-score years to wear
This Empire's crown.

To-day, throughout the world,
In every breeze unfurled,
Her standard's seen;
From India's coral strand,
From Afric's golden sand,
Resounds the anthem grand,
God Save the Queen.

And Canada that links
The two great oceans' brinks,
Repeats the strain.
To keep our own wide land
Part of that Empire grand
We'll work with heart and hand,
With might and main.

Her Empire's vast increase
In power, in wealth and peace,
Her reign has seen;
Of ev'ry race and creed,
From all oppression freed,
Her subjects ever plead,
God Save the Queen.

BRITISH RAILWAY ENTERPRISE.

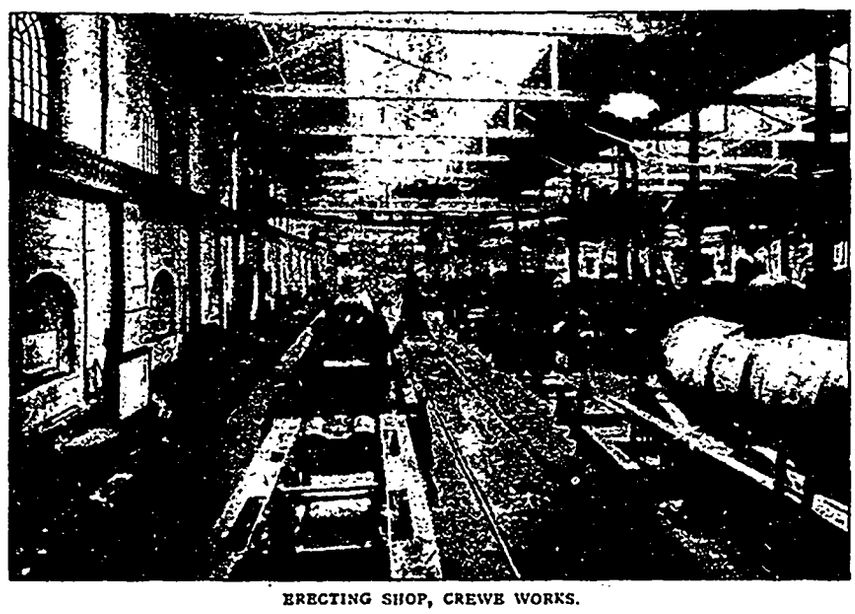
(Correspondence of THE CANADIAN ENGINEER.)

My letter under this head last month made some general comparisons between the railway systems of Great Britain and the United States, and showed that in the great essentials of safety of passengers, speed and economical administration, as well as profits to investors, the railways of Great Britain take the lead.

RAIL MILL, CREWE WORKS.

This, my concluding letter, will give some more concrete facts concerning the magnitude of the operations of a great British railway. In doing this I have singled out the London and North-Western Railway, not only because it is the largest railway corporation in the world, but because it is one of the best administered, and withal most popular with Canadian and American visitors to England. I gave incidentally some figures showing the splendid equipment of this road, and the admirable training of its officers and men, as shown in their ability to handle such enormous crowds of passengers and quantities of freight as they are called upon at times to transport. Figures are not always dry, and certainly the figures with which one is required to deal in describing the work of a great corporation like this, are eloquent in themselves. The capital of the London and North-Western Railway is a little over $600,000,000, the magnitude of which will be realized when I mention that the total capital invested in all the industries of Canada of whatever kind is, according to the census of 1891, $354,620,750. The report of the company for the half year ending June, 1896, shows that the following passengers were carried: First class, 981,785; second class, 1,461,405; third class, 33,416,013; season tickets, 41,815, or at the rate of nearly 72,000,000 per year, and so far as I know not a single passenger's life was lost. This total more than equals the population of the United States, Canada and Newfoundland combined. In one week last year (that before the Bank holiday) the passenger traffic receipts were $1,560,000. And yet the total mileage of the London and North-Western, including leased lines, is only 1,912. The return of rolling stock at the meeting referred to showed 2,335 engines, 1,778 tenders, 4,369 passenger cars or "coaches" of various classes, and 65,850 cars for various classes of freight. This is exclusive of "duplicate working stock," among which are 445 engines. The company also own 4,078 horses—enough to make a strong cavalry force for an army, while its human employes, numbering 60,000, would certainly make a respectable army. The bill for coal and coke for the locomotive department for the past year was $1,975,000, and for "oil, tallow and other stores," for the same branch, $131,740. It requires $12,500 a day to keep the road in proper repair, the approach roads, bridges, signals and like items costing $700,000, and $500,000 a year goes in painting and repairing, besides $150,000 in rebuilding. Over $360,000 a year is spent for new ballasting alone. Every foot of the line is inspected every day, and every signal cabin along the whole system receives inspection each fortnight. In the signal department there are eleven inspectors with 500 foremen, "chargemen," and artisans, and the rodding they deal with would extend from Land's End to John O'Groats, and the wires would more than stretch across the Atlantic from Liverpool to New York. There are 18,000 signals and 1,500 signal cabins, there being nine complete cabins turned out each week at the works at Crewe, to replace worn out ones, some of them having twenty-four arms.

To keep the rolling stock of the London and North-Western in repair costs about $1,500,000. A third class passenger car costs in England about $3,000, and a first class composite one about $4,000, and each vehicle gets sixteen coats of paint before it is finished.

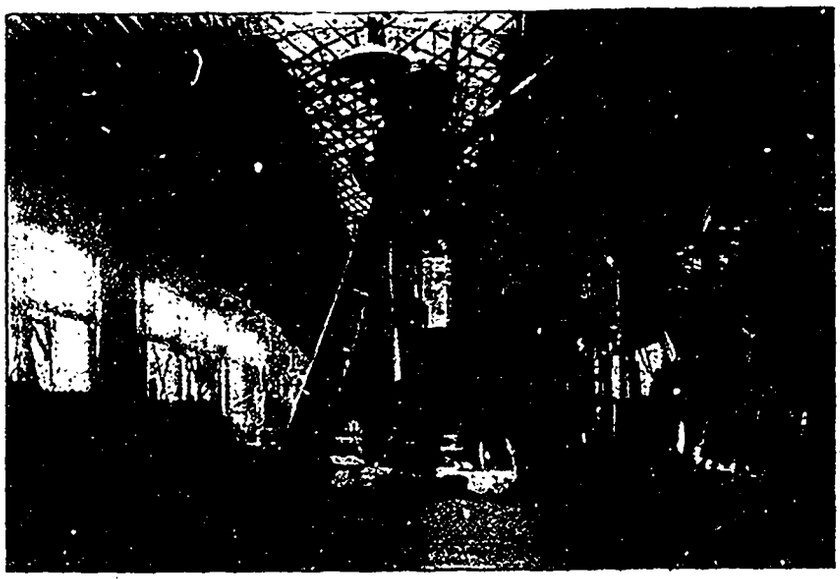


ERECTING SHOP, CREWE WORKS.

So much of the work of car building is done by machinery that the item of labor only costs $100 per car. The car works are at Wolverton, and employ 3,500 men; the goods trucks, or open freight cars, are built at Earlestown, near Liverpool, and employ 2,000

hands, and the cost of maintaining the rolling stock—exclusive of engines—is $2,100,000 a year.

The locomotive shops of the London and North-Western are at Crewe, and to the mechanical mind this is the centre of attraction of the system. It is marvellous to think of a town of this size being solely the creation of a railway company, and fulfilling the needs of only one department of it at that. On the 4th July, 1837 (the year the Queen came to the throne), the first train passed through Crewe, then a hamlet of 148 souls;



EIGHT-TON STEAM HAMMER, CREWE WORKS.

now it is what Canadians would call a "city" of over 30,000, the whole population depending on or working in the shops of this railway. In 1843 the shops occupied less than three acres of ground, and employed 161 hands; now they cover over 120 acres and employ over 7,000. The town has a Mechanics' Institute, built and maintained by the company, and connected with it is a Science and Art School, whose students have won more Whitworth scholarships than any other place in England. It has a volunteer engineer corps, 600 strong, composed entirely of men in the works. The shops have their own fire brigade, and similar organizations, all very efficiently maintained. The parliamentary division is now named after the town, which contains more than half the electorate.*

The first locomotive superintendent at Crewe was F. Trevithick, son of the great Trevithick, who, in 1805, brought out his wonderful "steam coach" and exhibited it on the very site now occupied by Euston station, the London and North-Western's London headquarters. In Trevithick's time the company had only 75 engines in stock.

At the Crewe shops, which now employ over 7,000 men, the company makes its own steel, has seven furnaces for steel of the Siemens-Martin process. The London and North-Western is the only English company that rolls its own rails, and a view of one of the rail mills is shown in one of the illustrations. The plant has a capacity of 45,000 tons of rail per year, and actually produces about 30,000 tons. The mill is driven by a 700 h.p. Corliss engine. An ingot of steel 3 feet long and 10½ inches square is taken out of the furnace and fed to the jaws of the swiftly revolving rollers of the mill. The ingot in passing to and fro in these grooves becomes longer and thinner with each squeeze; and finally, when it is formed into rail shape in the last pair of rollers, it is carried on smaller rollers to a circular saw, where the ends are cut off as easily as a scantling of wood is sawn off in a lumber mill, and we behold a finished rail 30 feet long and weighing 90 lbs. to the yard, the whole process of making the rail occupying only a minute. "Within the works," writes W. J. Gordon in an article on this town in *Pearson's Magazine*, "there are five miles and more of the pigmy track of 18-inch gauge which covers the floor of its shops like a spider's web, on which run the miniature engines that once replaced the horses on the Shropshire Union Canal. Anything in the metal way used in railway practice you can get at Crewe from start to finish. You can see the steel made in the converters with all their roaring pyrotechny, and you can follow it from point to point, until it moves off by itself on the rails (made from the same converter), and flies north or south on its trial trip at 50, 60, 70, aye, 80 miles an hour." To build an engine in the ordinary way takes four weeks, but one engine was built here in the space of 25½ hours. The process of erecting an English engine is as follows: The different parts, such as boilers, frame plates, cylinders, axles, etc., being previously made in their respective shops, are brought here to the erecting shops, where first the frame plates are fixed by temporary cross-bars into the place they will occupy when the engine is complete. The cylinders and foot plate are then fixed in position, and when the skeleton is complete the boiler is

BOILER SHOP, CREWE WORKS.

lifted on by a crane. Then the cylinders are fitted in, and the wheels (which are usually of cast steel, and to which the axles have already been fitted) are then run under and the frame lowered down on them. The

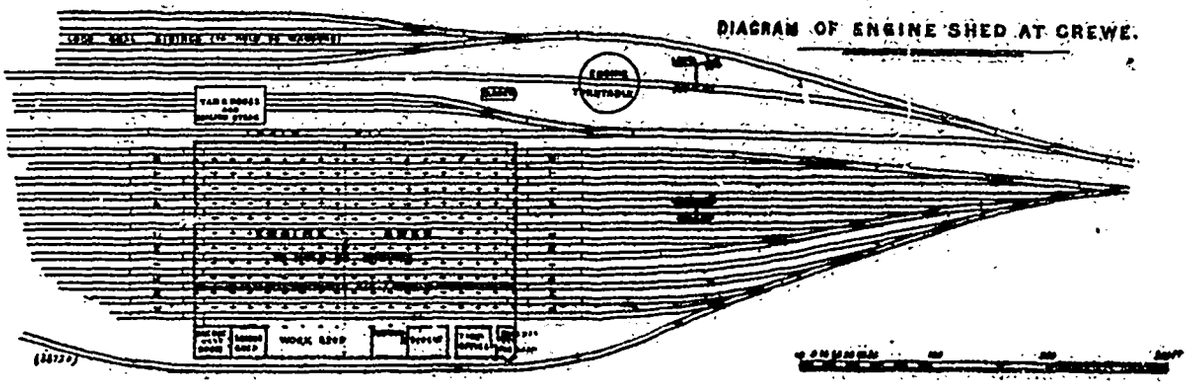
*For a fuller description of Crewe and its shops see article in *English Illustrated Magazine*, Feb., 1892, by C. J. B. Cooke.

next work is the connecting of the rods and all the intricacies of the valve motion, and then all the internal and external fittings are completed. Before she is taken to the paint shop and polished up, she is sent out on her trial trip. As mentioned before, over 2,000 engines pass through these shops each year for overhauling and repair, and all the engines of the line consume about 3,500 tons of coal per day.

In the wheel shop some very fine machine tools are to be seen. Some of the lathes are capable of turning a wheel nine feet in diameter. One machine called a "roughing lathe," has seven tools all employed at once in taking a rough cut off the crank axle, tearing the steel away in huge bites and making the axle ready for the finishing tool. A "nibbling machine," with 160 cutting tools, eats its way into the solid forging of a crank and cuts out the "throw" or inner bend of the crank. The boiler shops, a view of which is here given, employ several hundred hands, and the noise of riveting is like the roar of a tropical hail storm.

A new engine shed has just been completed, after a design by F. Webb, the able superintendent, to hold 60 standard tender engines. It is a "through and through" shed, and will be used principally for the "turnback" engines arriving at Crewe with goods trains from either the north or south. These will pass into the shed at one end as they come off work, and after cleaning, will come out at the other end for the return journey. The length is 272 feet 7 inches, whilst the breadth is 184 feet 1 inch. All the ironwork is made to template and to standard patterns, so that any part will fit any similar shed, many of smaller dimensions having been erected at different points of the company's lines. The arrangement of tracks is shown in the diagram, which is reproduced from *Engineering*, of London.

DIAGRAM OF ENGINE SHED AT CREWE.



To finish with a few more general statistics. The wages bill of the traffic department of the London and North-Western is $8,455,000 a year; over $1,000,000 a year is spent in fuel and light for the waiting rooms and cars; the uniforms for the men cost $150,000 a year, and the printing and stationery amounts to over $300,000, the actual weight of tickets sold being about 70 tons a year. The passenger trains run over twenty-one million miles a year, and the goods trains (freight) nearly as many, making a total of forty-one million miles. The receipts from passengers and freight make an annual total of over $32,500,000, and the total weight of passengers and freight thus carried is estimated at 38,000,000 tons.

But, as Mr. Gordon says in the article previously quoted, "there is a North-Western afloat as well as a North-Western ashore; the company is not only a railroad owner, but a canal owner and a steamboat owner. It pays over $57,500 a year in light and harbor dues; its steamboat repairs cost over $75,000 a year; its marine coal bill is over $90,000 a year, and the manning of its fleet costs $215,000 a year. Altogether it spends a trifle under five hundred thousand a year on its steamers. And its canals at Lancaster and Huddersfield cost over $35,000 a year. During the same period it paid the Government $75,000 as passenger duty, and its rates and taxes reached the enormous total of over $750,000. Its telegraphing costs $285,000 a year. To its superannuation fund, insurance, provident and pension societies and schools it gives $225,000 a year. Curiously enough, it has among its directors one that is hereditary, as the Great Western has one in Sir Watkin Wynn. This is the Duke of Sutherland, whose father is still known in railway circles as "the real live duke," from an incident which occurred on a line contrasting very decidedly with the North-Western, being that in Sutherlandshire, in the Dunrobin and Helmsdale country, which his Grace practically paid for out of his own pocket. One day he was driving the express on this line as the train passed two navvies. 'There Bill,' said one of them, 'that's what I calls a real live dook; he's a-driving his own engine on his own line, and burning his own blessed coals!' He would be a rich man of whom that could be said on the North-Western."

For THE CANADIAN ENGINEER.

RAILWAY ENGINEERING.*

BY CECIL B. SMITH, MA. E., MEM. CAN. SOC. C. E., ASSISTANT PROF. OF CIVIL ENGINEERING IN M'GILL UNIVERSITY.

ARTICLE III.—TRAFFIC.

Wellington demonstrates that the traffic revenue increases with the (*population per mile of railway*)^2.

This is based on the rough assumption that the volume of traffic increases as the distance between two towns diminishes, or that the gross traffic receipts between two towns is nearly a constant, and thus if on a given line we have two traffic points and call traffic 1. Then with three traffic points the traffic $= 1 + 2$, and with n traffic points the traffic $= n\frac{(n-1)}{2}$, or when n is large we may neglect the second ter: 1 and say that the traffic for n points $= \frac{n^2}{2}$. Now if we apply this to the individual as a unit, we may deduce the general statement given above. This assumption is not tenable when applied to a special commodity which originates at a fixed place, such as coal. Because the traffic is the same for two towns 150 miles or 15 miles from the coal pit, depending entirely on the demand for coal, on the other

* This series of papers will be issued in book form as soon as they have appeared in THE CANADIAN ENGINEER.

hand it is augmented by the fact that short haul rates are usually higher than long haul for the same service. Even this consideration, however, will not hold at the present day for suburban steam traffic, because it is being terribly crippled by electric suburban railways. On the whole, it is probably still true for a road of considerable length of general traffic, not largely suburban.

This view is upheld by the following table, of the internal traffic of New York city:

Year.	Population.	Trips per year per inhabitant.	Value by (n)² Formula
1860	814,000	45	45
1870	942,000	122	60
1880	1,206,000	175	99
1885	1,393,000	213	132

By which we see that the gross returns exceeded the ratio of $(population)^2$, but as the length of haul also increased it is probable that the net revenue about followed the law given. The following table, also, of a broader and more general character, confirms the view given:—

TABLE I.

SHOWING INCREASE OF POPULATION AND RAILWAY EARNINGS IN UNITED STATES AND CANADA, 1870 TO 1895.

	Year.	Miles of Railway.	Gross Earnings ÷ 10,000	Population ÷ 100,00	(Col. iv.)²	Rates of Col. iii. Col. v.
Canada.	1875	4,300	$1,958	39.	1,521	1.29
	1880	6,800	2 355	43.	1,849	1.27
	1885	10,200	3.223	45.	2,025	1.59
	1890	13,100	4,680	48.	2,304	2.03
	1895	16,091	4,680	51.	2,601	1.79
U.S.A.	1870	54,000	37,000	385	148,225	.249
	1875	74,000	50,000	440	193,600	.258
	1880	94,000	60,000	501	251,000	.239
	1885	128,000	77,000	565	319,225	.241
	1890	166,000	120,000	626	391,876	.307
	1895	180,000	107,500	690	476,100	.226

This table shows (assuming that the population served per mile of railway increases in the same proportion as the population of the country as a whole does) that the gross earnings, both in Canada and the United States, have increased more rapidly than the $(population)^2$; however, the rapid falling off from 1890 to 1895 in both countries suggests that this may not entirely hold true in the future.

As another indication of the same law, compare Canada and United States for 1895. (See Table II.)

	Gross Earnings per Mile.	(Pop. per mile of Railway)²
Canada	$2,908	$(317)^2 = 100,489$
U.S.A.	5,945	$(382)^2 = 145,924$

Which shows that the gross returns per mile of railway are even more than in the proportion of "square of population per mile of railway."

In any given case it will be difficult to estimate the actual tributary population, which may be decreased by competition, increased by feeders or affected by industrial conditions, but if applied on a large scale to eliminate irregularities, we may look on it as quite accurate enough to guide us in comparisons of routes. Thus, supposing a railway by altering its general location can be made to serve 1,200,000 people instead of 1,000,000, we may estimate its gross returns to be increased from 100 to 144, or 44 per cent., while if the road is not materially longer, or poorer physically, the increase in operating expenses will be much less in proportion.

Revenue is often considered to be injured by a long line between terminals, but this is, largely, a mistaken idea; the only case in which it is true is when there is keen competition between two places, by two or more routes, in which case the rate is fixed by the shorter line, but in non-competitive and local traffic, or even in the case of a road forming one link in a trunk line, rates are fixed by the mile or divided on a mileage basis, so that if a road can be located through more populous districts, built cheaper or with lighter grades, then the advantages of higher traffic charges, greater volume of traffic, less working expenses and fixed charges may any or all be in favor of the longer line. Incidentally, in Canada bonuses are often given on a mileage basis. These remarks apply only to moderate increases in length of line of from 5 to 10 per cent.

The folly of long tangents, creating more first cost, and often missing local traffic points, is a blunder somewhat common; the idea of serving the public by passing through the *very heart* of each populous district should be more fully appreciated, for ultimately, whatever traffic a road may have is from door to door, including cartage and bus fares; most evidently is this so at competing points. But the most important effect is that a good railway service convenient to the public will foster and increase traffic, while a town given the go-by for the sake of saving a little in land damages, or distance, has often had its prospects blighted forever; it is most important that a road should establish large roomy depots and obtain plenty of yard room, while land is inexpensive, in anticipation of future growth on the part of any prosperous town. Wellington estimates the loss of traffic for each mile a depot is distant from the centre of population at from 10 per cent. to 25 per cent., being greatest at competing points and in manufacturing towns.

TRUNK LINES.

Most trunk lines are liable to suffer from competition, and, to protect themselves, buy or build feeders, and this has concentrated railways into large systems, but a general rule is to link together the largest possible population, quite regardless of minor losses in distance. The limit should never be approached when the increase in revenue is no greater than the increase in length of line, or when differences of distance are so great as to discourage traffic or encourage the construction of a competing road, and an exception might also be made in the case of being able to pass midway between two towns and serve them fairly well by branches.

The N.Y.C. & H.R.R. is a striking example of a road much longer than any of its competitors, but with light grades and a heavy tributary population, it is largely independent of its through traffic, and can handle it as "excess traffic" at a very low rate; on the other hand, the Pennsylvania R.R., soon after its completion west, built feeders in every direction, and thus held traffic that would otherwise soon have passed into other hands owing to its heavy grades.

Other general conclusions regarding trunk lines are:

(1) That they should never attempt to make a small sea or lake port a terminal, but have the largest possible terminals even at the expense of considerable extra distance. As instances of this, witness the Intercolonial making arrangements to enter Montreal, the Erie Railway abandoning Dunkirk as a terminal and building into Buffalo, and the Mexican National attempting to establish a port at Corpus Christi, instead of Galveston, which proved a failure.

TABLE II.—RAILWAY STATISTICS, 1895.

CAPITALIZATION, FIXED CHARGES, WORKING EXPENSES, EARNINGS, ETC.

Item.	Canada.		Great Britain.		United States.	
	Total.	Per Mile.	Total.	Per Mile.	Total.	Per Mile.
Mileage	16,091	.....	21,174	.....	180,657	§
Population	5,100,000	317	39,300,000	1,856	69,000,000	¶382
Square miles	1,609,000	.....	120,800	.....	2,970,000	¶
Population per square mile	3 2	.....	325	.....	23.2	.....
Capitalization.						
Bonds	$330,786,000	$20,557	$1,800,906,000	$85,000	$5,407,000,000	$30,000
Preferred stock	105,680,000	6,568	1,236,446,000	58,400	759,000,000	4,200
Common stock	255,769,000	15,897	1,772,862,000	83,700	4,961,000,000	27,400
Loans and floating debts	37,626,000	2,338	67,196,000	3,100	616,000,000	3,500
Bonus and Government aid	167,523,000	10,411	.....	.....	.....	.....
Total	$897,384,000	$55,761	$4,875,410,000	$230,200	$11 743,000,000	‖$65,100
Earnings, Etc.						
Passenger	13,311,440	827	181,949,000	8,593	252,000,000	1,390
Freight	29,545,490	1,836	214,450,000	10,033	730,000,000	4,040
Other	3,928,560	245	22,044,000	1,136	93,000,000	515
Total	$46,785,490	$2,908	$418,443,000	$19,762	$1,075,000,000	$5,945
Working expenses	32,749,670	2,035	233,159,000	11,011	726,000,000	4 020
Net earnings	$14,035,820	$873	$185,284,000	$8,751	$349,000,000	$1,925
Per cent working expenses to gross earnings	.70	.....	55¼	.....	67½	.....
Per cent. net earnings to total capitalization	1.56	.....	3.80	.....	2.97	.....
Fixed Charges.						
Bond interest	*$15,287,250	(4 62%)	‡$121,494,000	(4%)	$240,000,000	(4 42%)
Other interest on loans, rentals, etc.	†1,881,300	(5 0%)	‡ 2 688,000	(4%)	53 000,000	.....
Total	$17,168,550	.....	$124,182,000	.....	$293,000,000	.....
Net income	– 3,132,730	.....	61,104,000	.....	56,000,000	.....
Stock-bearing dividends	.....	.....	1,538,920,000	.....	1,716,000,000	.....
" not "	.....	.....	233,760,000	.....	3,245,000,000	.....
Dividends declared	.....	.....	61,104,000	.....	85.000,000	.....
Taken from surplus, or borrowed	.....	.....	.....	.....	29,000,000	.....
Passenger charge per mile	Estimated 2·5c.	.....	2.1c.	.....	2.07c.	.....
" per ton-mile	" 1¼c.	.....	2.0c.	.....	.84c.	.....
Earnings per passenger train-mile	$7c.	.....	99c.	.....	77c.	.....
" " freight "	$1.48	.....	$1.43	.....	$1.49	.....
Average cost per train mile	80½c.	.....	64⅔	.....	87c.	.....

* Includes 4½ per cent. on $14,212,600 bonds of which rate of interest is not obtainable. † Estimated at ⁵ per cent. ‡ Estimated at 4 per cent. on bonds and preferred stock. § Not including extra tracks. ¶ Only explored regions of Canada are counted in this calculation. ‖ U.S. stock heavily watered.

TABLE III.—RAILWAY STATISTICS, 1895.

TRAFFIC, EQUIPMENT, ETC.

Item.	Canada.		Great Britain.		United States.	
	Total.	Per Mile.	Total.	Per Mile.	Total.	Per Mile.
Gross earnings per inhabitant	$9 00	.....	$10 60	.....	$15 60	
Passenger Traffic.						
Number of passengers	13,987,580	870	930,967,000	43,900	543.000,000	3,066
Passenger cars	1,994	1 1/3 0	42,230	2.	33,112	1 0 0
Average haul (miles)	38*	.....	8	.....	23	
Average load	35*	.....	49	.....	39	
Passenger cars per 1,000,000 passengers	143	.....	45	.....	65.	
Passenger train miles	15,332,276	.....	184,200,000	.....	327,294,000	
Passenger trains per day (each way)†	1¼	.....	12	.....	2½	
Freight Traffic.						
Tons of freight	21,524.421	1,340	334,230,000	15,800	763,000,000	4,230.
Freight cars	52,118	.....	603,710	.....	1,196,119	
Average haul (miles)	110*	.....	35	.....	116.	
Average load (tons)	119*	.....	73	.....	180.	
Freight cars per 1,000,000 tons	2,421	.....	1,806	.....	1,717	
Freight train miles	19,939.699	.....	150,400,000	.....	491,410,000	
Freight trains per day (each way)†	1 1/10	.....	9 1/10	.....	3 1/10	
Mixed Traffic.						
Various kinds of cars‖	5.999	.....	31,088	.....	41,330	
Mixed train mileage	5,389.915	.....	4,300,000	.....	15,457.000	
Mixed trains per day (each way)†	½	.....	1/10	.....	⅛	
Total trains per day (each way)†	3 1/10 0	.....	22	.....	6 1/8 0	
Engines.						
Total number	2,023	.....	18,658	.....	35,111	Including switching engines.
Average yearly engine mileage‡	20,100	.....	18,160	.....	23,760	
Employees	55,000	.....	465,112	22.	785,000	4 1/10
" killed	50	.....	442	.....	1,811	
" injured	488	.....	2,654	.....	25,693	
Passengers killed	9	.....	83	.....	170	
" injured	60	.....	1,109	.....	2,373.	
" killed, 1 in	1,554,000	.....	11,202,059	.....	2,984,000	
" injured, 1 in	233,126	.....	838,387	.....	213,000	

* Based on assumed average passenger and freight rates. † 365 days in a year. Train each way called "one train per day."
‡ Including switching engines. ‖ Express, Baggage, Postal, Sleepers, Dining Room, Transportation Co.'s Cars, etc.

(2) That after joining together as large a population as possible without unduly lengthening their line, they should build or buy such a system of branches, as feeders, as will draw to the main line as large a volume of traffic as possible, even in the face of competition. No better example of this can be given than in the Province of Ontario, where the G.T.R. and C.P.R. both endeavor to have feeders in all directions, and fight each other in many towns. Almost all the independent small lines of that Province have disappeared.

Branch Lines.—Branch lines are usually unprofitable in themselves, *e.g.*, Midland Railway of Canada, a network of short lines operated by the G.T.R. at a yearly loss, for the purpose of securing a large volume of freight for its main line, and preventing the C.P.R. from getting it. This is the reason, in almost all cases, which causes the most prosperous roads to operate them, to swell the trunk line traffic, because once any branch line traffic is delivered to the main line, it being *extra* traffic, is very profitable, often costing almost zero to handle, while the toll collected is for the whole trip. Putting the cost of handling the unit of minimum traffic on a main line at 100, the cost of handling a single extra passenger or small parcel of freight is almost zero: in car load lots at 10 to 30 per unit, and in train load lots at about 50 per unit.

A branch line, however, usually costs nearly as much per mile to build as a main line, and nearly as much to maintain—certainly far more than in proportion to the traffic; so that we can usually lay down a rule of branch line location to make it strike the main line as soon as possible, but meet it at a town if possible in order to give the branch more return freight; country junctions of branches are deadly in their lack of traffic (other things being equal), therefore branch lines should rather be numerous and at right angles, or nearly so, to the main line, than to run parallel to the main line for any great distance, stringing together unimportant hamlets before joining the main stem.

Volume of Traffic.—The volume of traffic by Table III. is shown to be about $9 per head, per year, in Canada, and $15.60 per head, per year, for the United States. We may not assume, however, that it is uniform in Canada; but varies probably as rapidly as the square of the density of tributary population. The average town would probably be about $10 per year, per head, increasing to very much more for large towns and cities. The class of town also has a great effect; an industrial town such as Galt, Ontario, would afford far more traffic per head than such a town as Whitby or Cobourg, owing to the pursuits of the inhabitants being different. The great volume of suburban traffic cannot be counted on in the future, as the cheap roadbed, etc., few restrictions, frequent service, and convenient depositing of passengers, enables electric lines to serve such a traffic very successfully. This is a serious problem for steam roads to face, as suburban traffic has been, in the past, a very profitable feature to many roads.

INCREASE OF TRAFFIC.

The per cent. which operating expenses bears to the gross revenue varies enormously. Roughly speaking, the road which economizes in its investment, on which it pays interest, is apt to have heavy operating expenses. This percentage in Canada varies from 256 per cent. to 43 per cent., with an average of 70 per cent. for Canada in 1895.

These working expenses may be roughly divided as follows:—

(1) Maintenance of line and buildings	15	70
(2) Working and repairs of engines	22	
(3) " " cars	6	
(4) General expenses	27	

Now careful estimates show that only about half of these expenses are increased by an increase of traffic beyond a meagre minimum, which is the reason why it is so important to select a route giving the most traffic, as it is the *increase* of traffic over that which gives profit enough to pay fixed charges, to which we must look for profit to the stockholders, and a very moderate difference in first cost, revenue or working expenses means success or failure.

In any young country like Canada traffic increases rapidly at first, the increase being twofold: (1) A natural increase due to increased population; (2) An increase fostered by the newly discovered wants of a people not before served by a railway, the critical period of a road's history being usually the first few years of its existence, before a solid, steady revenue has been secured.

In England, New England States or Eastern Canada, the growth of traffic may be estimated at 5 to 6 per cent. per year for a given line. While in Western America or any new country, 10 to 15 per cent. per year will not be too much to figure on. The usual way of estimating traffic is by the number of trains per day over roads of certain maximum grades; but on roads of small traffic, which do not wish to run less than one train per day each of freight and passengers, the trains are not apt to be loaded well, and again two trains per day will be considered necessary to accommodate the people long before they will be regularly filled, so that it is only on roads of heavy traffic that it can be divided into the number of trains that will just accommodate it.

ARTICLE IV.—RECEIPTS.

Referring to Table II., "Railway Statistics," it will be seen that American freight charges are lower than English with a less volume of traffic. This anomaly is explained by the frequent, lightly-loaded freight trains of England run at a high speed, with small cars and heavy terminal charges. An adoption of heavy American cars, larger trainloads, and a slightly decreased speed, with perhaps five freight trains per day instead of ten, would enable English freight rates to be lowered more than one-half, and effect an enormous economy. Partly due to high rates on freight, but chiefly due to enormous traffic, the receipts on English roads are nearly $20,000 per mile per year, as against $5,900 per mile per year in the U.S.A, and $2,908 per year per mile in Canada; operations for 1895 showed net earnings to be 3.8 per cent. interest on gross capitalization of English roads, as compared with 2.97 per cent. per year in the U.S.A., and 1.56 per cent. per year in Canada.

This great difference, in spite of the capitalizations of the railways, per mile of railway, being $230,000 for Great Britain, $65,000 for U.S.A., and $55,760 for Canada, is due to two distinct causes, (1) volume of traffic, (2) decreased percentage of operating expenses to gross earnings due to this increased traffic, the net earnings being $8,751 per mile for England, $1,925 for U.S.A., and $873 for Canada. Let us now discuss the position which Canadian railways occupy financially, first taking Canadian railways as a whole, and, second, classifying them:

ARTICLE V.—CANADIAN RAILWAYS.

The returns for 1895 are about as poor as could be selected, and those just handed down for 1896 show a slight improvement, but this may be due to temporary retrenchments, which have to be made up for sooner or later, such as track and car economies, by letting the condition run down slightly. The net earnings of Canadian railways of $873 per mile give net receipts of $14,035,820, but the interest on bonded debts, and estimated amount of loans, etc., amounts to $17,168,000* (approx.), or a net loss of over $3,130,000, and nothing with which to pay interest on the $167,000,000 that the various Governments have given either in the form of an investment in Government railways or as bonuses, and nothing with which to pay dividends on stock. This does not look encouraging; competition and popular clamor keep rates down to the lowest possible notch, and so long as our traffic is small it seems certain that, considering the severe climatic conditions under which our roads are operated, and the evident economy of management (70 per cent. of gross receipts as compared with 67½ for U.S.A.), the present rates must be fully maintained, if not raised. The stock of Canadian railways is not all real, but estimating that one-half is real and one-half water, we have $180,000,000 invested bearing no interest, besides the $167,000,000 which the people of the country have sunk in them in order to have sufficient railway accommodation. Even neglecting interest on all loans, floating debt, etc., there is still a deficit on bond interest of $1,252,000, which is met year by year by issues of more bonds and stock, or by creating floating debts which are periodically so converted; we go on year by year mortgaging futurity. It is hoped that in a few more years increased traffic will enable the bond interest to be fully met, and in this the increased solidity of permanent way will greatly aid. The average cost per train mile is very low (80½c.), considering our high price of coal, severe climate, rather inferior road beds, small number of trains per day, and good wages paid; it reflects great credit on Canadian management as a whole.

Let us now analyze Canadian workings by dividing the roads into four groups. (See Table IV).

(1) *Canadian Pacific Railway System.*—This road shows a low bonded debt, moderate stock, and high Government aid per mile (much of this latter, however, being tied up yet as land grant); on this account, and because it can charge higher rates in the west, it is enabled to keep its net earnings large enough to pay bond interest, and on prosperous years has considerable left over to pay dividends on stock. If dividends were declared in 1895, they were drawn quite justifiably from the surplus; but on the whole, the C.P. Railway by a very efficient management, high train-mile earnings ($1.45), and low first cost, is by far the most prosperous of Canadian railways, in spite of such low gross earnings as less than $3,000 per mile. The future increase of traffic in the North-West will enable it to lower its rates and still make a profit; but for the present, it is hardly clear how this can be done. The C. P. Railway also has the advantage of new equipment which does not need such heavy repairs. It is gradually improving its road-bed by the construction of masonry and steel in place of wooden structures.

* This is based on the assumption in Table II. that the interest on loans, floating debts, etc., is 5 per cent.; probably a large proportion of it bears no interest.

TABLE IV.—ANALYSIS OF WORKINGS OF CANADIAN RAILWAYS FOR 1895

	CANADIAN PACIFIC RAILWAY SYSTEM.						GRAND TRUNK RAILWAY SYSTEM.						Dominion Government Railways.		Remaining Railways of Canada.	
	Main Line.		Branches.		Total.		Main Line		Branches.		Total.					
	Total.	Per mile.	Total	Per mile.	Total.	Per mile.	Total.	Per mile.	Total.	Per mile.	Total.	Per mile.	Total.	Per mile.	Total.	Per mile.
Miles	3,575	.....	2,709	.....	6,284	.....	884	.....	2,290	.....	3,164	.....	1,383	.....	5,261	.....
Capitalization—																
Bonds	$98,923,000	$27,700	$47,027,000	$17,300	$145,950,000	$23,200	$ 75,249,000	$ 85,100	$33,643,000	$14,800	$108,892,000	$34,400	.....	.....	$75,944,000	$14,400
Preferred stock	6,494,000	1,800	3,505,000	1,300	10,000,000	1,610	89,541,000	100,900	2,556,000	1,100	91,800,000	29,000	.....	.....	3,671,000	700
Common stock	66,000,000	18,300	12,410,000	4,600	77,410,000	12,300	109,383,000	123,700	50,000	.....	109,433,000	34,600	.....	.....	68,929,000	13,100
Loans and floating, etc	1,948,000	500	3,445,000	1,300	5,393,000	900	15,143,000	17,100	75,000	.....	15,219,000	4,800	.....	.....	17,014,000	3,200
Bonus and Government aid	58,996,000	16,500	17,454,000	6,400	76,451,000	12,200	.....	.....	10,301,000	4,500	10,301,000	3,300	$58,759,000	$42,500	22,012,000	4,100
Total	$231,291,000	$64,700	$83,921,000	$30,900	$316,913,000	$50,900	$289,013,000	$326,800	$46,625,000	$20,400	$335,645,000	$106,100	$58,759,000	$42,500	$187,767,000	$35,600
Interest on bonds	4,122,000	.....	2,295,000	.....	6,407,000	.....	3,335,000	.....	1,535,000	.....	4,921,000	.....	.....	.....	3,95 ,000	.....
Interest on loans and floating, etc	97,000	.....	173,000	.....	270,000	.....	767,000	.....	4,000	.....	781,000	.....	.....	.....	851,000	.....
Apparent total fixed charge	$4,219,000	$1,180	$2,458,000	$900	$ 6,677,000	$1,060	$4,143,000	$4,690	$1,539,000	$680	$ 5,683,000	$1,800	$3,000,000	$2,243	$4,810,000	$910
Gross earnings	.....	.....	.....	.....	17,962,000	2,860	.....	.....	.....	.....	16,091,000	5,090	3,170,000	2,250	9,642,000	1,830
Working expenses	.....	.....	.....	.....	11,317,000	1,800	.....	.....	.....	.....	11,054,000	3,510	.....	.....	7,168,000	1,370
Net earnings	.....	.....	.....	.....	+$6,645,000	$1,060	.....	.....	.....	.....	+$4,997,000	$1,580	— $ 80,000	.....	+$2,474,000	$460
Per cent. of working expenses to gross earnings	.....	.....	.....	.....	63	.....	.....	.....	.....	.....	69	.....	.....	.....	74	.....
Apparent net income	.....	.....	.....	.....	— 32,000	.....	.....	.....	.....	.....	— 685,000	.....	— 80,000	103	— 2,336,000	.....
Train mileage	.....	.....	.....	.....	12,319,500	.....	.....	.....	.....	.....	15,381,800	.....	4,230,000	4 1-5	8,732,000	.....
Average trains per day	.....	.....	.....	.....	23	.....	.....	.....	.....	.....	63	.....	.....	12	24	.....
Earnings per train mile	.....	.....	.....	.....	$1 45	.....	.....	.....	.....	.....	$1 05	.....	$1 10	73c.	$1 10	.....
Cost of train mile	.....	.....	.....	.....	91	.....	.....	.....	.....	.....	72c.	.....	75c.	73c.	82c.	.....
Operating expenses—																
Maintenance	.....	.....	.....	.....	151	.....	.....	.....	.....	.....	113	.....	.....	25	.....	.....
Working and repair of engines	.....	.....	.....	.....	19	63	.....	.....	.....	.....	24	.....	.....	36	.....	.....
Working and repair of cars	.....	.....	.....	.....	4		.....	.....	.....	.....	7	63	.....	14	.....	.....
General expenses	.....	.....	.....	.....	244		.....	.....	.....	.....	264		.....	28	.....	.....

It is noticeable that the cost per mile of the main line, $64,000, is not as high as the average of U.S.A. railways, and the route is very rugged, while the branches containing many first-class roads in Ontario and elsewhere have only cost $30,900 per mile, and very little, if any, has been charged against the main line, as in the Grand Trunk system.

(2) *Grand Trunk Railway System.*—The. main line, built in early days when wages and material were high, built too solidly for its traffic, built in disregard of what is now known to be the true principles of railway location, and since then, burdened still further to pay bond interest and buy branches, is loaded with an enormous debt. The branches were often injudiciously bought, or bought to protect its traffic at a sacrifice, and do not pay. Taking the road as a whole, it is loaded with a heavy debt; suffers from keen competition, not only from Canadian, but U. S. railways; and by being thus forced to haul at low rates, has never been able to meet its obligations in spite of a traffic of $5,090 per mile, which increases to $6,000 per mile in good years. Its operating expenses are higher, and train earnings lower than they should be, and a more vigorous management with a more careful study of maximum train loads by the tonnage system may effect improvement. This system has been the backbone of Canada; it has received very meagre aid ($3,300 per mile) from governments or municipalities, and the bondholders and owners deserve the highest praise fc .ie integrity of management which has characterized it; a less scrupulous one would have thrown it into a receiver's hands after having plundered it for a few years. This has been done in America very often, with a severe loss to British bondholders. It is noticeable that the branches have been bought, largely, by mortgaging the main line; it is impossible to arrive at the cost of each.

(3) *Dominion Government Railways.*—These cost as much to operate as the earnings amount to. The cost per mile is a good example of actual cost, there being no inflation of capital. The Intercolonial was well built through a rough country; but could be built to-day for less than $30,000 per mile, owing to less cost of explosives, steel, labor, etc. It seems evident that for the light traffic of $2,240 per mile, there are too many trains per day; 4½ trains per day for 365 days is too much, and although the people on the route might object, the economy of reducing traffic to about three trains per day, say one passenger, one mixed, one freight, would effect a great saving; this is evident by the very small train-mile earning, 72c.

(4) *Remaining Railways of Canada.*—These contain several high class roads, such as Canada Atlantic and Michigan Central; but on the whole, they are those roads which have been built to serve local needs or to develop country; their cost per mile ($35,500 being total capital against them) is small, but traffic still smaller; their earnings are not nearly sufficient to pay fixed charges, and some borrow more each year to pay it, while others default payment. The future of many of them is not reassuring until their traffic increases; but they are, on the other hand, many of them aiding in the development of country that would otherwise be beyond reach.

The need for more railways in Canada, except for some very special reason, is not at present apparent.

THE Rossland, B.C., council will buy at once a chemical engine, hose wagon and hook and ladder truck.

For THE CANADIAN ENGINEER.

TOWNS WATER SUPPLY AND ITS DISTRIBUTION.

BY W. M. WATSON, TORONTO.

The geographical advantages of Canada are superior to those of most countries. There is none where there are such a large number of fine sheets of water of good potable quality, and almost every town and small village could have a plentiful supply of good water, inside each house, at a moderate cost, if the Government would engage engineers and mechanics who have skill and experience, to work out a comprehensive scheme in each district. It is a crime to supply a town with tainted water, or compel those living in villages to depend on wells of doubtful purity, which sometimes run dry when water is most in demand. Abundance of good water in the house convenient for use at will is a sanitary necessity, and it is the duty of the governing body to arrange for and secure a permanent supply at a reasonable expense and charge to the consumer.

When constructing waterworks, care should be taken in arranging and joining the iron street mains and conduits and every other apparatus used for distributing or conveying the water, so that they cannot be injured by frost or dirt, or by the pounding of water hammer caused by sudden concussions of confined air. The joints should be all well and carefully made, and if lead be used, each joint should be run full and solid at one teaming of the ladle, at least to a depth of two inches. Maiden or new pig lead should always be used for jointing. Each joint should have two circles of hemp rope driven well back and tight, for the lead to wedge against. It is the hemp rope that keeps the joint tight; the lead holds it to its place, so it is necessary to have a good quality of rope. Above all else, it is necessary to make proper provision for cleaning out every part of the pipe system, and to prevent waste or leakages, which not only wastes money, but damages the roadbeds and the foundations of property adjoining the line of pipes.

Water suitable for domestic use should be transparent, without smell, taste, or suspended matters, totally free from any excreta or sewage deposits of any kind. Marsh or nullah water, which is loaded with vegetable debris, must be carefully avoided. Water for industrial purposes should be void of minerals, because they increase the cost of soap and scouring materials when used for cleaning purposes, they scale steam boilers and heating pipes, and interfere with the production of colors when dyeing fabrics. The French cloths are always softer to the touch than British, because of the quality of water used in finishing and dyeing, and thousands of pieces of manufactured stuffs are sent over to France from England to be dyed and finished and then returned. Tainted dirty water with a mixture of fine sand would ruin a stuff manufacturer or dyer in a short time. It is advantageous to secure water well ærated, similar to the water at the foot of Niagara Falls, or rain water, which during its fall through the atmosphere secures (according to analysis made by Dr. E. A. Parks, F.R.S.), a large percentage of oxygen.

D. G. F. Gaskins, C.E., when delivering his presidential address before the British Association of Waterworks Engineers at Nottingham last year, stated that to manage a waterworks a knowledge was demanded which could only be obtained by close study, application and practice. This is different teaching to that of a promi-

nent civil engineer, who wrote to me saying that there was no room in Canada for experienced waterworks superintendents, because the colleges were turning out yearly more students than there were such places to fill. If the students fill such positions raw from the colleges, without learning the trade and securing working experience, whatever salary or wages they receive, it is little better than robbery of the ratepayers. A valuable engineer never attempts to construct, or even manage the construction of systems that have been planned and laid out from his own ideas. He keeps his position, and expects the mechanic and manager to faithfully keep his.

Mr. Mansergh, in his fifteen-thousand dollar report on Toronto waterworks, expressed himself in a way that can only be interpreted to mean that he considered the construction and management of all American waterworks systems of a low standard. He attributed the reason to the fact that the city of Toronto had to pump over 100 gallons of water for each inhabitant each day, to waste or misuse—adding the important remark, as in other American cities. (See copy of report in the *Surveyors' Journal.*) The reason why there is a low standard of public works in this country in comparison to the works in the old country, is because there is no proper check placed on the local authorities by the Government. A single ratepayer having a substantial grievance and who can prove that the local authorities are wasting public money, or mismanaging the public business, or allowing the public works to be mismanaged, or voting themselves funds, etc., can petition the English Local Government Board, who will send an expert engineer to make a full inquiry, and if abuse of the trust put in the representatives elected by the popular vote be proved, or it is found that any of the officials are not worthy of the confidence placed in them, he will report the same to the Government, who will take measures to correct the evil.

I was appointed to investigate a waterworks on which there had been an inquiry of this kind, and I proved that most of the wealthiest manufacturers were daily stealing large amounts of water, and that less than half the amount of water provided by the ratepayers of the town was paid or accounted for. The result of the Government interference in this case was a saving to the public taxes of about $30,000 each year afterwards.

Mr. Griffith, C.E., states that under proper management the advantages of local authorities owning their own waterworks are as follows:—

1. A local authority elected by residents in the districts has a greater personal interest in the matter of supply, and is better qualified to administer the undertaking in their own interest than a private company, whose only object is profits.

2. A local authority need not make any profit out of the supply. They can also borrow capital for construction of the works cheaper than a private firm and reduce the charges for supply to consumers accordingly.

3. Public sentiment is always in favor of having such a universal necessary of life and health in their own hands.

The chief difficulties against public ownership are:

1. The periodical changes of council, and sometimes even the constitution, which often interferes with the continuity of a policy.

2. The liability of the works being handled by men appointed through society, family or political influences, in place of having skilled mechanics and experts.

3. The habit, which is sometimes allowed or blindly ignored, of selling favors and accepting perquisites, which often is the cause of scamp work being done, and of public works costing more than similar works done by private business firms, or such well conducted councils as Glasgow.

The revenue from the sale of water in Toronto is stated in the newspapers to be $445,000; taking the population at the highest stated number, viz., 190,000, it runs about $2.30 per head; an average for each house of five inmates of $11.50. They say we owe on account of the waterworks $3,817,287.32, or an average per head of $20.09. Had the Toronto waterworks been constructed and managed by a business firm with the ability of the T. Eaton Co., for example, it would not have cost half, and the charge to consumers could have been proportionately less.

There cannot be a great difference between the need for water in European and Canadian towns which have similar conditions, only that English towns use a great percentage of their water in supplying cheap public swimming baths of large dimensions. The difference in consumption has no connection with the fact that the heat or cold is more excessive, because the returns given us of the water pumped in Toronto in the months of April and November, when there is no garden or street watering, public water fountains, no frost needing taps to be kept running, nor anything at all different to any British town, gives only a little different figures to those published for any of the other ten months.

Mr. Palmer, C.E., states that the Malvern authorities supply each water consumer with a meter, and the average consumption is 5½ gallons per head per day. I know several small towns that do not use meters which use less than 6 gallons of water for household purposes per head per day. The total quantity of water used for all purposes in the town of Nottingham, with a population of 250,843 last year, was stated to be under 21½ gallons per head per day. In Bradford, a town of 240,000 inhabitants, they used 26 gallons per head through meter for manufacturing purposes, and about 27 for all other purposes, including several large swimming baths. Mr. Bateman states that he tested a group of 14 towns in England, and found the average consumption for all purposes was 24 gallons, and in a single group of working class houses, containing 82 inmates, the average consumption per day per head was 7½ gallons. I myself tested a house in Toronto by having a new Siemens water meter fixed on for five years. The house had eleven inmates, two baths, one basin, w.c., hot water and range boilers, hose pipe, stable and horse. The average amount of water taken each year was under 28,000 gallons, less than 7 gallons per head per day.

The Toronto *Star*, on May 1st, stated that only 198,000,000 gallons of water were sold to manufacturers in a year in Toronto, or under three gallons per head, leaving about 100 gallons per head per day for sanitary and domestic consumption, or 75 gallons over the consumption of similar British towns. If Toronto were situated in England, there would be a government inquiry into the cause of this waste. Returning again to the mechanical and engineering side of the subject, as I have before stated, the best water for public use is rain water collected from clean land, because it cannot possibly be contaminated by mineral, manurial or sewage deposits. Taking a supply from a river near its source, or from an elevated lake, is often as good as collecting rain water. When taken from a

river, the mouth of the suction pipe should face the way the water flows, because by so doing the best water will be drawn in, while the floating impurities will pass forward with the current. When from a lake, it should face downward for the same reasons. Taking water from a lower level than the town is built on is often injudicious, because it may be fouled by the sewage from the population living within the watershed, which sometimes contains an area of several thousand square miles, and should the population be small at present, and the impurities from the sewage imperceptible, it may soon alter. All large towns should have forethought sufficient to arrange for a good permanent supply while the opportunity serves. To depend on a supply by pumping and long suction conduits is risky and expensive, and it is probably cheaper to carry a supply fifty miles and have a proper gravitation system. (1) Because the source of supply being necessarily at a higher elevation than a pumping source, it is less liable to be contaminated. (2) Though the first cost of works may be more on account of the long length of trunk mains which might have to be conveyed through tunnels and across ravines on viaducts, yet the annual expenses of pumping in wages, repairs, renewals, etc., will probably amount to more than would pay the interest on the capital expended on a comprehensive, well engineered scheme. Such a plant would be safe and permanent, besides free from contamination, because by making judicious arrangements to supply the villages located on the route of the pipe, by measure, sufficient revenue might be collected to pay the interest on the cost of running the trunk pipe through their section of territory.

When it is necessary to store water in reservoirs so that the supply can be abundant when the rainfall is least, such reservoirs should be carefully covered over and ventilated. In form they should be deep rather than extended, so as to lessen the evaporation, to keep the water cool and at an even temperature as far as possible all the year round, to prevent the water from absorbing the impure gases from the atmosphere, and prevent the sun's rays from increasing the microbes and bacteria. When large natural reservoirs are made in the hills they must necessarily be open, and the face of the water exposed to the sun and air; such water should be passed through a good, clean filter immediately before entering the supply pipes. In fact all water, however collected and stored, should be filtered.

It is a fact that the purer and softer the water is the easier it is to contaminate. It will attract and absorb minerals and poisonous gases with a wolfish appetite. At Harrogate in England there are eleven springs of water, each loaded with different minerals and chemicals, which each stream has taken up on its passage through the earth from the seat of the rainfall to the springs.

Then another example: Six families living in good, airy, isolated houses, went on their holidays for a few weeks to the seaside. A short time after each family returned home some of its members were taken ill with typhoid fever. Being superintendent of the water supply, it was my duty to investigate so remarkable an occurrence, and found that the owner had broken the laws of water distribution by allowing his tenants to take the whole of their water supply from a large shallow open cistern hidden in the false roof that was open from end to end over all the sleeping rooms of the six houses, and that the loft had no ventilation whatsoever; so that all the poison contained in the atmosphere of the sleeping rooms passed through the porous plastered ceiling, and having no other means of escape was absorbed by the sheet of water in the cistern, and the water became poisoned before being used by the inmates. A French writer, has indeed proved that the human system can be trained to receive large doses of poison without serious injury. If his theory was incorrect, how could so many people live in a poisoned atmosphere, yet have general good health. The trouble with this group of families was that they had lived at another place for a time and broken the continuity of the doses, and when they returned home and began to take them up again on a healthy, well-ordered constitution, the sudden start upset them. The water would be worse than usual on account of a small quantity only having been used during the time of absence. I have related this at length to show the great importance of covering fresh water tanks and reservoirs, and the advisability of erecting them in places sufficiently removed from any chance of contamination.

With the object of removing dirt from the lower points of street water mains, some engineers connect the ends of the pipes together and form a circuit of water down one street and up another. The method does not remove the evil, but distributes over a larger area the dirt or polluted water in the pipes. I believe the circulating policy is adopted in Toronto, for I am sometimes engaged to remove fish and other obstructions from taps and valves. I also notice if a bath full of fresh water stands for a few days, there is a sediment at the bottom. Then water taps and other waterworks appliances only keep in good condition about a quarter as long as at places where the water is free from fine sand and grit. The cost of repairs and renewals on account of fittings being injured by the grit must amount to a large sum throughout the whole city. I once witnessed water flowing from a branch pipe from which a fire hydrant had been removed run black for about fifteen minutes, leaving a large quantity of gritty deposits on the ground, and at another time a six-inch water main that had been taken out on account of a defect, had about one inch of black and green sludge adhering to the lower side.

The dirt could not lie in that position, nor the water get so far polluted as to run dirt for so long a time, if reasonable provision were made to clean out the pipes and suction conduit, and the conduit were laid in such a mechanical way that the joints could be kept permanently water tight. I don't see how they can be kept tight during the alteration of the temperature of the water they lie in, if the sketch shown in the *Telegram* newspaper be correct and reliable. The proper way in my opinion to lay down distribution water mains for a town is to lay the large carrying mains along the roads having the highest elevation, and take out branches commencing with a cut-off valve and air ball, then continue them down along the streets to the lowest points of each street or section of streets, and on the terminating end of each branch pipe affix a full-sized sluice valve about ten yards beyond the last service pipe. Round the sluice valve build a well or valve chamber with a gully trap and drain pipe twice as large as the water pipe, and construct the bottom one foot below the valve. Solids and impurities of all kinds contained in water mains that are under pressure are always forced to the lowest points, and can be easily removed by opening the terminating valves, about once a month or oftener, according to the quality of the water, for about one half minute.

Water mains should be as carefully graded as gas or sewer pipes, and have air balls of the self-acting kind (Fig. 1) fixed at all the highest points, and full-

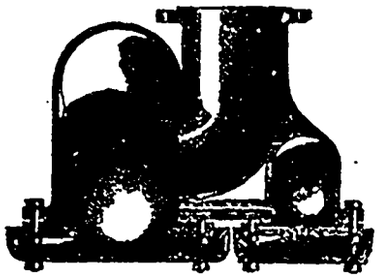


FIG. 1.

sized sluice valves at all the lowest points and dips, so that the whole system may be emptied and cleaned when necessary, and freed from deposits of grit and slime.

It must be remembered that water will run through water without moving the water adhering to the sides of the pipe it is passing through, and if the mains are larger than is needed to pass the supply taken from them, and the water is soft and pure, the motionless water clinging to the sides will set up an action with the metal and become hardened and turn into a brown calcareous matter, and continue to grow and diminish the bore of the pipe until there is just sufficient room to pass the necessary stream, when it will stop and continue in that shape for any length of time. For example, I inspected a fire hydrant intended to protect an isolated hall in a corner of a town, and found that it would not deliver any more water than the common bib water tap on the kitchen sink. On cutting the three-inch main to find the cause, I found it calcarized and the bore reduced as above stated, and the whole of that branch line for about one half mile had to be relaid with new pipes. Had the terminating sluice valve been open full wide once a month, and the dead water clinging to the sides of the pipe let out, along with any calcareous scales that might have started to form, it would never have been necessary to relay, and the hall would not have been in jeopardy for several years.

A 30-inch earthen pipe having cemented joints, that carried water from one storage reservoir to another on the moor land, got its bore diminished by fine rootlets passing through the cracks in the cement joints, growing inside and choking the interior. The calcareous matter growing on the inside of water mains can be removed by a machine called a ferret, which is so constructed that the pressure of water turned on behind it will force it through a moderate length of water pipe, and during its passage it will scrape the inside clean. When this method is used, clean-out doors must be provided at short intervals.

Neither large nor small water filters are of any use except proper provision is made for cleaning them easily, because no matter what material is used for a filtrate there is a limit to its usefulness. The best filters are made from either animal charcoal well pressed together, so that the water must pass through the coal, or magnetic carbide of iron. For purifying fresh water that is void of sewage deposits, about 15 inches of fine washed, clean, sharp sand and 20 inches of gravel will make a suitable filter, if the top layer is removed and clean washed; then spread on again about once each week. This will make the water of a bright color and pure. If I were to build a filter on a large scale I should have a graded concrete bottom, so that the water on escaping from the filtrate material would come together and form a stream to enter the distribution pipes. I would then have a false grated bottom, bearing on pillars, to hold the filtrate material. I would run the water to be treated over shallow troughs, the bottoms pierced with very fine holes at a convenient elevation above the filter, so that all the water intended to be filtered would fall into the filter in a fine spray similar to a needle bath; falling a distance say of four feet, in the form of a fine spray, the water would be aerated. I would also make a good system of ventilation that would insure a strong current of air to be continually passing between the cemented and false grating floor at the bottom of the filter. The water should pass slowly through at a pressure of about two feet above the face of the sand.

When water is delivered to consumers the shut-off tap usually fixed in the sidewalk near the street line should be of the screw-down pattern with the valve working loose inside, so that when full open it would allow water to pass through towards the house, but it would not allow any to return back into the mains. The tap would have a double action; it would not only make a first-class stop tap, but also a foot or check valve. (See sketch of the loose valve inside the bib tap shown.) This would prevent any fluid being forced or

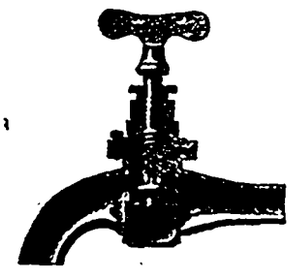


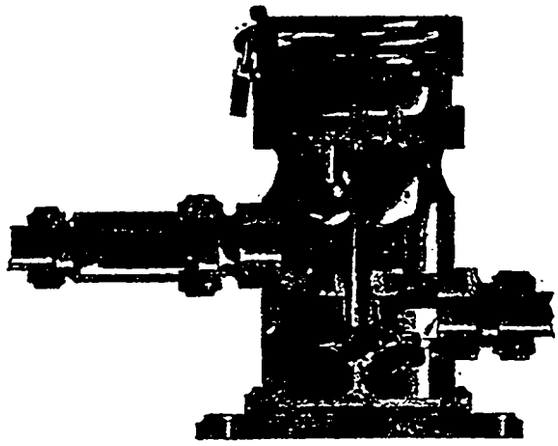
FIG. 2.

drawn into the street mains, and effectually prevent the return of hot and tainted water from water-heating boilers, steam and range boilers, etc., which is at present very prevalent.

Lead water pipes when laid in the earth should not be near any metal, because a galvanic action will be produced; nor near an electric car line, for the electricity will damage the lead if the soil it lies in is damp and a good electric conductor. Nor should it be laid near any tile or other drain, because a leakage of water would find a downward way of escape, and could not be easily found; nor under any manure pipe, or near dirt or filth of any kind, because when the water is motionless in the pipe it will absorb some of the foul gas thrown off from such filth through the lead coating, and become tainted. Lead is the handiest metal for small water pipes, because it can be easily bent to any angle. When damaged by frost or water hammer it is easy to repair without removal. When laid underground it will sink with the soil, stretch, or give and take a little without injury. On the other hand, when rigid iron is used it will break before bending, and if damaged a full length has to come out. It is very unfortunate that a chemical action sets up between pure soft water and lead, which poisons the water when it stands motionless in the pipe for a few hours, and thousands have been seriously injured in health by drinking and cooking with water poisoned in that way. The water that poisoned the Louis Philip family of Claremont contained seven-sixteenths of a grain of lead per gallon, and the water taken from the same source had injured to various degrees thirty-four per cent. of

the population of the town. Analysts differ as to whether water can be poisoned by passing through galvanized or zinc pipes or not. I am positive that distilled water can be injured by using galvanized vessels, and if so other water must be injured to a less degree. Black iron, specially made very strong and soft in nature, so that it can be bent easily, is the healthiest article for use for service pipes. Some of the means suggested for removing the evil and still using lead pipes for domestic water supply, are: 1. To line the lead pipe one-sixteenth of an inch thick with block tin; 2. To give the pipes a bituminous coating; 3. To boil the lead pipe before using in a strong solution of sulphur and soda.

As a superintendent of waterworks, I have had the responsibility and care of many Siemens and Adams water meters, which are used largely because they are light and handy to fix. They are simple in construction, measuring the water by forcing it through a turbine or baker's wheel very similar to garden sprinklers that spin round when delivering the water. The act of the turbine turning round moves the dials and registers the quantity. I have never seen large meters of this kind in use. A meter to insure accuracy for a long period must measure the water by loading and unloading a vessel similar to a dry gas meter. When the Siemens pattern and all similar meters become worn, or the inside gets thickly coated with scale or dirt, the water will pass through unregistered, and they can also be easily tampered with. I here show a sketch and give the manufacturer's own description.



This meter is constructed upon the well known principle of Barker's mill The measuring medium consists of a drum, working on an upright spindle at the bottom, and in a collar at the top. The water is conveyed by the conducting tube into the centre of the drum, and allowed to escape at three or more apertures on the periphery of the same, giving to it a rotary motion. At each revolution of the drum a certain number of cubic inches of water is delivered, so that it is only necessary to register the number of revolutions to ascertain the quantity; this is effected by wheels and pinions, and the result indicated in gallons or feet, upon a graduated dial.

In conclusion, I may say that when the steel conduit was about being laid down across Toronto bay, I suggested, in a letter to the *Globe*, printed January 18th, 1888, that a subway should be made from the north side of the railway tracks to the nearest point of the Island, large enough for a car track, a carriage-way and two sidewalks for foot passengers; that the sidewalks should be raised similar to the long subway at Montreal, and that two conduits, one under each sidewalk, should be laid on blocks or rollers so that the tube could be easily inspected; after leaving the subway the two conduits should be joined and conveyed across the Island to the intake, trenched into the ground. Until something in this way be done to make Toronto supply from Lake Ontario a safe and permanent source, free from the contaminating influence of the filthy bay water, the supply will remain risky and polluted when the conduit leaks, or is loaded with sand.

ELECTRICITY IN RAISING OIL.

An interesting and highly successful experiment has been carried out at Petrolia by W. H. Ashworth, manager and electrician of the Electric Light Company of that town, in applying electricity to the pumping of oil. Out of the 8,000 oil wells, which yielded about 800,000 barrels in Canada last year, there are nearly 6,000 in and around Petrolia. One would think that in a town like Petrolia, where they have "oil to burn," so to speak, they would use some kind of crude oil engine, or at least use oil as fuel for the steam engines that are required on the fields. But they do neither. They use steam engines to work the pumps that lift the crude oil, and they use wood and coal for fuel for these engines. As those acquainted with the petroleum business know, the wells are bored in all directions about the town, many of them in the back yards of the owners' houses; so that the visitor on approaching the town sees a forest of derricks, looking like the stumps of trees left after a fire has passed through a green forest. Under each derrick is a well, worked either by a "walking beam" or a "kicker"—that is, two arms joined at right angles, one arm slanting vertically, the other horizontally, the latter having the pump rod attached to its outer end. A group or "batch" of these wells are operated from one engine, rods and scantlings being connected from the engines to the kickers and walking beams. The wells run by one engine are at all kinds of angles to each other, this being easily accomplished by a crude horizontal wheel, making a quarter turn and back, and so pushing and pulling the rods of the pumps on its line. By putting a wheel whenever a well has to be reached at an angle, a dozen or even thirty wells may be reached from a single engine. Mr. Ashworth last July undertook to operate a "batch" of wells from the dynamo in the Petrolia Electric Light Co.'s power house, and installed a six K. W. 500-volt Canadian general machine in a small building in the field beside one of the old engine houses. The little shed required for the purpose was only half the size of the steam power house, and no heavy foundation or boiler setting was required. The machine was placed on a frame consisting of two pieces of 10" by 10" timber on each side, one on top of the other, to give a clearance from the ground for the driving gear, which was a set of pulleys belted so as to reduce the motion imparted from a main shaft operating a crank at either end, the two cranks being placed so as to give an alternate motion to the two sets of pump rods; this simple apparatus was attached to 16 very heavy wells known as "water wells," and running at much higher than the usual speed, but they have been run most successfully by electricity ever since. No boy or man is required for firing, and the machine requires no attention after it is started each day. Last year in Ohio or Pennsylvania one or two wells were experimentally operated by electricity, there being a separate dynamo for each well, but this, we believe, is the first case on record when a "batch" of wells has been electrically operated.

JAMES LYDIATT, formerly of the Wallaceburg, Ont., Glass Works, proposes to start a glass factory in London, Ont., which has the necessary sand near as well as superior railway facilities. The city is of course expected to assist the project.

THE LACHINE RAPIDS POWER PLANT, MONTREAL.*

BY WM. I. BISHOP, MONTREAL.

The problem of utilizing the power of the St. Lawrence River at Lachine Rapids, near Montreal, is one which has for many years engaged the attention of engineers and capitalists. Their almost unanimous opinion has been, however, that although considerable power could be obtained during the summer months, the drowning of the rapids during high water would so reduce this that any scheme requiring continuous power the whole year round would not be feasible. Support was given to this idea by facts observed during the running of a small grist mill erected on the site, for which power was obtained by throwing out a small wing dam. This mill was compelled to shut down during a part of the winter, owing to back water. Another serious objection was that great quantities of frazil or anchor ice run through the rapids almost all winter, and it was thought impossible to prevent its filling up the head race and wheels.

About five years ago Messrs. T. Pringle & Son and W. McLea Wallbank, of Montreal, after a careful study of the question, came to the conclusion (which has been proved since the river bed has been laid bare) that the backing up of the water and drowning of the rapids was caused by the great bars of rock which rise out of the river bed at an acute angle, facilitating the collection of frazil and the formation of natural ice dams.

The Lachine Rapids are probably the most famous of the series of rapids along the St. Lawrence River from Lake Ontario to Montreal. Every one who bas ever taken the steamer trip down them, which is one of the most enjoyable experiences of every pleasure-seeker's visit to that city, will recall the rock barriers, which make their presence manifest to the practiced eye by the turmoil of the waters, even when wholly submerged.

Above the rapids the river widens into a broad expanse, known as Lake St. Louis, some six miles wide and 14 miles long The rapids themselves are about five miles in length, and their total fall is about 30 feet. Briefly stated, the plan for power development which is being carried out by the Lachine Rapids Hydraulic & Land Co., is to project a dam into the stream at a point about one mile above the foot of the rapids, and by a dike parallel to the river bank and extending up stream 5,000 feet from the river end of this dam, to make a broad head race, which will take water from a point where the water on the rapids is about 11 ft. higher than the dam. Below the dam there is a further fall of about 10 ft. in a distance of about a mile to the foot of the rapids.

The works are designed to utilize 15,000 cubic feet of water per second, which will be about 10 per cent. of the entire flow of the river at low water

The general map of the rapids shown gives a good idea of the location of the company's power plant with reference to the rapids and the city of Montreal.

GENERAL DESCRIPTION OF WORKS.

By reference to the general plan (Fig. 2) it will be noted that the present scheme, as now being carried out, will consist of: (1) A head race 3,705 feet long, formed by a wing dam composed of a 40-foot masonry ice breaker at the entrance, 3,305 feet of overflow cribwork, and 360 feet of cribwork carried up square to the same level as the top of the piers of the main dam. (2) A main dam of 43 masonry piers on concrete foundations, the piers being 4 feet thick and 17 feet high above the level of the floor of the flumes and the top of the foundation The piers form 36 flumes, three waste weirs, and the foundations for three power houses. (3) A guard dam forming the tail race, consisting of 300 feet of cribwork 10 feet wide and 900 feet of embankment formed of rock taken from excavations. (4) A system of booms and cribwork piers designed to keep the wheels clear of floating ice, driftwood, grass, etc.

The head race is to be excavated to a depth of 12 feet below the top of the overflow dam, and is at the narrowest point near the entrance 525 feet wide, with a sectional area of 6,300 square feet, so that, allowing a discharge of 200 cubic feet per second from each wheel, or a total of 14,400 cubic feet for 72 wheels, the velocity of flow past this point will amount to about 2.3 feet per second. As the head race widens out to nearly 1,000 feet at the flumes, this velocity will, of course, be much reduced, so that there will be little, if any, lost head due to an excessive speed of current

The current in the river just above the entrance to the head race runs at the rate of about six miles per hour, and this striking a body of water moving at the rate of only two-thirds mile per hour will give it a tendency to strike almost directly outwards, carrying with it most of the frazil, driftwood, etc., that it may contain. It is also a fact that the current has always had a tendency to strike outwards at this point, owing to a curve in the river bank just above the head-race entrance.

The water in the head race will freeze over completely in winter; and, as is well known, no frazil will form under the ice; but should any commence running before the ice forms, the racks are so hinged and arranged that they can be lowered to the bottom, or taken out completely, allowing it to run through the wheels. The crib piers and booms are so arranged that there will be no danger of the ice shoving down on to and destroying the racks. The greater part of whatever ice forms in the head race will go over the overflow dam, and the small balance will go through the waste weirs without trouble.

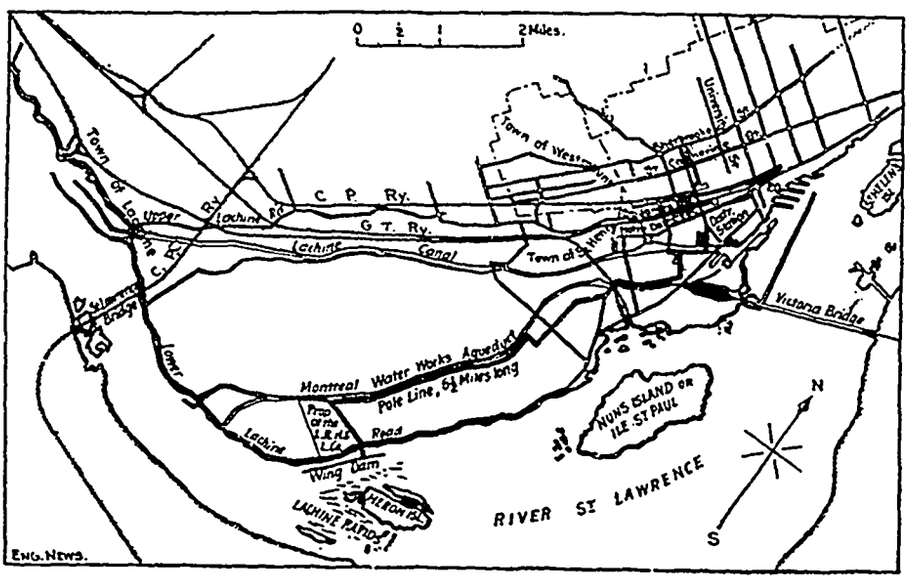


FIG. 1.—MAP SHOWING THE LOCATION OF THE POWER PLANT AND POLE LINE OF THE LACHINE RAPIDS HYDRAULIC AND LAND CO.

CONSTRUCTION OF FALSE DAMS.

Work was commenced in the fall of 1895 by throwing out a false dam (Figs. 2, 3 and 4) of stone and earth at right angles to the shore; then by running a short wing dam down stream, enough of the river bed was made bare (Fig. 5) to enable the contractors to get sufficient stone by excavation to grade to continue the dam further out into the river, and to commence running a wing dam down to the site of the main dam, on which are the wheel houses. Every foot added to the wing dam down stream, laid more of the river bed bare and allowed excavation to be made down to grade. This work was carried on during most of the winter by means of steam drills, and the rock taken out was used to construct another dam (Fig. 2) at right angles to the shore, 150 feet above the extreme upper end of the proposed wing dams. These two false dams were connected during the past season, and when they were sufficiently advanced an opening was made in the lower dam and the water in the upper portion drained out, enabling the whole of the work to be done on a comparatively dry river bed.

* From the *Engineering News*, New York.

Much trouble was experienced in building these dams, owing to the raging current which at several places swept away 75 per cent. of the material, consisting of large boulders, etc., as fast as it was dumped in. The fact of their having been built of such large stones has also given the dams a tendency to leak badly, in spite of banking with earth mixed with pea-straw, etc.

CRIBWORK.

The cribwork dams were then commenced. These consist of, first, a high crib 360 feet long (Fig. 6) built of 12 x 12-inch face timbers laid to 2-inch joints with 8-inch flatted ties laid 8 feet apart in each course and 8-inch longitudinals, and, second, 3,305 feet of overflow crib with 12x12-inch longitudinals and purlines. The top is hipped up with an easy slope on the shore side and covered with 2-inch plank and 8-inch tamarac split poles with the bark on. The slope on the side towards the river is steeper, and is covered with 8-inch tamarac squared on three sides and laid on purlines. The vertical face of the whole dam on the shore side is sheeted with two layers of 2-inch plank and an ample talus of gravel is laid along the shore side. Both cribs are filled with carefully placed stone of moderate size, and are scribed and bolted to the rock when above the grade adopted for the bottom of the head race, 12 feet below the top of the main dam. Below this it is considered that the stone filling is ample security, and the cribwork is merely scribed to fit closely to the rock. The wing dam cribwork, above the main dam, is 20 feet wide at the bottom, and the cross ties are run entirely through wherever possible.

The masonry ice breaker at the upper end of the wing dam is 40 feet long and 20 feet wide; it is built on a concrete foundation two-thirds the depth of the water (which is 21 feet deep at this point), of rough bush-hammered masonry. The top is bevelled to 5 feet below the water line, and 1½-inch chains are imbedded in the concrete to fasten the upper boom.

piers. The piers are 4 feet thick by 48 feet long, 21 feet 6 inches c. to c. for both flumes and waste weirs.

POWER HOUSES (FIG. 9.)

The power house walls are built in a similar manner, and contain between them massive concrete foundations for the generators. The walls are four feet thick along the front and sides to the line of the down-stream end of the piers; beyond this the masonry is only 3 feet thick and 3 feet high, with a 16-inch brick wall up to the top of the piers.

The generator foundations are constructed in the form of heavy columns with arches between, and afford every facility for getting at the holding down bolts of the generators.

Vacant spaces between and behind the foundations are filled with stone flushed over with eight inches of concrete up to the same level as the flume floors or tail water. These spaces will be utilized for heating apparatus, storage, etc., and will be accessible by a spiral staircase and a hatchway 4 x 5 feet.

SHORE ABUTMENT.

The shore abutment (Fig. 15) is also built of masonry four feet thick, and from the line of the rack runs into the bank in a sloping direction. This sloping portion is backed with three feet of clay puddle up to the frost line, four feet below the ground level. There is also a wing wall 12 feet behind this of concrete, three feet thick, running 23 feet into the bank.

The portion of the abutment next the flume is backed with concrete four feet thick, running up six feet above the flume floor, and with clay puddle three feet thick above this up to the frost line. These precautions are taken to preclude any possibility of leakage around the back of the abutments.

A cribwork embankment is carried along the shore from the corner of the abutment to a point about 50 feet up-stream. All ties in this crib are kept so that the ends will be below the frost line.

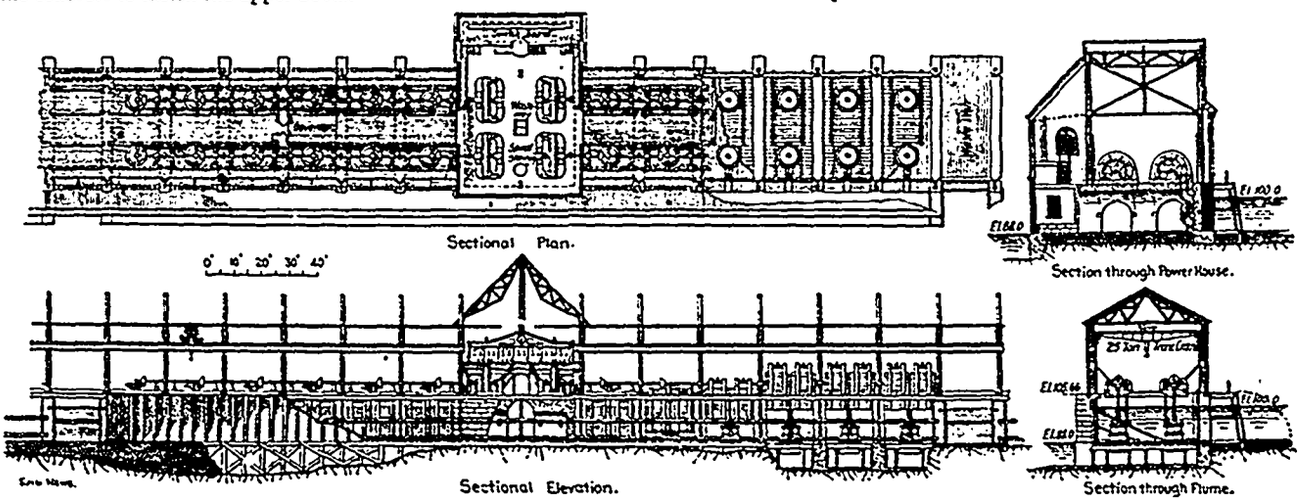


FIG. 9—DIVISIONS THREE AND FOUR OF MAIN DAM, SHOWING PLAN, ELEVATION AND SECTION OF POWER HOUSE AND TURBINE SETTINGS.

MAIN DAM.

The main dam piers (Fig. 7) are built of rough bush-hammered masonry 4 feet thick, laid on a concrete foundation 4 feet 6 inches thick, which runs up to the level of the flume floor. The rock under the wheel pits was first excavated and levelled off, and owing to its shaly and unreliable nature a layer of concrete 1 foot thick, composed of 2 parts sand, 1 part Portland cement, and 6 parts stone (these proportions were used throughout the work), was laid over it, holes being left to receive the columns supporting the flume bottoms Caissons (Fig. 8) of 2 x 4-inch stuff, laid on the flat and well tied through, were then run up to the level of the underside of the timbers supporting the flume floor. These timbers of 12 x 15-inch pine were then laid, running back 15 inches into the concrete, and were bevelled off so as not to weaken the foundation.

The caissons were brought up to the level of the flume floor and filled with concrete. Two longitudinals of 10 x 12-inch British Columbia fir were run under the floor timbers and 15 inches into the caissons along the front of the flume. These are each supported by six 6-inch I-beam columns placed in holes in the wheel pit bottom above mentioned, which were then flushed up. Masonry was then laid on this foundation to a height of 17 feet above the flume floor. This masonry is of a very high class character, the blocks being extremely large and averaging about 2 feet in thickness; they are laid in cement mortar, composed of 2 parts of sand to 1 of cement.

Two recesses, 12 x 8 inches, 36 feet apart, are provided for the gates and stop logs, the down-stream one being 6 feet from the back of the piers, and the up-stream one being 4 feet from the front of the

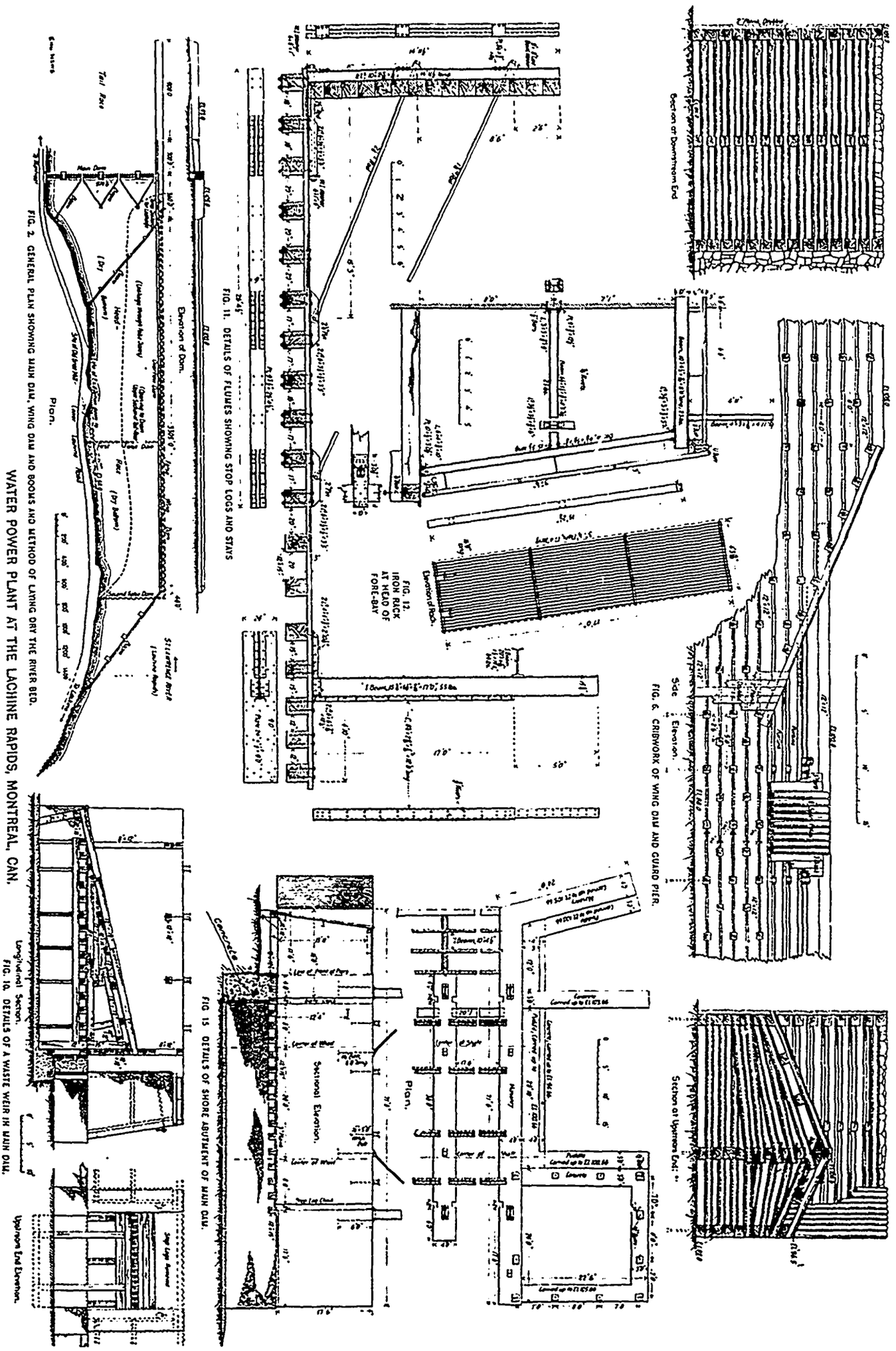
WASTE WEIRS (FIG. 10).

The floor timbers and flooring for the waste weirs are finished in the same way as the flumes, 12 x 12-inch stop logs are laid in the up-stream check, and the upper four of these can be taken out and replaced to suit the level of the head water. A heavy timber slide is built over the floor for ice, etc.

Arrangements were made to drain the water through the waste weirs under the flooring during construction. This was done by omitting the concrete wall along the front from the rock bottom up, and by placing slides into which one set of 12x12 stop logs, and one set of 2x4 stop logs will be dropped and the space between filled with concrete, when the construction is completed.

HEAD GATES.

Each flume is provided with a set of two head gates of pine, 5 inches thick, for a height of 5 feet, and 4 inches thick above, with an iron sliding filling gate in each, and two 8x4 inch uprights with a cross piece between fitted with wrought-iron shackle to raise the gates by. The head gates move in slides fitted into the check in the masonry and fastened to an upright in the centre of the flume consisting of a 15-inch I-beam and an 8-inch channel into which a strip of wood is fitted, and to this the distance piece between the two gates is screwed. This upright is braced just at the water line by a 20 inch I-beam running across the flume and 11 inches into the wall on each side; it is securely fastened at the bottom to an iron plate nine feet long, two feet wide and half-inch thick, rag-spiked to the floor timbers.



WATER POWER PLANT AT THE LACHINE RAPIDS, MONTREAL, CAN.

FIG. 2. GENERAL PLAN SHOWING MAIN DAM, WING DAM AND BOOMS AND METHOD OF LAYING DRY THE RIVER BED.

FIG. 11. DETAILS OF FLUMES SHOWING STOP LOGS AND STAYS

FIG. 12. IRON RACK AT HEAD OF FORE-BAY

FIG. 6. CRIBWORK OF WING DAM AND GUARD PIER.

FIG 15 DETAILS OF SHORE ABUTMENT OF MAIN DAM.

FIG. 10. DETAILS OF A WASTE WEIR IN MAIN DAM.

The gates are intended to be raised and lowered by a travelling crane, and will probably be taken out and stored under water after the wheels commence running, as they would obstruct the light if left in position. The space between the top of the gates and the flooring of the building is filled with three-inch plank laid in the check and bolted to the upright behind the gates.

STOP LOGS.

The stop logs (Fig. 11) are 12 x 12 inches, laid into 8 x 12-inch recesses in the piers and braced by two sets of iron eye bolts, three in each brace, running diagonally down to the flume floor and pin-connected to the angle-iron fastenings, which are riveted to an iron plate 9 x ½-inch x 26 feet 4 inches bolted to the floor timbers. These bolts run out to a bevel casting, bearing on the channel iron uprights, and are provided with a nut at the outer end and can be removed if necessary. The uprights are formed of two 10-inch channels placed back to back with a space for bolts between, and held together with cross plates just under the bevel castings. These braces are so placed as to take all strain off the masonry piers.

RACK AND BRIDGE.

The rack and bridge framing rests on 12 x 12-inch timbers running lengthwise of the main dam and 11 feet 6 inches from the front of the piers, well supported by 12 x 12 uprights; a butting piece is placed at each pier and braced where necessary by 3-inch plank.

This framing is laid level with the flume floor and is omitted in front of the waste weirs. The rack and bridge rest on steel frame-work constructed of 6-inch I-beam uprights, 12-inch I-beams running lengthwise between piers to support the racks, while 10-inch I-beams are under the bridge floor, which is about 6 feet wide. The outer one of the bridge beams is faced with a 10-inch timber against which the rack rests. The rack (Fig. 12) is made of 3 x ¼-inch bars, 17 feet long, laid to 2¼-inch centres in sections 4 feet 3½ inches wide, well bolted through and with thimbles between each bar. Each section is supported on two castings (Fig. 13) so

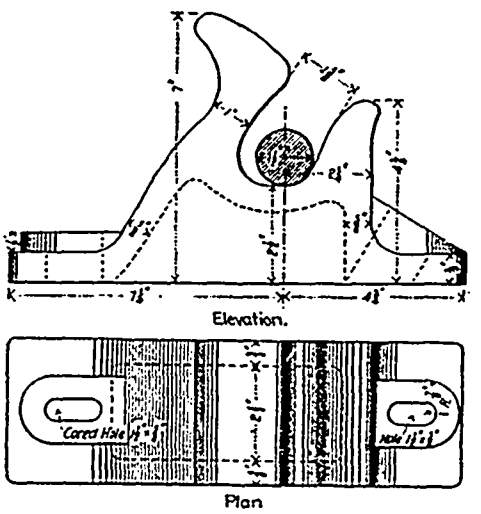


FIG 13.—CASTINGS FORMING HINGE SUPPORT OF RACK FOR PROTECTING THE TURBINESOF THE LACHINE RAPIDS POWER PLANT.

shaped that the rack may be swung over so as to lay on the head race bottom (which will be levelled off in readiness), or it can be easily taken out and replaced without the necessity of sending down a diver to unfasten the bolts.

The rack is constructed in this manner so that it may be taken out of the way in order to pass frazil through the wheels, in case the frazil should begin running before ice forms over the head race. If the rack were permanently secured in the ordinary way, the frazil would adhere to the rack bars and impede the flow of the water.

The bridge beams are floored over with 2-inch plank, and a rail is carried along the bridge about 2 feet from the edge, giving ample room for a man to rake the rack.

BOOMS.

The system of booms (Fig. 2) is as follows: (1) At the entrance to the head race on a very easy rake will be placed a boom 1,340 feet long, constructed in the form of a Howe truss, the chords being three 12 x 12-inch timbers, the main braces 3-inch plank, and the counterbraces 4 x 12-inch timbers.

The 3-inch plank is laid solid on the top and bottom, and between the 12 x 12-inch timbers and the 4 x 12-inch timbers are placed on edge between the layers of plank. The whole is securely spiked and bolted every 8 feet with three bolts, one through each 12 x 12-inch timber, the bolt diameters varying from 1¼ inch to 1¾ inch. The boom is in sections 250 feet long, with a clear span of 220 feet, and is 14 feet wide and 4 feet deep. Its details are illustrated in Fig. 16. It will be securely fastened to the shore and the ice-

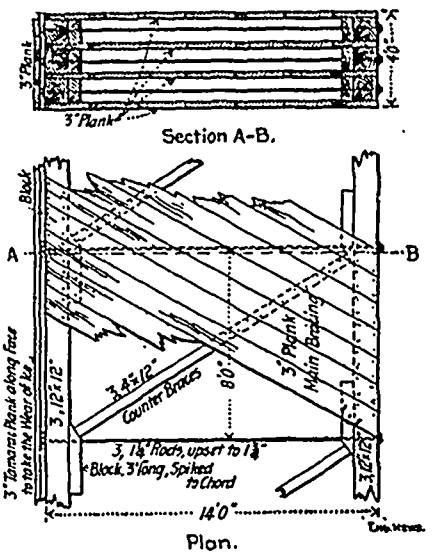


FIG 16.—HOWE TRUSS FORMING BOOM ACROSS HEAD RACE.

breaker, and will be supported by four crib piers, 30 feet square, constructed of 12 x 12-inch timbers and filled with stone.

These cribs are made large, as they stand in about 25 feet of water. (2) At the lower end of the overflow dam will be placed a boom 1,000 feet long, constructed of three 12 x 12-inch timbers fastened with 1¼-inch chains and 1¼-inch bolts. This boom will be secured to a timber sunk into the ground at the shore end and will rest against a buttress on the overflow dam. It will be supported by four crib piers 13 x 22 feet, the fronts of which are at a slight angle to the sides, so as to obstruct the flow as little as possible. (3) At a distance of 250 feet from the front of the main dam are placed two piers, 13 x 22 feet, with ice breaking faces and constructed of 12 x 12-inch timbers.

Booms constructed of two 12 x 12 timbers, with bolt and chain fastenings, are secured to these and inclined to the waste weir entrance, forming a complete protection against any trash which may be allowed to pass the second boom (if the water level ever falls below the top of the overflow), and against ice which may form in the head race up to the second boom. All the boom piers are provided with suitable snubbing posts capped with galvanized iron and are filled with stone.

TURBINES.

Each flume will contain (Fig. 9) two special 54-inch Victor turbines, a total of 72, which are connected in sets of six turbines to twelve generators, four in each power-house. These wheels are set vertically on 3-inch plank flooring, and will develop 200 h.p. each, under a 11-foot head, a total of 14,400 h.p. Under this head they will run at 64 revolutions per minute and discharge 12,000 cubic feet of water per minute.

Each set of six wheels is connected by bevel core gears to a common jack-shaft, and this transmits their power at a speed of 175 revolutions per minute to a 3-phase generator of 750 K.W. guaranteed to stand 25 per cent. overload. The speed is regulated by a governor guaranteed to control the speed within two per cent. from no load to full load.

The gears and shaftings are supported on heavy cast-iron saddles resting on 15-inch I-beam girders, two beams to a girder, bolted at the ends to the piers by bolts running 24 inches into the piers These girders also support by stirrups 8-inch I-beams on which the gear-shed flooring of 3-inch plank lies. This flooring is so arranged that the stop logs may be taken out and hatches are hinged over the space required to take out the head gates. At the back and front of the gear shed beyond the ends of the 8-inch floor beams the flooring rests on 12-inch timbers.

GEAR SHEDS.

The gear sheds (Fig. 14) are of steel frame with peak roof, Fink truss design. The uprights at each pier are lattice columns and are arranged to carry 21-inch I-beams on which a 25-ton hand power crane will run from end to end of the building, a distance of 975 feet. The distance from the floor to the eaves of the shed is 25 feet, to the peak 36 feet, and the distance between uprights, or the clear width of the shed inside, is 38 feet. A wooden sheathing of studding and planking will be run along the sides and covered with corrugated iron. Between the roof trusses, which are 21 feet 6 inches apart, 6 x 12 inch purlines will be laid. Over these two

layers of 1¼-inch boards will be laid, with two-ply 10-ounce roofing felt between, and the whole will be covered with four-ply plastic asphalt.

POWER HOUSES

The power houses (Figs. 9 and 14) are built of steel frame, and the roof is of special design, the distance to the peak being 50 feet; 12-inch brick walls are carried all around the front, back and sides, except where the travelling crane passes through, above which a wooden partition will be run up with doors to close when the crane is not in use Loads carried by the crane will pass through openings 12 feet wide on each side. The inside dimensions of the power houses are 64 x 44 feet The flooring is of concrete covered with 1-inch slate to prevent dust rising from the concrete.

The generator foundations form the flooring as far back as they go; beyond them 12-inch I-beams are laid with terra cotta between, over which three inches of concrete and slate is laid. The flooring is given a pitch of ¼-inch to the foot for drainage. A hatchway 4 x 5 feet, and a spiral stairway is provided for access to the vault-like recess below the generators and pipes, to carry the cables to the switchboard, etc, run through the floor.

On the massive arched foundations are to be placed the generators; these will stand 11 feet high above the floor, have a base 15½ x 10 feet, and weigh about 45 tons each They are held down by four 2¼-inch bolts 12 feet long, which can be readily taken out if required Two stone blocks, 30 x 24 inches x 16 feet, are placed under the generators, one at each side Two 4-pole exciters of 75 K.W. capacity are placed at the down-stream end of the power house. They are belted to the main shaft and will each serve two generators, but either of them is capable of exciting four generators. The bases of the exciters are securely bolted down to the I-beams on which they rest.

SWITCHBOARD.

The switchboard arrangements are not yet completed, but they will probably stand on an elevated structure at the down-stream end of the power-houses; they will be built entirely of marble and finished to an ornamental design.

Power will be transmitted to the distributing station in Montreal, a distance of six miles, at a pressure of 4,400 volts. This will be carried by 36 No. 0 copper wires strung on double petticoated insulators on six cross arms. The poles are of lattice steel work set 6 feet into concrete, and are placed 100 feet apart. From this station the power will be distributed throughout the city in underground conduits.

The capital stock of the Lachine Rapids & Hydraulic Land Company is $2,000,000. The officers of the company are: President, G. B. Burland; vice-president, T. Pringle; managing director, W. McLea Walbank, directors, E. Kirk Green, Peter Lyall and S. Carsley, of Montreal, and Alexander Fraser, of Ottawa. The engineers of the work are Messrs. T. Pringle & Son, and W. McLea Walbank, of Montreal, and Dr. Cary T. Hutchinson, Postal Telegraph Building, New York city, is in charge of the electrical department of the work. The contractors for excavation, masonry and cribwork were Wm. Davis & Sons, Ottawa; for turbines, shafting, gears, etc., the Stillwell-Bierce & Smith-Vaile Company, Dayton, O., for electric machinery, the Canadian General Electric Co, Peterboro, Ont., and for steel construction and pole line, the Dominion Bridge Company, Montreal.

There have been used in the work 8,700 cubic yards of concrete, 6,000 cubic yards of masonry, and 2,900,000 feet B.M. of timber; 225,000 cubic yards of rock have been excavated.

The writer wishes to acknowledge his indebtedness to Messrs T. Pringle & Son, from whom the detail drawings used in the preparation of this article were obtained.

For THE CANADIAN ENGINEER.

THE OTTAWA WATERWAY TO THE GREAT LAKES

BY A. J. FORWARD, OTTAWA.

(Concluded.)

Besides ore, however, there must be taken into account flux fuel, labor and transportation facilities. The city of Ottawa is built on limestone. On this point Mr. Birkenbine's report says:

"Limestone is abundant in the territory about Ottawa, and the Geological Survey officers state that both limestone and dolomite, as well as intermediate qualities of magnesian limestone, are obtainable. It is therefore possible to find either near the mines or near the furnace location an abundance of limestone for flux."

Facilities for obtaining and cost of fuel are, perhaps, the two most important elements. To quote Mr. Birkenbine again:

"To appreciate the position of Ottawa to a fuel supply, we may first consider its position in relation to the anthracite coal region of Pennsylvania. Taking Scranton as a centre, the circumference of a circle which passes through Ottawa, would also pass through or close to Cleveland, Ohio, London, Ont., and Rouse's Point, N Y. As the railroad connections between Scranton and Ottawa are nearly direct, and as there is no duty on anthracite coal, this fuel should be delivered in Ottawa at approximately the same all-rail rates that prevail to the other points named. Very satisfactory coke for furnace use is now being produced in Pennsylvania, 100 miles nearer Ottawa than Connellsville, and the use of such fuel would give Ottawa an advantage of fully 100 miles over Chicago in distance."

Pennsylvania coal can be brought in by direct all-rail routes as stated, or via the Rideau Canal. Nova Scotia coal comes as far as Montreal in considerable quantity, there entering into competition with American coal. It could be brought to Ottawa at very slightly increased cost. Within eight or ten miles of the city are extensive peat bogs, which might be successfully used for coking purposes Peat also occurs along the line of the Rideau Canal, and in the vicinity of Caledonia Springs, close to the Ottawa River. And in case of the location of furnaces here it would be worth while to inquire into the value of the refuse from the various saw-mills, which now is allowed to pollute the river. This might be used as a fuel when converted into gas, as at present practised in Norway and Sweden in the manufacture of iron of the highest quality. The location is also one of the most favorable in Canada for the manufacture of charcoal iron, for from the forests of the great Laurentian area might be obtained supplies of charcoal for years to come. Labor is plentiful, cheap, and of good quality. With waterways south, east and west, and railways radiating in all directions, and located near the convergence of all the great trunk lines of Canada which have been or may be built, Ottawa would be in an ideal situation to distribute the manufactured product. To the western market she would be as near by water as Hamilton, and 250 miles nearer to Montreal. The Canadian Pacific and Ontario railroads running north to the Ottawa River, could be supplied to the best advantage. With cheap iron, cheap lumber, cheap water-power, cheap electricity, and cheap transportation, manufactures would spring up in the Ottawa Valley, and would create markets. And clearly, all development of mineral and forest resources to the northward, as well as all settlement in that direction, will have the Ottawa River as their base of supplies in the future as in the past.

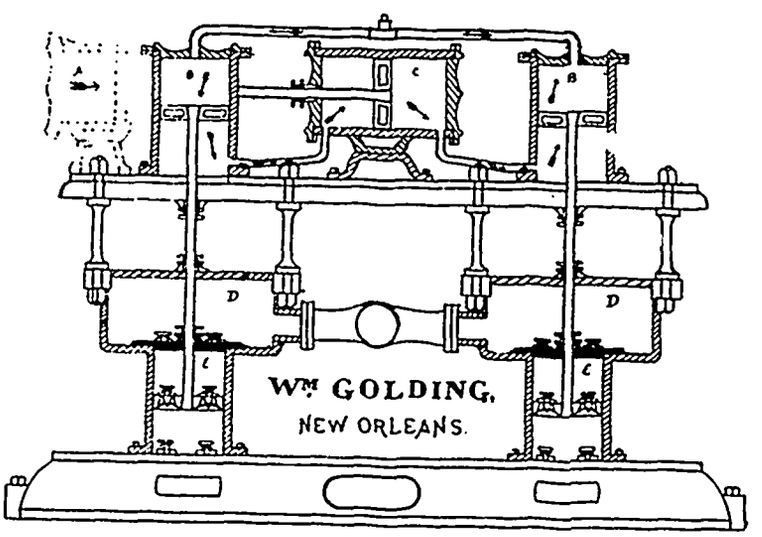
In these days of Deep-waterways Conventions we hear much said of the enormous traffic of the great lakes. It is interesting to note that nearly 75 per cent. of that is composed of lumber and iron. In view of that fact, and considering that these two products constitute our most abundant and valuable resources, residents of the Ottawa valley may be permitted to question the sweeping assertion that all Canadian routes to the seaboard are disqualified "because they run through a district that can furnish but very little freight in either direction." We have iron enough to supply the continent. W. C. Edwards, M.P., one of the most prominent lumbermen in Canada, referring to the extensive forest area, and commenting on the methods of Canadian lumbermen, recently expressed the opinion, from his seat in the House of Commons, that a very large output of lumber from this region might be continued indefinitely, if proper neasures for forest conservation are adopted. Unless there is some material error as to the extent and nature of our resources, or as to the functions and effect of waterways in developing these, there appears to be ground for asserting that the opening of the navigation of the Ottawa River to the great lakes will accomplish more for the advancement of Eastern Canada than any public work in our history, not excepting the Canadian Pacific Railway. Its beneficial effects in aiding the settlement of the North-West, as well as the northern districts of Ontario and Western Quebec, are beyond the scope of this paper.

THE report of the investigation commission appointed by the Dominion Government to inquire into the affairs of the Kingston Penitentiary reported that the sewage works of the prison were badly planned, improperly constructed, faultily equipped, inefficient in operation, extravagant to maintain, and revolting to attend. The engineer is not responsible for the design of the present system, but he is not blameless as regards its equipment and operation. In dealing with the water supply for prison purposes, there appears to have been the grossest incompetency on the part of the engineer. The heating system is said to be operated without regard to the favorable conditions which exist to secure economy in expenditure.

STEAM ROAD ROLLER

The Good Roads Machinery Co. of Hamilton have been appointed agents in Canada for J. & H. McLaren, of Leeds, proprietors of the McLaren patent steam road roller, which has obtained a high reputation in Great Britain. It is a modification of the Gold Medal Traction Engine made by the same firm, and like it, is noted for simplicity, efficiency, economy and durability. The McLaren roller is made in various sizes from 7 to 20 tons weight, and an average machine will compress over 2,000 square yards of 4-inch metalling in a day of 10 hours at a cost of $5 to $6, including coal, men's wages, interest on capital, wear and tear, etc. The front rollers are carried on a patent swivelling carriage, by which a fruitful source of breakage is avoided, and at the same time it admits of rolls of large diameter, which turn easily and accommodate themselves to inequalities of the road. The hind rollers are mounted on the main axle, and the gearing, which is of the best steel, is so arranged and the position and width of the wheel so adjusted that the pressure per foot of ground covered by the hind rollers is assimilated as closely as possible to the pressure on the ground covered by the front rollers.

The boilers are made of the best quality of steel plates throughout, tested by cold water to 240 lbs. for a working pressure (if required) of 140 lbs. on the square inch. All the plate edges are planed up true, and all rivets closed by powerful hydraulic machinery. The steel spur gearing is practically unbreakable. The rollers are cast of a specially hard mixture of cast-iron to avoid undue wear. They are cast several inches wider than actually required, the extra width being cut off in the lathe from the top (or "spongy") side of the casting, so that perfect solidity is ensured for the full width of the roll. Each roller is fitted with scrapers on both sides, and the engine is fitted with a water tank, coal box, water lifter for filling the tank from any convenient source of supply, injector for feeding the boiler, as well as a pump worked by an eccentric on the crank-shaft. A powerful brake is fixed on the engine for working on steep ground, and all the working parts are thoroughly case-hardened. Each machine is fitted with a complete outfit, such as firing tools, a pair of lamps, waterproof cover, and an assortment of working tools—hammer, cold chisels, screw keys, oil-can, etc., etc.



At a slight increase of cost the McLaren roller can be supplied on the compound principle, and it is claimed that these compound traction engines are the best proportioned and most economical on the market.

TARIFF CHANGES.

The tariff revisions brought down by the Government, May 25th, contain evidences of a careful desire to conserve the interests of the manufacturers wherever possible. In discussing the duties on mining machinery, to which THE CANADIAN ENGINEER took exception in our last issue, the Minister said:

"In the matter of mining machinery, in our tariff resolutions were included a class of mining machinery exclusively used for mining, and provided that it should be admitted duty free. Under the old tariff there was a clause of somewhat similar character, restricting it to kinds of machinery not made in Canada. We found difficulty in the interpretation of that clause, and we have found there would be difficulty in the interpretation of our new clause, owing to the uncertainty as to what is mining machinery exclusively.

"We have had interviews with gentlemen interested in the manufacture of mining machinery, and also with many people who use such machinery, and after very full discussion, we determined to place 25 per cent. duty on certain articles of mining machinery, and to specify all the articles which we wished to make free. There are a few items of mining machinery which are made in Canada, and which are well made and satisfactory to mining people, and these classes will still have to pay 25 per cent. Then we place on the free list a large number of items which are desired by miners. Item 535 in the amended resolutions reads as follows. Mining, smelting and reducing machinery, viz.: Pressure or exhaust fans, rotary pressure blowers, coal cutting machines, except percussion coal cutters, coal heading machines, coal augers and rotary coal drills, core drills, miners' safety lamps, coal washing machinery, coke-making machinery, ore drying machinery, ore roasting machinery, electric or magnetic machines for separating or concentrating iron ores, blast furnace water jackets, converters for metallurgical processes in iron or copper, briquette making machines, ball grinding machines, copper plates, plated or not, machinery for extraction of precious metals by the chlorination or cyanide processes, monitors, giants and elevators for hydraulic mining, amalgam safes, automatic ore samplers, automatic feeders, jigs, classifiers, separators, retorts, buddles, vanners, mercury pumps, pyrometers, bullion furnaces, amalgam cleaners, gold mining slime tables, blast furnace blowing engines, wrought iron tubing, butt or lap-welded, threaded or coupled or not, not less than 2½ inches diameter, when imported for use exclusively in mining, smelting, reducing or refining."

Special concessions are made to some lines of metal manufacturers. The carriage-makers get considerable raw material free. Steel for toolmakers is reduced from 15 per cent. to 5 per cent. Scrap iron, which was $4 a ton under the old tariff and was reduced to $1.50, is further reduced to $1. Steel ingots and billets are brought down from $4 a ton to $2 a ton. Structural iron is reduced from 15 per cent. to 10 per cent. Iron bridges are increased from 30 per cent. to 35 per cent.

TWIN PUMP.

The Twin Pump here depicted is believed by its inventor, Wm. Golding, C.E., New Orleans, to have a new system of actuation. Chambers *B C B* are filled with water. Steam cylinder *A*, shown in dotted lines on left upper corner of sketch, actuates the piston in chamber *C*, forcing the water into chamber *B*, under the piston: the water above the piston passes through pipe *E* to chamber *B* on opposite side, in the direction indicated by the arrows. The return stroke of the steam piston reverses the motion, thus causing the pump pistons to rise and fall with absolute certainty. There are many services for which this combination will have preference over all other movements, notably for air pumps and for moving large quantities of water; for drainage and for irrigation, where minimum first cost and cost of transportation and installation are important items.

ACETYLENE LIGHT FOR MAGIC LANTERNS.

Editor CANADIAN ENGINEER.

SIR,—Within please find one dollar for another year's subscription for your valuable paper. I find much good information in it. While reading your account of Mr. Willson's calcic carbide works, of St. Catharines, I was forcibly struck with the idea of lighting my magic lanterns with the acetylene light. I would like you to give your readers information how to generate, and what to get to produce the quantity and cost for a sufficient light for a small house where there are now three or four gas lights. Yours kindly,

P. T. TROWERN,
Chief Engineer Asylum for Insane, Toronto.

[A description of the Niagara Falls acetylene gas machine appeared in our April number, and that apparatus, among others, is a serviceable one for the production of the acetylene light. The carbide and acetylene works operated by Mr. Willson at Merritton now ship the carbide in conveniently small tanks made of galvanized iron, each holding 100 lbs. of the dry carbide, which, we understand, is sold at $4 per tank, or $80 per ton. On this basis it is estimated that the gas produced by the carbide is equal to coal or water gas at 60 cents per 1,000 feet. Mr. Maundell, of Woodstock, has experimented with the following result: 1 lb. of carbide will produce five feet of gas, which will yield 240 to 250 candle power, at a cost of four cents. Thus 1¼ feet of acetylene gas will give

about 60 candle power for one hour at a cost of one cent.; while with ordinary gas, at $1 per 1,000 feet, 10 feet will yield 25 to 35 candle power for one hour at a cost of one cent, or about half the quantity of light. An improved burner for acetylene gas has been brought out in the United States, making a more economical light and giving better distribution than those heretofore in use, which are different to the ordinary gas burner, though attachable on the same pipe. The method of generating is referred to in the February and April numbers.—Ed.]

PUMPING BY COMPRESSED AIR.

The Pohle Air Lift is a system of pumping water from artesian wells by means of compressed air without the use of any moving parts Its advantages are claimed to be that it pumps larger quantities of water with greater economy and reliability. In addition sand or grit does not affect it, the water is purified and one air compressor (usually located in the engine room) will pump from any number of wells regardless of distance. Two properly proportioned pipes are placed in a well, the one an air pipe leading to the air compressor and connected with the other—the water discharge pipe—near its base, through what is known as the foot or end piece. The compressed air is forced through the air pipe into the foot piece and water pipe, and by its inherent expansive force, layers or pistons of air are formed in the water pipe, which lift and discharge the layers of water through the end of the water discharge pipe at the surface or tank. At the beginning of the operation, the water surface outside of the pipe and the water surface inside of the water pipe are at the same level; hence the vertical pressures per square inch are equal at the submerged end of the pipe, outside and inside As the compressed air is forced into the lower end of the water pipe, it forms alternate layers with the water, so that the pressure per square inch of the column thus made up of air and water, as it rises inside of the water pipe, is less than the pressure per square inch outside of the pipe. Owing to this difference of pressure, the water flows continually from the outside to within the water pipe by gravity, and its ascent through the pipe is free from shock, jar or noise of any kind These air sections, or strata of compressed air, form water-tight bodies, which in their ascent in the act of pumping are said to permit no "slipping" or back-flow of water. As each air stratum progresses upwards to the spout, it expands on its way in proportion as the over-lying weight of water is diminished by its discharge, so that the air action, which may have been, say 50 lbs. per square inch at first, will be only 1.74 lbs. when it underlies a water layer of four feet in length at the spout, until finally this air section when it lifts up and throws out this four feet of water, is of the same tension as the normal atmosphere.

One of the many advantages which are claimed for this system is that the water is aerated, and this is an important consideration, as is usually acknowledged, and Prof. Thos. M. Drown, of Lehigh University, recently stated that the success of filtration is largely dependent upon aeration The Ingersoll-Sergeant Drill Co., 26 Cortland street, New York, which construct plants on this system, states that it is already in successful operation in a number of cities in the United States.

THE annual report of the Minister of Railways and Canals shows that the number of miles of completed railway was 16,387, an increase during the year of 296 miles, besides 2 106 miles of siding. The number of miles laid with steel rails was 16,137 The number of miles in operation was 16,270. The paid-up capital amounted to $809,817,900, an increase of $5,177,[illegible]; the gross earnings to $50,545,569, an increase of $3,760,087 and the working expenses aggregated $35,042,655, an increase of $2,292,986, compared with those of the previous year, leaving the net earnings $15,502,914, an increase of $1,467,096. The number of passengers carried was 14,810,407, an increase of 822,827, and the freight amounted to 24,266,825 tons, an increase of 2,742,404 tons. The total number of miles run by trains was 44,500,692, an increase of 3,838,712. On the Intercolonial Railway system the loss on the year's operations was $55,187. The Windsor branch showed a profit of $20,085. The P.E.I. Railway showed a loss on the year's operations of $78,662 02. The Grand Trunk Railway carried 7,587,148 tons of freight, and the C.P.R., 4,576,632 tons. The number of passengers carried by the Grand Trunk was 5,077,671, and by the C.P.R., 3,036,619. The total gross earnings of the Grand Trunk amounted to $16,506,000, and of the C.P.R. to $20,175,000. The total net earnings were $4,962,000 for the G.T.R., and $7,973,000 for the C.P.R. The passenger traffic yielded the C.P.R. $4,759,000, and the Grand Trunk, $5,002,000. The G.T.R. had no passengers killed during the year.

LITERARY NOTES.

In 1894 a memorial was presented to the county council of Wentworth recommending that a prize be offered for a history of Wentworth. Acting on the memorial the council offered a premium of $100 for the best historical essay, and the prize was awarded to J H Smith, the inspector of public schools for the county. This has now been published, with some additions and illustrations, and those who may have the opportunity of reading this instructive pamphlet of 140 8vo. pages will heartily commend the judgment which awarded the palm to Mr. Smith. It is not commonly known that a white man entered the forests of Wentworth County as long ago as 1669 This was no other than La Salle, the intrepid French Canadian explorer, whose journeys are recorded by Galinn, one of the priests who accompanied him, and whose narrative is quoted from an interesting paper by B. E. Charlton, a former mayor of Hamilton. For the actual settlement of Wentworth we come down to about the beginning of the present century, and in that short time the settlement and development of the county—in population, wealth, education and in all that contributes to make a progressive and enlightened community—has been remarkable. In fertility of soil, wealth of orchards and gardens, charm of rural scenery, variety of agricultural products and intelligence of its inhabitants, Wentworth has become famous, and Mr. Smith's graphic sketch shows that it is also rich in historical records. Among these not the least to be proud of is the memorable battle of Stony Creek, in which a band of 704 British put to confusion and flight an American army of 3,500, and by this bold assault turned the tide of invasion from the whole province of Upper Canada. Mr. Smith's style is very pleasing, his language choice, and it is saying much for the value of his work that while dealing with local events, there are very few pages in his work which will not be both instructive and entertaining to readers who may have no personal interest in the county itself.

The address of George E. Drummond, Montreal, president of the Mining Institute of the Province of Quebec, on the history of the pig iron trade of 1896, read before the Institute at its last annual meeting, has been reprinted in pamphlet form. Mr. Drummond presents the claims of the producers of Canadian pig iron with his well-known ability and clearness, and gives, moreover, a very instructive review of the iron trade of Great Britain and the U. S during the past year. While the large consumption of pig iron in Great Britain seems to show sunshine, Mr. Drummond sees clouds ahead there. A large part of the demand in Britain was for war office and navy yard contracts, while the large imports of American pig iron, taken in conjunction with the decreased exports of British iron products, indicate impending changes of great moment The combined output from Scotland, Cumberland and Furness district, and the Cleveland district of Britain, last year was 5,624,573 tons, or 601,622 tons over 1895; but this increase was only in the home trade, and the exports to France, Russia, Spain Portugal and Canada all showed a decline. Very little Scotch iron came to Canada, American pig being so much cheaper in this market—the difference being fully $4 per ton. It is estimated that only 2,454 tons of Scotch pig came to Canada last year, against 22,913 tons in 1892. Furthermore, the home mines in Great Britain are beginning to show signs of depletion, the "black band" being nearly worked out, and British consumers are seeking new mines in Spain to take the place of the Bilboa mines, which are also being worked out. The price of Spanish ore will therefore increase relatively and this will make American competition a factor all the more prominent as time goes on. The American production of pig iron in 1896 was 8,623,127 tons, which, though it showed a decrease of 9 per cent. since 1895, was still ahead of all other countries in the world Mr. Drummond computes the production of pig iron in Canada in 1896 at 61,839 tons, being an increase of 41 per cent. over 1895 This does not include the returns from Drummondville, Que., which had not been received. There was also produced 12,964 tons of Canadian steel, 1,243 tons of forgings, and 4,575 tons of puddled bars, etc. To produce this quantity the following Canadian materials were used: Ore, 82,705 tons; coal, 114,554 tons; coke, 46,219 tons; charcoal, 557,400 bushels, and limestone, 34,946 tons. Of foreign materials there was used at the Hamilton Blast Furnace Co.: American ore, 32,025 tons; or about 72½ per cent. of their total consumption; and of American coke, 30,217 tons. The Nova Scotia Steel Co.'s works used 7,269 tons of Newfoundland ore, 3,164 tons of Spanish ore; while the Canada Iron Furnace Co. (Radnor Forges) and the Londonderry Iron Co. used solely Canadian material. In the course of this able paper Mr. Drummond points out that in point of labor the worst kind of competition the Canadian iron producers have to contend with is the negro and convict labor of the Southern States. The latter is

"virtually a system of legalized slavery," the state prisoners being auctioned off to mining companies who pen the prisoners in the mining camps, and get the most out of them, paying the State so much per year per man. Mr. Drummond fairly argues that some sort of protection ought to be had against such a system of labor. Not the least interesting feature of Mr. Drummond's pamphlet is the copy of a petition signed by over 1,400 farmers, miners, merchants and others of the counties of Joliette, Vaudreuil, Nicolet and St. Maurice, addressed to the Dominion Government in behalf of a policy of encouragement to the iron industry of those regions.

The publishers of the *Canadian Manufacturer* are showing commendable enterprise in preparing a special issue containing the new tariffs of Canada and the United States. To this will be added the tariff of Great Britain—for, though Britain is a free trade country, its tariff of dutiable articles makes a longer list than most people imagine—and the whole will make a very valuable paper for reference purposes. This special number will be sold at 10 cents, and will be issued as soon as the Canadian and American tariffs are settled.

The magnitude of the paper and wood pulp industries of this continent are well set forth in a special number of the *Paper Mill and Wood Pulp News*, recently issued by L. D. Post, 21-23 Centre street, New York. This number contains 84 pages 12 x 16 inches, and the splendid machinery and appliances that now go to the equipment of the big paper mills are depicted in a fine series of photo-engravings. Mr. Post is to be congratulated on his enterprising paper. It is devoted to the various phases of the paper and pulp manufacture, and is published weekly.

"Notes on Copyright" is the title of a really valuable treatise on Canadian copyright by Richard T. Lancefield, the librarian of the Hamilton Public Library. Mr. Lancefield has made a study of this subject for several years, and he is the best authority on the subject in Canada to-day. The present work treats of copyright in general, and of the special features of the copyright law of Canada, of Great Britain, and of the United States. A chapter is given to the question of royalty, and the Canadian Acts of 1872 and 1875 are defined, and the text of the suspended Act of 1889 given. The provisions of the Berne Convention are set forth, and much other information presented in a clear and understandable form, and the forms of application for copyright are appended. Altogether Mr. Lancefield has presented the first complete text book on Canadian copyright, and it is published at the nominal price of 30 cents per copy.

"Railway Technical Vocabulary of French, English and United States Terms," by Lucien Serraillier, has just been issued from the press of Whittaker & Co, 2 White Hart street, Paternoster Square, London, E.C. Price, 7s. 6d As the author states in the preface, railway terms are comparatively modern; many have been coined independently in each country as required by the progressive development of railways, by the improvement effected in railway plant and appliances, and by the adoption of new methods, constructive and administrative. Some international nomenclature is needed which shall give the technical equivalents of these terms in each language, and thus save the time and labor often evolved in looking up special text-books for any terms which may occur either in foreign technical literature, or in the course of the annually increasing business dealings between home and foreign railways. It is to be hoped also that some understanding may ultimately be arrived at by which either a process, operation, or appliance shall be known by one name only in each language, so as to avoid the confusion and uncertainty which often arise when various expressions denoting the same object are adopted by different railways in the same country.

CATALOGUES.

A. B. Jardine & Co., Hespeler, Ont., have placed before the trade a handsome new catalogue of their machinists' tops, tube expanders and blacksmiths' tools.

Water Pumped by Compressed Air, is the title of a most interesting illustrated pamphlet which the Ingersoll-Seargeant Drill Co, 26 Cortlandt street, New York, is sending to its friends and those interested in the development of compressed air as an industrial force. A description of the Pohle air lift system will be found in another column.

The Montreal Pipe Foundry Co., Ltd., has issued a neat pocket-sized catalogue, which contains in addition to tables showing pressure of water in pounds per square inch for different heads, the thickness of metal and weight per length for different sizes of pipe under various heads of water, specific gravities and weight of a cubic foot of various substances, etc., and a number of pages for memoranda, which make it a very useful companion.

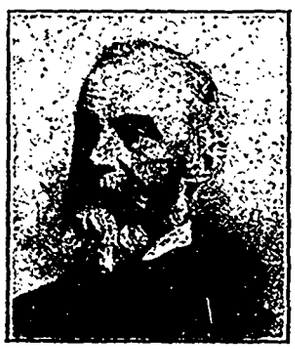
W. S. Rockwell & Co., furnace engineers, 26 Cortlandt street, New York, are sending their '97 catalogue to the trade in Canada, showing the advantages of the Rockwell improved duplex system for burning fuel oil.

The Clarence E Van Auken Co. of Chicago, illustrates its catalogue of steam specialties by photo-engravings of some of the finest buildings in the United States, in the heating of which the apparatus manufactured by this firm is employed.

The full page illustration in the catalogue issued by M. Beatty & Sons, Welland, Ont., gives an idea of the variety and size of the contractors' and mining machinery which is turned out by this enterprising firm. Steam dredges, ditchers, derricks, shovels, hoisting engines, horse-power hoisters, hoisting machines, stone derrick irons, gang stone saws, centrifugal pumps and other machinery is shown, much of it as it appears in actual operation in the execution of contracts.

THE LATE ALAN MACDOUGALL, C.E.

A serious loss was sustained by the engineering profession of Canada by the death of Alan MacDougall, C.E., which took place at Exmouth, Devon, England, April 23rd. Mr. McDougall was the third son of the late Col. MacDougall, of Edinburgh, Scotland, where he was born and received his education. He served his pupilage under Charles Jopp, consulting engineer of the North British Railway Company, under whom he had charge of several important works, especially on the Dalkeith Branch of the N.B. Railway. He came to Canada twenty-five years ago, and was employed on preliminary surveys and construction of the first sixty miles of the narrow gauge railways, as chief assistant under Edmund Wragge, consulting engineer, leaving the road before completion. He had charge of construction of the North Grey branch of the Northern Railway. He was for four years in the Department of Public Works, in charge of harbor and river improvements on the upper lakes and lower St Lawrence, until in the crisis of 1877 the staff was disbanded. Going to Scotland, he obtained employment



ALAN MACDUGALL, C.E.

on the North British Railway, as chief indoor assistant to the chief engineer; had charge of the survey and draughting department. Returning to Canada in 1882, he was a divisional engineer on construction of Canadian Pacific Railway for one season, after which he devoted himself to sanitary science, and commenced practice in Toronto, where he worked up an extensive practice in every branch of sanitary engineering and science. His opinions have been sought by municipalities in every part of the Dominion on waterworks, drainage, and other health questions, and also in Newfoundland, where he was offered the city engineership of St. John's, which he was unable to accept. Before leaving he received the thanks of the St. John's Board of Health for his services rendered during an outbreak of diphtheria. Among the numerous places he has advised on sewage and water supply may be mentioned: Stratford, St. Catharines, Port Arthur, Belleville, Peterboro, Goderich, Ont., and Brandon, Calgary in the North-West, and Vancouver, B.C.

Mr. MacDougall was married to a daughter of the late Dr. McCaul, in his lifetime president of the University of Toronto, and leaves a widow and four children, two sons and two daughters.

THE Gatineau Valley and the Pontiac and Pacific Junction Railway Companies are desirous of extending their lines into and through the city of Hull to the bank of the Ottawa River, to erect a commodious station at the junction of the railways, and to build a workshop for the use of both roads. An application has been made to the Hull city council, asking for the grant of these rights.

IRRIGATION IN THE NORTH-WEST TERRITORIES.*

BY WM. PEARCE, DOM SUPT MINES, CALGARY, N.W.T.

The object sought to be attained by sending your society an article on irrigation in the North-West Territories, is not so much that the climate of Ontario is such that the subject is one of considerable interest to many in that Province, though one who has observed the beneficial effects of irrigation will unhesitatingly assert that in very many localities, and in the majority of seasons, irrigation, to a certain extent, would be beneficial and highly profitable; nor does he require the gift of prophecy to foretell that within the life of the present generation it will be practised to a very much greater extent in the humid districts than even the enthusiasts on the subject anticipate. Before leaving this branch of the subject it may not be out of place to observe that few, if any, that were reared in a humid clime, and afterwards lived in an arid or semi-arid one, where irrigation was necessary, but were impressed with the neglected opportunities in irrigation in the humid portions. Particularly is this applicable to gardening and the growth of trees. Further, you in Ontario irrigate to a much greater extent than you imagine. Every gardener, in watering his plants, shrubs and trees, sprinkling his lawn, etc, is engaged in irrigation.

Writers of good repute have asserted that the Garden of Eden was irrigated, and that assertion can be fairly if not fully proven, and slight reflection will convince anyone that all the ancient civilizations existed wholly in irrigated territory. The subject is not new, but older than the earliest records, so that no apology is necessary because of its newness.

There is any amount of scope for the inventive genius intelligently applied by the members of this association on lines for which your training has to a very considerable extent fitted you, and in which your tastes will no doubt find the most congenial employments, viz, in the solution of devices for accurate measurements of water and the division thereof. Although inventive genius of a high order has been brought to bear on these contrivances for centuries, they are far from arriving at anything like the accuracy desirable This, to those who have not given the subject any attention, will no doubt seem surprising, but an investigation thereof will demonstrate its truth, and the attempt of its solution will be found most interesting even should the results not prove successful.

Another branch of the subject equally interesting and valuable viz., designs for dams for diversions of water from the beds of the streams, or for creating reservoirs for storage thereof, head gates, and other gates required along the systems, falls or drops for water which are necessary to a greater or less extent on all systems of any size, spillways or checks necessary to prevent the breaking of banks, etc., arising from local storms or cloud bursts, flumes of various designs for carrying water over or around obstacles of various kinds, tunnels, bridges, culverts, etc, the best manner of making the topographical surveys necessary, not only to obtain the information requisite to design the minor ditches or canals of any system, so that economy and thoroughness in their construction may be attained; also the same information over a lesser area required for the purpose of the distribution and application of the water when delivered at some point on or near to the land on which it is to be applied. Implements for levelling the land so that the water can be cheaply and thoroughly applied thereon. It may seem strange that after water has been applied on land for centuries that there should be room for ingenuity or a material improvement in this line, but such is the case; the conditions vary so that what may be suitable in one case may not be applicable in another, and with us where the products from irrigation must be sold at best at moderate prices, there is necessity for the greatest economy on the lines mentioned.

Anyone who may think this subject an uninteresting one will find himself agreeably astonished. Running water has a fascination for all.

In 1894 the Dominion Government instituted surveys, gauging of streams and collection of data necessary to ascertain the amount of water available, and those portions of the territories on which it could be best applied, also for the location of sites for the storage of water; this last has a very important bearing, as has also the conservation of forest areas.

The experience of other countries, particularly that of our neighbors to the south, has demonstrated that no time is to be lost in making the reservations for the purpose indicated—as settlement, the construction of roads and railways have naturally occupied the points which are most vital in storage of water, if such is to be stored at the minimum of cost and at the best points. At one point in the Rio Grande, the United States Geological Survey report that the creation of a reservoir at the best point, in fact the only one, will necessitate the reconstruction of a railway, which would involve the outlay of hundreds of thousands of dollars, this might have been obviated without material cost to said railway had the reservation been made before the construction thereof.

Up to the close of the season of 1896 the Canadian Irrigation Surveys had been extended over a considerable area. The complete work comprises 1,296 miles of line levels, 3,811 square miles of contour topographical surveys, and 44 detailed surveys of reservoir sites. In addition to this some 223 miles of location have been completed for proposed irrigation canals, some of which are of considerable magnitude. The question of the water supply available for irrigation in the portion of the territories requiring irrigation has been examined into; 319 gaugings of streams have been completed, and the discharge of a large number of springs, and the volume of numerous lakes measured. The information needed in attacking the many complex problems connected with the flow of or storage of water has necessarily to be of an exact character, and the field work in connection with the irrigation surveys has to be carefully performed, so that in some instances great rapidity is not attainable; however it will be seen from the above statement that good progress in this important work has been made.

There are now in operation in the Territories 157 irrigation canals and ditches supplying water to areas varying from 10 acres to 10,000 acres. The total area under ditch and capable of being irrigated therefrom comprises some 140,000 acres, of which only a portion is as yet being supplied with water, but this portion is being rapidly extended as fast as the land can be prepared to receive the water, and from present indications, and with fair encouragement, the growth of irrigation will undoubtedly be rapid.

Very full reports of what has been accomplished, illustrated with maps, plates and diagrams, have been issued by the Department of the Interior for the years 1894 and 1895, and the one for the past season will shortly be forthcoming, and any member of the association whose interest in this subject is aroused would probably obtain copies thereof by application to the secretary of the Department of the Interior.

The cost of irrigation in the United States has been $8 15 per acre for preparing the land and $12.12 additional. With us the cost will be considerably less.

The district of country which requires irrigation may be described as follows.

Bounded on the south by the international boundary, on the west by the Rocky Mountains, the other boundary being described as follows. Commencing at the intersection of the international boundary by longitude 102° west, thence northwest to latitude 51° 30' north, thence west to the Rocky Mountains, containing about 80,000 square miles or upwards of 50,000,000 acres.

Its elevation on the east averages about 1,600 feet above the sea, and the western boundary of the cultivable district about 4,000 feet.

The duty of water will be high, as there is always considerable rainfall and the subsoil being a heavy clay. It is estimated that with storage facilities, which can be economically constructed, there will be water enough for seven or eight millions of acres.

The problems in connection with the application of water will require the highest statesmanship, so that it may be so distributed that the irrigated portions may be as proportionate y as possible distributed around the non-irrigated portion, so as to make the latter contribute to the maximum extent as pasturage in connection with the irrigated portion.

The best mode of settlement to be adopted in the arid or semi-arid areas, has also to be solved. To utilize this vast area and obtain the best results, is a goal of the highest importance. This area must be devoted largely, if not wholly, to pastoral pursuits, and it is probable that the greatest volume of dairy products attainable on any portion of this continent, possibly within the same area in the world, may be raised in the tract under discussion.

It required considerable persistency on the part of a few who took up and agitated this question, to prevail upon our legislators to provide the legislation necessary for this subject, but in 1894 the country was fortunate enough to have an Irrigation Act placed in our statutes. It is probable in working out this question many defects will be found in same. It is hoped, however, that it will not be so productive of litigation as the Drainage Act has proved in at least one province in Canada. As the defects are discovered, they can, it is anticipated, be remedied by amendments to the said act. With us in the Territories, fortunately, the control of both the water and the land are vested in the same authority; thus we will

*A paper read before the Association of Ontario Land Surveyors.

avoid the great weakness that has been met with, and has proved so fatal to such a large number of irrigation enterprises in the western United States It has also been attempted, and it would seem successfully, to have the administration thereof under strong central control, thereby avoiding the rock which has frequently proved so fatal, viz , disputes and litigation. On no subject, even in connection with rich and valuable mines of the precious metals, has there been so much heart-burning litigation, and in some cases many lives have been sacrificed in disputes arising out of water for irrigation purposes. It would prove much too lengthy to attempt in this to explain fully the provisions of the Irrigation Act, whereby such disputes are thought to be avoided, the making the title to water as secure as to land or any other property, doing justice to the consumer as well as the one who supplies the water, providing a speedy, equitable and non-appealable decision regarding any and all controversies which may arise out of the construction and carrying on of irrigation. None of the very many technical points or problems arising out of this subject have been attempted. It would make it much too lengthy, and had best be left and be taken one by one by any members of this or kindred associations There are dozens of problems which each in itself would justify the production of a paper sufficiently lengthy, interesting and valuable to claim your attention at any one session.

He who makes a hobby of any subject cannot understand why his theme has not the interest to others that it has to himself, and it may be that to many of you this effusion may appear dry and uninteresting (it is at all events not a dry subject). But this promise can be safely given you, that at least 999 out of every thousand who take the trouble to enquire into this subject will be interested, and a goodly percentage will be as great enthusiasts as the writer. This is not a reckless assertion, but one fully borne out by experience If even to a very small percentage of you an interest in this is aroused, the writer will be highly gratified and a thousand fold repaid for the slight trouble taken.

ASSOCIATION CANADIENNE DE SECOURS MUTUELS DES INGENIEURS-MECANICIENS.

The Mechanical Engineers' Society of the Province of Quebec, was formed in 1894. The object of the association is not only to insure for its members benefits in case of sickness or in case of death, but also to give them the technical instruction so necessary in our days These lectures are given semi-monthly by outside specialists, or by members of the union. By an intelligent administration this society, though having paid large sums of money to sick members, has to-day a surplus a good deal more than some older societies The election of its officers for the year 1897 took place on the 20th April, with the following results. President, E F. Valiquet; 1st vice-president, H. Beauchamp, 2nd vice-president M. Guimond, treasurer, W. Gendron, financial secretary, E Leroyer; recording secretary, A. Bélair; assistant recording secretary, Jos Gingras, corresponding secretary, A. Tessier introductor, A. Habig; door-keeper, O. Tontaine; trustees, M. U. Lessard (president), E. Brisbois, A. Provost, J. Langevin, F. Lavigne, N. Depatie, Jos. Verdon, delegates to Central Council, Brisbois, Guimond; examiners, R. Drouin, E. F. Valiquet, H. Denis.

From a photograph by J. A. Dumas.

M. E. F. VALIQUET,

President of the General Association Canadienne de Secours Mutuels des Ingénieurs-Mécaniciens de la Province de Québec.

At a special meeting on the 4th of May, the ex-president, R. Drouin, installed the new officers. There in a short speech President E. F. Valiquet gave Ex-President R. Drouin a well-deserved compliment for his administration, and thanked him for his services to the association. We publish above the portrait of the new president and vice-president.

Mr. Valiquet is an employee of Rutherford & Sons, Attwater ave, Montreal, saw mills, as chief mechanical engineer, for the last five years.

M. HENRI BEAUCHAMP,

1er Vice-Président de l'Association Canadienne de Secours Mutuels des Ingénieurs Mécaniciens de la Province de Québec.

BEFORE THE CANADIAN SOCIETY OF CIVIL ENGINEERS.

The following abstracts of papers were prepared by members of the C.S.C.E., and read at a recent meeting :

Water-Power—Its Generation and Transmission.*

BY SAMUEL WEBBER, CHARLESTOWN, N.H.

The author arrives at the conclusion that it is practically possible to store and secure for power about one-third of the total annual rainfall. This rainfall he reckons at 42 inches as a fair average for the larger part of the United States east of Kansas and Nebraska, amounting therefore to about 3 cubic feet per second per square mile of catchment area. One-third of this or 1 cubic foot per second per square mile of drainage surface is therefore the supply which can usually, by the aid of storage, be relied upon.

A sketch of the evolution of the modern turbine is then given, the credit of inventing the inward and downward combined flow turbine, which is the exemplar of all modern American turbines, being given to A. M. Swain, a mechanic who had been employed at the Lowell machine shops in the construction of the Boyden and Francis wheels. The result of this change from the Founeyvon type is to produce turbines of equal power in one-half the space and at one-fifth the cost.

The first cost of turbine installations is discussed and itemized for several plants, and is shown to vary from $50 to $100 per horse-power. The cost of water power per horse-power per annum is estimated in three instances at $8.04, $10 and $11.05; and is stated to be generally covered by the figure $15 per annum per horse-power.

In the discussion the credit for putting in the first pair of turbines coupled together on a horizontal axis is given to Emile Geyelin, of Philadelphia.

Water Power of Caratunk Falls, Kennebec River, Maine.†

BY SAMUEL M'ELROY, NEW YORK CITY

The river basin is of about 5,917 square miles area, of which 3,800 square miles are forest, and 450 square miles are lakes and ponds, 311 in number. (Moosehead Lake alone has an area of 120 square miles.) Mean summer temperature 61° F. to 67° F., winter do. 19° F. With a large snow fall the thaw of the lower layers maintains the winter stream flow; and in spring the dangerous freshets of milder climates are delayed until the ice is, as a rule, brittle.

The Caratunk falls have large natural pondage above and below the falls, whose cascade has a natural fall of 28 ft.

Annual rainfall 44.5 inches (1839 to 1888), maximum 45".6 (1887), minimum 33".7 (1860).

There was no time to make a continuous gauge of the river; but from experience on this and other rivers a safe present plant outlay for 5,000 horse-power was determined upon.

The lowest permissible flow is discussed for various rivers, special reference being made to the lessons to be learnt from the Lowell and Lawrence water powers. The rainfall for 50 years of the Kennebec basin is analyzed, and the conclusion is arrived at that the fall is good now for 5,000 horse-power, as above, and has a great prospective value as the timber supply diminishes, and allows the Moosehead Lake, now impounded for logging purposes, to become available for maintaining an equable flow in the summer.

The cost of dam, flume, head-gates, wheel pit, etc., was in this case $15 per horse-power for the 3,500-h.p. actually provided on the

*Trans. Am. Soc. Mech Eng., Vol. XVII., p. 41.
†Am Soc. Mech. Eng., Vol. XVII., 1896, p. 58.

west side; cost of wheels for 3,000-h.p. about $9, or $24 in all. The fixed charges on this the author reckons at $5.24 per h.p. per annum.

For comparison the cost of a 3,000 horse-power steam plant in this pulp-mill (where no exhaust steam is used for other purposes) is calculated, and found to be $52.17 per h.p. per annum. (Coal $6 per ton.)

Reference is made to the commercial value of a water-power; that at Lowell with a 4,085 square mile basin being valued at $2,787,200; and at Lawrence with an area of 4,553 square miles, at $2,866,720.

Hundreds of feet of floating light wood frames are used in Maine in the races above the mills to promote ice formation, and prevent the production of anchor ice. At Caratunk the reach above the dam freezes for two miles up stream, with blue ice 24 inches thick, which effectually prevents the anchor ice from getting to the falls.

In the discussion Mr W S Aldrich discusses curves of combined turbine and dynamo efficiency for various loads.

The Underpinning of Heavy Buildings.*

BY JULES BRENCHAUD.

The writer refers to the great difficulties experienced in preventing injury, by settlement of heavy buildings, when it is necessary to excavate and build on the immediate adjacent building site.

The specific case treated is of a building which was to be carried 30 feet (2 stories) below the street level, over half of which had to be made water-tight, as it was below water level. The total depth of foundation being 45 to 50 feet below the sidewalk, these foundations consisted of close-fitting rectangular pneumatic caissons all around the exterior of the new building site and cylindrical intermediate ones for columns.

As every square foot of the property had to be built upon, the problem was to pin the adjacent buildings up during caisson sinking and construction periods. This was accomplished by placing vertical cylindrical iron columns in slits in the walls, extending from the foundation upwards. These were founded at the bottom on rock or very hard hard-pan, and at their tops the bearings were spread out by transverse horizontal slits in the walls, in which were placed nests of I beams on top of the columns.

The cylindrical columns were 10" to 30" in dia., the smaller ones being forced down by a 60-ton hydraulic jack, in sections 5 feet long, at a time, to proper bearing; some also were partially sunk by water jet. The larger ones under the heavier building were sunk by compressed air, as neither the water jet nor jack would force them through a layer of hard-pan to the rock.

The larger columns were first made of cast iron, but after one becoming injured by forcing past a boulder, the rest were made of riveted steel sections.

These columns were filled, after sinking, with Portland cement concrete.

The writer then details several similar cases where the application has been successful, and concludes by stating that while this method is not (evidently) of universal application, it will be found the best means of transferring the load of an adjacent building to a lower foundation with a minimum of obstruction to the building site about to be used, also that as these underpinnings are left in place, there is no danger of that slight subsidence which takes place when other kinds of temporary underpinning are removed.

[This method is evidently expensive, and only applicable when the bearing soil is poor, *e.g.*, quicksand—and the necessity imperative, when necessary it would appear to be a very admirable one.]

Methods and Results of Stadia Surveying.

BY F. B. MALTBY.†

For good results from stadia surveying, both good workmanship and good equipment are necessary. The writer recommends for use a transit-theodolite having the same graduation on vertical and horizontal circles (preferably reading to 20"), with a telescope magnifying to not less than 30 diameters. Field of the telescope to be flat and as large as possible. Vernier of the vertical circle to be swung from the horizontal axis of the instrument, and to be provided with a good level, to keep its zero in position independent of the plate levels. Such instruments are not at present in common use. Rods to be of well seasoned white pine 5 inches wide, 12 feet long and ⅝ inch thick, shod with strap iron at each end, straps having hole in them to place over station nail. Rod to be well pointed, graduated symmetrically, and preferably after the pattern used by the Mississippi River Commission. The length of the rod divisions may be determined by trial so as to correspond with the wire interval of the instrument, or may be laid off to some standard of length. The last is perhaps preferable, as the average stadia constant can be determined with great accuracy by running over long lines under all conditions of weather and exposure, the exact length of such lines being previously determined by triangulation. Value of the stadia constant varies in practice according to description of work to be done. Usually it is from 100 to 125; with such constant the graduations on the rod should be meters or yards and tenths rather than feet, 3½ to 4 inches being the minimum graduation spot desirable in ordinary practice.

Party should consist of topographer, recorder, and as many rodmen and axemen as circumstances call for. Topographer can average 500 points observed in a day, and it is true economy to work the topographer and recorder up to their full capacity by supplying them with all the rodmen and axemen that they can keep busy. Topographical surveying is to define general features rather than precise points as land monuments, and care should be taken that the area covered should be taken in equal detail in all parts. To secure this, the writer advises the use of a small plotting board about 15" x 20", upon which a continuous plotting of the stations can be carried on to small scale as they are occupied, and the fact that all the area has been fully covered can be graphically demonstrated. The sheets are made to overlap in the usual manner, and are of great assistance in the final plotting. For reducing the observations, the Colby slide rule is recommended, and three reductions per minute are instanced as easily as possible with this apparatus.

The line of occupied stations is plotted by lat. and dep., or by distances and bearings from a printed circle on the paper. The latter is quicker but not so accurate as the former. For plotting the intermediate and side readings the Colby protractor is particularly recommended. About 3½ points plotted per minute is given as average work for two men.

Statements of the final errors of many stadia run lines are given, and the writer's opinion is given that a discrepancy of not more than 1 in 1,500 can be obtained in average work, and that this is considerably more accurate than ordinary chaining. Levels when the instrument is equipped with a level on the vernier arm of the vertical circle can be carried for all distances within 0.50 feet.

The cost of surveys made by stadia varies very greatly, and a few examples are given:—

City of Baltimore topographical work (including buildings, streets, alleys), etc., $1.50 per acre, 200 feet to 1 inch. City of St. Louis topography 73 cents per acre, 200 feet to 1 inch. Mississippi River Commission, 1,000 feet to 1 inch, including 5 feet contours, buildings, roads, fences, etc., 1891, $36 per square mile. Missouri River Commission, 1895, $31 per square mile; minor instances from 20 to 50 cts. per acre. In the discussion it is stated that the inaccuracies of stadia work are less than those due to plotting and expansion of paper under varying conditions, that attempts at minute accuracy only add to the difficulties and expense of the work, and that the best use is made of the method when the work is carried on, without regard to the optic conditions of the atmosphere, and reduced by a constant obtained by stadia measurements of triangulation lines.

The Liverpool Waterworks.*

G. F. DEACON, M. INST. C. E.

The Liverpool new water supply is taken from the Vyrnwy River in Wales, and the aqueduct connecting Liverpool with the reservoir is about 76 miles long. It includes 4 tunnels, 6 railway crossings, 13 river crossings, and 6 canal crossings, the latter including the Manchester ship canal. These crossings are in most cases subways, though in some cases the aqueduct was carried overhead.

Lake Vyrnwy is said to be the largest artificial reservoir in Europe, its area being 1,121 acres, and its capacity 12,131 millions of gallons below sill of dam and above outlet to the aqueduct. The author states that the dam for impounding this lake is the first high masonry dam used in Great Britain, its extreme height from overflow to base of foundation being 144 feet. A carriage and footway 19 feet wide is carried along the crest of dam on masonry arches. The author states a novel feature of this dam is the employment of relief drains from the foundations emptying into a tunnel in the heart of the dam. The idea of these drains was to prevent the development of pressure due to invisible springs, which it was thought, when the reservoir was full, might accumulate to such an extent under the foundations as to be of importance as one of the forces to be considered having a tendency to overturn the dam.

To quote the author's words: "Along the base of each of the more important beds of rock, not within 15 feet of the faces of the

*Proc Am. Soc. C. E., Vol. XXII., Dec., 1896.

†Journal Assn. of Eng. Societies, Sept., 1896.

*Proceedings of the Inst. C. E., Vol. CXXVI.

dam, a drain was formed by the masonry between six inches and nine inches square, and from these drains funnels were carried up, in different vertical transverse planes of the dam, to above backwater level." There are 27 of these funnels in a length of 66 feet of the deepest part of the dam, which empty into a longitudinal tunnel 4 feet 3 inches by 2 feet 6 inches, from which a cross tunnel to face of dam serves as an outlet and for access to main tunnel.

The tunnel under the River Mersey was one of the most difficult parts of the work, and the author states was the first tunnel ever constructed by means of a shield, under a tidal or other river, through entirely loose material. This tunnel had a cast iron lining of nine feet interior diam., and it was driven through loose water bearing strata 51 feet below high water. Inside the tunnel was laid the aqueduct, consisting of two 32 in. diam pipes, of riveted steel plates. The author says the site for this tunnel was favorable for laying the pipes in the muddy bed of the river, but that parliamentary exigencies forced upon the corporation the construction of the tunnel, for which the site was the worst possible.

These water works were begun in July, 1881, finished July, 1892. The total cost has been about £2,300,000 for a supply of 14,000,000 gallons per diem, but the author claims it can be increased to about 40,000,000 gallons per diem for additional cost of £1,600,000.

Electric Flashes.

W. B. CLOSE is now manager of the Toronto Suburban Street Railway Company, Toronto Junction.

THE new Victoria Bridge will carry the wires which will bring electric power from Chambly to Montreal.

E. SLADE has gone into the electrical supply business, in Quebec, and will handle chiefly lighting fixtures.

IN Quebec the Lower Town Street Railway Company has sold its franchise to the new electric company for $20,000.

WORK is to be hurried on the Quebec street railway. An opening on the 22nd is what the management is working for.

THE Brantford Electric and Power Co. is now running its new turbines, which are capable of developing 600 horse-power each.

NIAGARA FALLS SOUTH, ONT., has granted a franchise to the Lundy's Lane Electric Railway to run over certain streets of the town.

THE agitation for an electric railway to connect St. Catharines and Beamsville, Ont., is going on, and there are prospects of success.

A. O. GRAYDON, C.E., city engineer, London, Ont., is one of the provisional directors of the Chatham City and Suburban Railway.

WM. SNIDER & Co., Waterloo, Ont., electric light, have commenced building their engine room. A 75 h.p. Corliss engine will run the dynamos.

IT is proposed to extend the London, Ont., Street Railway beyond the asylum for the Insane to Pottersburg, and also to connect the city with the town of Lucan.

A CORRESPONDENT of the St. Johns, Que., *News* says that the proposition for an electric railway from Montreal running through the Eastern Townships to Sherbrooke, is not taken seriously by the township people.

COATES, SON & Co., bankers, London, Eng., recently placed an issue of £50,000 of the Montreal Royal Electric Company's shares, there being more offers than were applied for in the company's circular. The issue price was 140.

THE Aylmer Electric and Manufacturing Company, Ltd., applies for an Ontario charter to supply heat, light and power by steam and electricity in Aylmer, Ont.; capital, $20,000; the incorporators are H. H. McDiarmid, D. C. Davis, J. Simpson, Aylmer; J. W. Campbell, W. H. Irving, Toronto.

IT is probable that Hamilton, Ont., will appoint an electrical engineer as assistant to the city engineer, owing to the increasing share of the engineer's duties which have to do with that subject. G. Black, Hamilton, is favorably mentioned for the position.

F. E. HARVEY, doing business as the Citizens' Telephone Exchange, with office at Waterloo, Que., has assigned. The assets are placed at $11,000 to $12,000, and the liabilities at $6,000 to $7,000. The principal creditors are: C. E. Harvey, Waterloo, $2,600; E. T. Bank, $1,000; John Bradford, Granby, $1,000; W. N. Call, Waterloo, $850. C. E. Harvey is curator.

A TELEPHONE cable has been laid across the inlet between Moodyville and Vancouver, B.C., by the New Westminster and Burrard Inlet Telephone Company, under the supervision of H. W. Kent.

HODGKINS & HOSHAL are building a factory, 40 x 60 feet, for the American Carborundum Co., Niagara Falls, Ont., in which the company will begin the manufacture of its product by June 15th, in order to hold its charter. Sufficient power to carry on work on a small scale has been obtained from the electric light company.

THE Consolidated Railway Company's systems in Victoria, Vancouver and New Westminster, B.C., are now owned and operated by a new company formed for the purpose of acquiring them in London, England. The new company, which is called the British Columbia Electric Railways Company, Limited, took possession on the 15th of April and are making a number of improvements.

JUDGMENT has been given in the first of the trials arising out of the tramway disaster at the Pointe Ellice bridge, Victoria, B.C., May, 1896, the jury deciding that the city was liable for the disaster. The plaintiff, Mrs. Gordon, whose husband was killed, was awarded $10,000 damages, $7,000 to herself, $1,000 to the eldest son, $1,500 to the youngest child, and $500 to a step-son. A number of other suits will follow.

THE longest electrical transmission plant in the Dominion of Canada was put in operation a few days ago near Three Rivers, Que. This plant was installed by the Royal Electric Company of Montreal, for the North Shore Power Co., and transmits 700 h.p. from Grand Chute, on the Batiscan River, a distance of 17 miles, to the city of Three Rivers, Que., where the power is used for arc and incandescent lighting, as well as for power. S.K.C. two-phase apparatus is used throughout. A full description of this long distance high voltage plant will be published very shortly.

THE Hamilton *Times* says recently of the Cataract Power Co., of Hamilton, Ont.: A company has been formed to take Lake Erie water from the new Welland Canal at Allanburgh and from the Chippewa River at Port Robinson, and turn it into Lake Ontario via DeCew's Falls, utilizing the water power of the falls to generate electricity, which will be conveyed to Hamilton to pump Lake Ontario water into the city, to run our street and suburban railways, to light the streets and to move the machinery in the factories. J. Patterson expects that he will have 5,000 horse-power available four months hence, and 50,000 to 60,000 horse-power at a later date.

THE Toronto Street Railway Co. is celebrating the Queen's Jubilee, putting on the road 20 handsome open cars, to be known as "The Jubilee Set." Each car is 27 feet long, and 7 feet 6 inches wide, 6 feet longer than the present open cars. The extra length will allow a space of four inches more between the seats, adding greatly to the passengers' comfort. The cars are painted white and gold, carry bicycle racks on the back, and have double steps at the sides. The latest style of motor made by the Canadian General Electric Co. is used, and each car will seat 70 passengers. Manager Wanklyn and Superintendent Gunn maintain that the "Jubilee Set" are the finest open cars on the continent.

THE Sherbrooke Gas and Water Co., Sherbrooke, Que., has recently made extensive additions and alterations in its plant; the station has been enlarged, and there have also been installed two additional water wheels. The electrical plant has been increased by one 180 K.W. and one 75 K.W., "S.K.C." two-phase generators, in addition to the 75 K.W., S.K.C. two-phase generator which was purchased about a year ago from the Royal Electric Company, and which makes the plant one of the most complete incandescent plants in the Dominion. The management of the company has installed a power circuit from the alternating two-phase apparatus, and are now serving power and light successfully from the same generators and lines.

THE Packard Electric Co., Ltd., St. Catharines, Ont., has recently placed upon the market its type "L" transformers. These transformers are claimed to be unique in design, and their efficiency at all loads is guaranteed by the makers to be greater than that of any other. The Packard Co. will, at the request of any central station, conduct tests for core loss, copper losses, regulation and insulation, of their type "L" transformers in competition with those of any other make. It also guarantees these transformers not to increase over 40° in temperature after running full load for eight hours. The all day efficiency is very high. One unique feature of these transformers, which will appeal to the central station and their line men, is that they require but one cross-arm upon the pole, and do not require any separate hangers; the arrangement for hanging being permanently attached to the transformer.

ELECTRICITY is to be used for pumping water for irrigation purposes at Korachien, Egypt.

THE electric light by-law, recently voted on in Chatham, Ont., was defeated by a majority in all the five wards of the town.

THE Cataract Power Co., Hamilton, Ont., has received permission from the city council to erect poles. The city will collect $1.00 per pole from the company.

THE Rogers Electric Co., of London, Ont., are installing a 200-light plant in D. S Perrin & Co's biscuit works in that city. The Goldie & McCulloch Co. of Galt are supplying the engine.

LA Compagnie Electrique de Saint Etienne de la Malbaie applies for a Quebec charter, with a total capital stock of $5,000, headquarters in the parish of St. Etienne de la Malbaie: to exercise the industry of electricity in all its branches. The incorporators are as follows J. Warren, Pointe au Pic; H. Simard, P. Maltais, A Larouche, J Couturier, A Guay, La Malbaie.

ACHILLE GAGNON & Co., Victoriaville, Que., who began in December last furnishing incandescent light to the towns of Victoriaville and Arthabaskaville, have found it necessary to increase their plant owing to the rapid increase in their lighting. They have ordered a 75 K.W., "S.K.C." two-phase alternator from the Royal Electric Company, Montreal, as it is their intention to furnish power as well as light from the same generator and circuit. Their first installation was single phase alternating, but finding that they could also secure some power business during the day, they decided to operate their plant 24 hours per day, and for this purpose secured an "S K C" two-phase machine, from which they serve both lights and power.

THE Boiler Inspection and Insurance Company announces that its special service department has arranged to extend the advantages of competent and periodical inspection to electrical dynamos and motors. The services of a competent electrical engineer, R. A. Ross, have been secured as consulting engineer, and skilled inspectors will make careful and periodical inspections, and do whatever is necessary in order to keep the motor or dynamo in proper running order. The chief advantages to motor and dynamo users in such an arrangement are, that the risk of having the power supply stopped is greatly lessened through the frequency of inspection, and the annual cost of maintenance being a fixed amount can be better provided for.

THE Quebec Court of Appeal has given judgment in the case of the Bell Telephone Company vs. the Montreal Street Railway Company. The appeal was from a decision rendered by Judge Davidson dismissing plaintiffs' action for $27,626.07, damages alleged to have been suffered on account of defendants building and operating an electric railway on the streets of Montreal. The first proceedings of the case were instituted by plaintiffs in January, 1894. It was maintained by plaintiffs that the current from defendants' wires had seriously injured many of the plaintiffs' telephone wires; that on account of the influence of defendants' wires plaintiffs had been compelled to construct costly return ground wires; that the defendants had not the proper authorization from the city council for operating its system now in vogue; that the damage to plaintiffs' wires could have been obviated by defendants using a double instead of a single trolley system; that for these and other causes plaintiffs should be awarded the sum claimed. In answer to these allegations defendants produced proof to show that the Street Railway Company had been given license to operate an electric railway on the streets of the city; that if plaintiffs had expended money on improving the telephone system defendants should not be held responsible for it; that the city council had the power to authorize an electric system to be operated on the streets of the city without first consulting plaintiffs; that said city council had in its contract with defendants specified that the electric system used by the street railway was the same as now in vogue; and that in consequence defendants were in no wise responsible if plaintiffs had suffered loss by its operation; that the streets of the city were as free for defendants to use as for plaintiffs. Sir Alexander Lacoste rendered judgment on the appeal, dismissing it with costs, upholding the judgment of Judge Davidson. The learned judge, after going exhaustively into the facts of the case, decided that the city council acted legally when it authorized electricity to be used by the Montreal Street Railway Company as a motive power; that they had power to sanction the system now used by defendants being operated in the city; and that, finally, the streets not being the private property of the Bell Telephone Company, it could not assume control of them and sue for damages; for these, and other reasons, the judgment rendered in the Superior Court was upheld and the appeal dismissed with costs.

Mining Matters.

OIL was struck last month at the Parkhill, Ont., Mineral Oil Syndicate's test well on S. Atmore's farm.

GOLD has been reported from several new locations in Simcoe county, Ontario

ANTHRAXOLITE is reported from Gooderham, Ont., near Lindsay. The deposit is said to be extensive.

FROM Kamloops, B.C., come reports of very rich mines situated in a fine grazing country, and within a few miles of the C.P.R.

THE General Mining Association, Ltd., Sydney Mines, N.S., has ordered two Lancashire boilers from I. Matheson & Co., New Glasgow.

ASBESTOS which is said to be a particularly fine quality is said to have been discovered by W. Bannister and Jno. Rutherford, on Fish Creek, 25 miles from Calgary, N.W.T.

AS knowledge of the mid-east-Ontario mineral region increases, the gold-bearing area grows in size. It is now shown to extend north as well as east and west from Hastings county.

CLOSE to the Fire Mountain prospect near Harrison Lake, B C, another claim has been opened up, the principal owner of which is J Leckie, Vancouver. One assay ran $300 in gold.

FREE gold has been found, it is said, in the Black Bear. The lower workings of Le Roi show considerable free gold, and it is regarded as possible that it may develop into free milling mines.

ENGLISH experts who have been inspecting the large iron deposits in the vicinity of Conception Bay, Newfoundland—deposits more than 14 miles long—report favorably on the quality of the ore.

IT is now stated that the Deloro mispickel mines in Hastings County, Ont., are turning out $1,000 a day in gold. The company has, besides its regular staff, three gangs of prospectors hunting for fresh leads.

GOLD has been discovered at Jay's River Road, three miles from Milford, N.S. The lead is said to be over 100 feet wide, and consists of porphyry and pyrites, sprinkled with gold and galena. It assayed $24 to the ton.

GEORGE W. PIERCE and F. H. Lippett, part owners of the Colorado Ore Sampling Works, of Denver, Col., were recently in Slocan, B.C., looking for a site for ore sampling works to be established in that region.

THE first International Gold Mining Convention will convene in Denver July 7th, 1897, and continue in session during the 8th and 9th. This is the first step towards uniting the interests of those taking part in this most important industry.

ACCORDING to the Coldwater, Ont., *Planet*, Benjamin Dempsey and John Yates, of Midland, Ont., were in and around Coldwater and icinity recently, taking the heights of land and examining the ground, and have discovered oil in the neighborhood.

CHARLES R. MAY, of the Easton & Anderson Company, London, Eng., manufacturers of mining machinery, has been in the Marmora district recently superintending the erection and starting of a new ore crusher on the property of the Gold Fields Company.

DREDGING for gold is to be carried on extensively on the Saskatchewan this season. Six mining scows have been built at Walter & Humberstone's yard, Edmonton, this spring. All but one will use steam machinery. It is reported that work will start on three others shortly.

THE famous "Paris Belle" case will go to the Imperial Privy Council. This is the Nelson and Fort Sheppard Railway Co. vs. Jerry *et al.*, in which the railway claims under its Crown grant against the miners' claim. The property in dispute is situated in the town of Rossland, and is very valuable.

AN employee of the Canadian Gold Fields Company has discovered a very fine vein of gold-bearing quartz on the company's property in Marmora, and F. Landenberger, of Belleville, Ont., says that he has struck a rich vein 9 feet wide, of free-milling gold-bearing quartz on his property in the township of Gwinsthorpe.

SIR HENRI JOLY DE LOTBINIERE recently published a letter from the secretary of the B. P. Gold Property Co., Ltd., which offered him 20,000 fully paid-up shares in the company for the use of his name as a director. Such schemes are worked every hour of the day How is it that Sir Henri's exposure is the only one made as yet? It is in the public interest to publish such matters. Sir Henri's reply was: "If I had the remotest idea of taking any shares in your company, the offer you make me by yours of twenty-second instant would be sufficient to prevent me."

THE announcement comes that gold has been found in paying quantities in Lavant township, Lanark county, Ont., on the farm now occupied by John Ferguson. Late last fall Barry & O'Brien, Renfrew, interested themselves in the find, and sunk a shaft to the depth of seventy-five feet. Samples were assayed and are reported to have given an excellent yield.—*Lanark Era.*

THE Ottawa Mining and Milling Company, of which the Hon. G. E. Foster and Messrs. Levi Crannell, A. W. Fraser, Geo. Hay, Hiram Robinson, John Coates, Charles Magee, E. Seybold, and J. Mather, are the leading stockholders, will, it is said, erect a customs stamp mill for gold ores on the Dick and Banning water power, about four miles from Rat Portage, Ont.

THAT the man who buys shares does not always buy a mine is well known, but it remained to be established that you might buy a mine and still have nothing, as below from an exchange: "The Orphan Boy, in the Big Bend country, considered a very valuable free milling proposition, with a large amount of ore on the dump, was sold under the hammer for $6,300 to satisfy the judgment of its manager, Mr. Haskins."

THERE is some great tunnel work being done just now on the Iron Colt, says the Rossland, B.C., *Miner*. The Iron Colt had made a contract with the Alberta company for the use of their tunnel, which is 350 feet long, not 300 as first stated, and starting at the end of this, with a depth of 160 feet, the Iron Colt tunnel will run 300 feet to connect with the shaft and pierce the ledge at a depth of 350 feet. Mr. Heacock, who ran the Alberta tunnel, has been engaged by the Iron Colt company to take charge of this work. The work is being done with a Rand giant drill—the largest drill ever brought into camp. Its cylinder is 3¼ inches [illegible], and with 90 pounds of compressed air it makes 300 strokes per minute, carrying 800 pounds with each stroke. It easily drills 18 inches in five minutes, a wonderful performance in the hard rock of this camp.

THE Government has determined on a vigorous administrative policy in the Yukon country. Thomas Faucett, Dominion Topographical Surveyor, has been appointed the first regular gold commissioner in that country, and with a staff of assistants, numbering seven, has started for the field. The party goes direct to Dawson City, at the junction of the Klondyke with the Yukon, and their time of duty extends over a period of two years. The duties of gold commissioner have until now been performed by Inspector Constantine, who is in charge of the North-West Mounted Police, but they have of late become so heavy that the departments, of necessity, had to be separated. To carry out the work as at present proposed it is believed the mining laws will have to be amended. William Ogilvie of the Department of the Interior will start for home when Mr. Faucett arrives at his destination, but other eastern officials will be sent out to engage in other departmental work. Among these will be a few surveyors, whom the government proposes sending to make a survey of the feasible waterways into the country.

Railway Matters.

THE trackmen on the C.P.R. have recently received an advance of ten cents per day in wages.

THE G.T.R. shops at Brantford, Ont., are working more hours per week at present than has been the case for many years.

DIVISION Engineer Chapman, of the G.T.R. at Allandale, Ont., recently examined the site of the proposed new elevator at Midland, Ont.

R. MARPOLE has been appointed general superintendent of the Pacific Division of the C. P. R., in place of H. Abbott, who has resigned.

S. SECOMBE, G.T.R. car foreman at Montreal, has been ordered to London, Ont., to assume one of the foremanships in the car shops there.

A LOCOMOTIVE exploded in the Intercolonial round-house at Richmond, N.S., May 14th, and the building was wrecked and the railway tracks torn up.

THE G.T.R. will double track its line between Montreal and Richmond, Que., at once, in preparation for the increased traffic consequent upon the rebuilding of the Victoria bridge.

IT is reported that acetylene gas is to be tried for lighting purposes in carriages on the London (Eng.) and North-Western Railway; it has already been experimented on with satisfactory results.

BIDS are asked until June 15 for the purchase of first mortgage bonds, amounting to $1,497,324, and 10,640 shares of the capital stock, amounting to $1,064,000, of the Port Arthur, Duluth and Western. Toronto General Trusts Co. are the agents.

THE work on the new buildings at the harbor terminus of the Ontario, Arnprior and Parry Sound Railway is progressing rapidly. The company is building two large docks, some twelve hundred feet each in length, and a cross dock for coal.

THE office of assistant general manager of the C.P.R. has been abolished, and Thomas Tait has been appointed manager of the company's lines east of Fort William, office at Montreal, and William Whyte has been appointed manager of the lines west of Fort William, office at Winnipeg.

A BILL respecting the Canada Atlantic Railway Company has been approved, providing that the company may extend its line from the present terminus at Lacolle, St. John county, Que., to points on the northeasterly boundaries of the States of New York and Vermont, crossing the River Richelieu by a bridge at Lacolle. Five years are given for the completion of this work, and the company is authorized to issue bonds to the extent of $25,000 per mile.

IT is announced that Malcolm & Ross, railway contractors, have secured the charter of the Restigouche and Western Railway, a line projected to connect with the Baie des Chaleurs Road at Campbellton, N.B., and run to St. Leonards on the St. John River, a distance of 110 miles. At Van Buren, Me., just across the river from St. Leonards, the new line will connect with the Bangor and Aroostook Railroad.

MUCH comment is made upon the British Columbia Government's plan for bonusing the Cassiar railway. The Cassiar country is to a certain extent like the Yukon, a rich gold country of immense area, but difficult of access, and dependent upon the coast for supplies for the miners. The application for this railway has been made by Warburton Pike, the great hunter. The Government promises to lease for 50 years to the company blocks of land not to exceed 10,240 acres per mile for each mile of road built. For this the railway must pay one and one-half per cent. royalty on all precious metals taken out, $50 a year for each claim taken up, $100 a year for every transfer of a claim, 50 cents per thousand for milling timber cut, and 25 cents per cord on cordwood, and 5 cents a ton royalty on any coal mined. These railway lands during the term of the lease are open to entry by free miners who, however, must give the company a half interest in any mine they stake out.

Industrial Notes.

CALGARY, N.W.T., recently voted $3,000 to replace the Elbow bridge.

CANADA MILK CONDENSING Co., Antigonish, N.S., has been incorporated.

THE Mac Machine Co., Ltd., Trail, B.C., is building a foundry 40 x 50 feet.

A DAM and bridge were carried away by a flood at Ile Verte, Que., recently.

A NEW Methodist church to cost $12,000 is to be erected at Renfrew, Ont.

THE Matane, Que., River bridge was carried off by a freshet a short time ago.

E. CANNIFF, of Winnipeg, has perfected a machine for preventing prairie fires.

THE Whitelaw Trading Co. is establishing a central butter factory at Brandon, Man

THE capital of the Prescott, Ont., Elevator Co., Ltd., has been increased from $175,000 to $300,000.

CITY ENGINEER MURDOCK, of St. John, N.B., recommends the installation of an additional high level pumping plant at Silver Falls.

SENATOR SNOWBALL'S saw mill at Chatham, N.B., has been thoroughly overhauled and new machinery added at a cost of $10,000.

BARBER & WATSON, iron founders and manufacturers of water wheels, Meaford, Ont., have dissolved partnership. C. Barber continues the business.

JOSEPH ROGERS' new sawmill at 16 Island Lake, Montfort, Que., is nearly built. It is to have a complete modern equipment and is expected to be running in about four or five weeks. Mr. Rogers is the pioneer settler of this vast lumbering district.

GEO. VICK & SONS, Orillia, Ont., will rebuild their flour mill at once.

CLARK & UTLEY, of Salmo, B.C., are building the bridge across the Salmon River.

SAULT STE MARIE Ont is agitating for a sewage system to cost at first about $40 000.

THE Wire Fence Manufacturing Co., St John, N B., is shipping its product to the East Indies.

M ROBSON Ayr, Ont., will build an elevator at once to take the place of the one recently burned

THE stand pipe of the Deseronto waterworks was completed last month by A. Davis, engineer, Montreal.

THE moulders in the McClary Manufacturing Co's stove-works are fully employed after a five weeks lay-off

THE bridge across the Bastican river at Price's Mills, St. Stanislas, Que., was carried away by a freshet recently.

TENDERS have been let for enlarging and improving St. James' church, South London, Ont., at a cost of about $6,000.

ROUELLE & HALLACK, late of Seattle, under the style of Robson Milling Co., will establish a sawmill near Robson, B.C.

A CONTRACT for a new public school on Albion street, to cost $14,500, has just been let to Schultz Bros. of Brantford, Ont.

BRANTFORD, ONT., is trying to secure a furniture manufacturing firm to occupy the Bain wagon works building in that city.

THE Maria Pulp and Timber Company, Maria, Quebec, on the north of Bay Chaleur, expect to begin work the 1st of June.

THE by law granting a bonus of $6,000 to the Bowmanville Rubber Manufacturing Company was carried by a large majority, May 22nd.

WILLIS CHIPMAN, C.E., Toronto, and Col. T. H Tracey, C.E., of Vancouver, have been asked to estimate on a sewage system for Rossland, B.C.

THE McEachren Heating Co has decided to build a new pattern shop. It will be added to the old Cant foundry building that the firm recently purchased.

PLANS have been invited by the New Brunswick Government for a new bridge across the Big river at Bathurst, N.B., to be of steel, with stone buttresses

IT is estimated by J. A. U. Beaudry, C.E., that the cost of improving the Sherbrooke, Que., water works, if the city should take control of them, would be $80,000

LEATHER & WATSON, steel and iron merchants and agents for railway equipment, Hamilton, have removed to their handsome new offices at the corner of King and James streets.

THE pipe foundry of J. & C. Hodgson, near Montreal, is to be opened soon. The factory has been closed during the last four years, owing to the duty on their raw material being too high.

MYER & WHITE, gas and gasoline engine manufacturers, Auburn, Indiana, have written the Mayor of Hamilton, Ont., with reference to the establishment of a branch of their industry there.

THE MacGregor-Gourlay Co., Limited, Galt, Ont., is now turning out the semi-automatic bicycle hub machines, and recently shipped one to the Welland Vale Bicycle Co., St. Catharines, Ont.

IT is said that Mr. Windler, of New York, has bought lands on the Saguenay river, Que., from Terres Rompers to Caron's Falls near the mouth of Riviere aux Sables, and will build a pulp factory there.

THE Carnegie Steel Co. has closed one of the largest contracts it ever made. It is for 18,000 tons of steel to be used in the construction of the new bridge, to replace the Victoria tubular bridge at Montreal.

THE property and plant of the Lunenburg Iron Co., Ltd., were sold recently to G. N. C. Hawkins, acting for the People's Bank, for $4,000 It is expected that the company will resume business shortly.

THE John Watson Mfg. Co., Ltd., Ayr, Ont., capital $75,000, will manufacture agricultural implements, etc. The incorporators are: J. Watson, sr., J. D Watson, W. D. Watson, A. E. Watson, E. D. Watson, Ayr, Ont.

A NEW acetylene gas machine, the invention of James G. Kerr, a young Canadian of Niagara Falls, Ont., is now claiming attention. It is claimed the invention permits of replenishing the supply of calcium carbide, from which the acetylene gas is generated, without allowing any of the gas in the machine to escape, or in any way interfering with its working. The spent carbide is also removed at the same time, the whole operation occupying less than two minutes time, and is done without soiling the hands.

THE Irondale, Bancroft and Ontario Railway bridge over Baptiste Lake was wrecked not long ago. The bridge is 1,922 feet in length, with pile approaches at either end, the centre spans being upheld by wooden piers.

WILLIAM JESSOP & SONS, the well known steel manufacturers of Sheffield, contemplate having a permanent branch in Toronto, and will erect a new warehouse this year if a suitable building cannot be obtained ready to hand.

ALBERT E REED, a large paper manufacturer of England, has purchased the Masterman sulphite pulp mill, on the Miramichi river N B He proposes to enlarge the capacity of the mill, so as to bring its product up to 30 tons per day.

THE Minister of Public Works has decided to at once proceed with the construction of a fireproof roof for the Western Block of the Ottawa Parliament Buildings, to be built of terra cotta and iron The work will be done by day labor.

THE St Raymond Company, of St Raymond, Que., is seeking incorporation, to carry on business as pulp manufacturers. The promoters are J Macfarlane, F. W Evarts, W Drake, G. F. O'Halleran and E H. Barber, and the capital stock $50,000.

CARLETON PLACE, ONT., will probably buy a hook and ladder truck with chemical engines, as at present the town has only one steam fire engine, and the underwriters have notified the council that the rating will be changed if better fire protection is not afforded.

PROFESSOR C. H McLEOD, superintendent of McGill College Observatory, has reported to the Department of Marine that finally the longitude of Montreal has been determined. The difference between the true latitude of Montreal and that previously stated is about eight feet.

THE George White & Sons Co., Ltd., of London, Ont., will be incorporated to carry on the machinery manufacturing business of Geo. White & Sons. Capital, $170,000. The incorporators are: G. White, H. B. White, H. J. White, W. White, F. J. White, E. A. White, London, Ont!

ENGINEER BUCK, who superintended the drawing of the plans and construction of the new arch bridge at Niagara Falls, is now in the employ of the Upper Suspension Bridge Company, preparing plans for a new bridge of similar construction. The new bridge will be over 1,200 feet long.

THE authorities of the Methodist Church at Aurora, Ont., are among the first to adopt the acetylene gas for church illumination. They have placed an order for a 50-light plant with the Niagara Falls Acetylene Gas Machine Co., and the church will soon be lighted with the new illuminant.

THE firm of Schlistig Bros., Brooklyn, N.Y., has had a representative in Toronto lately looking into the prospects of establishing a glue and button factory in Canada. They have practically decided to establish such a factory, costing $500,000, and employing between 200 and 300 hands.

G. W. YARKER, on behalf of the Duryea Motor Wagon Co., New York, has obtained permission from the Dominion Government to import free of duty, into Canada, a sample motor delivery wagon for three months, but not to be used for hire. The wagon company is looking for a manufacturing site in Canada.

THE G.T.R. foundry at Hamilton, Ont., is to be operated in future by a private company, which will make all the car wheels for the G.T.R. in Canada. Messrs. Griffin, of St. Thomas, Ont., and Drummond, of Montreal, are the chief proprietors of the new company. The iron used will be from the Radnor, Que., forges.

J. A. & W. B. HONEYMAN, owners of the Union Iron Works and the City Foundry of Portland, Ore., have decided to erect a foundry and machinery shops in Nelson, B.C. They will make iron and brass castings, manufacture boilers, mining and steamboat machinery, and do general machine manufacturing and repairing.

THE Richmond Industrial Company has abandoned the dam and factory property in accordance with the judgments of the Superior Court and the Court of Review, and dropped the appeal before the Supreme Court. A curator to the property will now be appointed by the judge, and it will be sold to satisfy the town's claim for debt and costs.

THE Toronto Industrial Club, Lt'd, proposes to build an apartment house to accommodate 600 people. Proposed capital, $300,000. In this connection it is only necessary to remind investors that well-finished houses, in excellent repair, to accommodate families of, say, five persons, can be had in Toronto within one minute's walk of the electric cars, at from $6 to $12 per month.

Victoria Dei Gratia Regina.

ADAM HOPE & Co., wholesale hardware men and dealers in iron supplies, Hamilton, Ont, have assigned. The trade liabilities are placed at $15,000 and indirect liabilities at $60,000. The Bank of Commerce and Bank of British North America are interested to the extent of $45,000 advanced on warehouse receipts.

THE engineer's plant for the sewage works of London, Ont., include a steel highway bridge across the river at the foot of King street, having a 163-foot span, with 305-foot steel approach on the east side and 153 feet on the west side. The roadway would be 16-foot with a five-foot foothpath. The bridge is necessary to carry a main sewer, and the traffic arrangements are supplementary to this.

THE International Association of Machinists, in convention at Kansas City, Mo., in May, elected the following officers: President, James O'Connell, Chicago; grand foreman and editor of the *Journal*, B Douglas Wilson, Chicago; secretary-treasurer, George Preston, Chicago; general executive board, Harry Smith, New York; J. Holmes, Toronto, Ont.; Stewart Reed, Toledo; P. G. Conlan, Kansas City; Hugh Doran, Chicago.

WATSON & MCDANIEL, Philadelphia, for whom Garth & Co., Montreal, are agents, are getting out patterns and putting in some fine matrice tools to produce a line of steam separators, back pressure valves, and entirely new straightway and duplex valves, mainly for bottom blow-off for steam boilers, and are also introducing a new hydraulic operating valve recently patented by Mr. Riggin, who has charge of the hydraulic department of Penna R. R. shops at Altoona, Pa.

THE Master Plumbers' Association of Toronto met May 12th, W. J. Burroughs, president, in the chair. Nine new members were admitted. The principal business of the evening was the election of delegates to attend the convention, to be held in this city from July 1st to 3rd. The Palmer House was selected as headquarters for the delegates, and the meetings will be held in Pythian Hall. It is expected that every part of the Dominion will send representatives. W. J. Burroughs and A. Fiddes, on behalf of the Toronto Association, will represent the National Association, and the following the Toronto Association: Geo. McGuire, Alex. Purdy, Jas. B. Fitzsimmons, K. T. Allison, Jas. Wilson.

OUR Canadian pulp factories should take advantage of the hint conveyed in a recent report regarding the making of a new material for flooring, wainscoting, etc., and which is being exploited largely by German manufacturers of wood pulp. The pulp is dried and desiccated into a dry powder, which is put up into convenient sized packages and sold to builders and consumers generally. This powder is all ready to mix with water like ordinary cement and is spread over the surface intended to be covered. It dries quickly and adheres closely to the surface and may be tinted any color desired. It is in a certain measure fire proof, and can, it is said, be smoothed with a plane like ordinary wood.

MAUDE BENNETT, the widow of the late Dickson P. Cottingham, in her quality of sole executrix to the estate of her late husband, doing business at 1822 Notre Dame street and 19 Phillips square, has assigned at the demand of Major Freeman. The liabilities amount to $17,155. The principal creditors are: Canada Paint Company, $2,854; R. C. Jamieson & Co., $2,884; Sherwin Williams Company, $1,483; W. Warland & Co., London, Eng., $935; Meakins & Co., $715; Montreal Rolling Mills, $708; B. & S. H. Thompson & Co., $702; J. Cox & Son, $624; A. Ramsay & Son, $593; Thos. Bryan, London, Ont., $525.

IT is about thirty-three years since James Morrison started a brass foundry in Toronto. In 1893 the business had grown to such an extent that a joint stock company was formed with an authorized capital of $300,000. Of this sum two-thirds was paid. Losses by bad debts in the business and unfortunate investments made by Mr. Morrison proved too heavy a drain on the business for its continued prosperity. At a meeting of creditors an offer of 20 per cent. cash was made to unsecured creditors on unsecured liabilities of $38,000, and accepted by all present. The Jas. Morrison Brass Manufacturing Co. will continue the business as formerly.

THE fencing manufactured by the Page Wire Fence Co., of Walkerville, Ont., has evidently found favor with consumers throughout Canada, as the company's warehouse is almost depleted of stock, although new looms were added this year sufficient to increase the capacity of the factory by sixty per cent. The wires made for the Page patent fence are hard spring wires specially manufactured for this particular purpose; and in the moving of the cross wires, the running wires are coiled in such a way that while all the necessary strength is imparted to the fence, the individual wires have the elasticity needed to save it from the effects of a sudden blow.

As a preliminary to the repair to the reservoirs the Montreal water works department will do the following work: Two new 30-inch values, one 24-inch valve and one 20-inch valve, $3,500; altering valves on pipe track, $6,500; connecting the 30-inch main from No. 1 turbine to the two 24-inch mains in the tunnel at the wheelhouse, $1,200; connecting the 30-inch main of No. 1 engine to the 30-inch main of No. 1 turbine, $1,600; connecting No. 2 engine to the 30-inch main of No. 1 engine, $1,700—a total of $14,500.

Marine News.

A STEAMER service between Cleveland, O., and Rondeau, Ont., is proposed.

THE Thousand Island Steamboat Co. has amalgamated the Alexandria Bay Steamboat Co.

THE C.P.R. has almost completed its new steamer at Roseberry, B.C., for use on Slocan Lake.

WM. WALKER, Kincardine, Ont., is engineer on the steamer "Crandella," Lindsay, Ont., this season.

THE dredging of the Thames from Chatham, Ont., to Lake Erie, is ordered by the Dominion Government.

A. M. PHILLIPS, acting superintendent, has been appointed superintending engineer of the Rideau and Tay Canals.

MICHAEL DELANEY'S tug "Charles Stewart Parnell" was destroyed by fire, May 20th, at the Grand Trunk wharf, Owen Sound.

THE St. John, N.B., city council is pushing the harbor improvements, and wharf building and dredging are going on vigorously.

CHIEF ENGINEER ANDERSON, of the Marine Department, has chosen a location for a lighthouse on Flower Pot Island, P.E.I., which will be built during the summer.

THE steamer "Nellie H.," recently launched at Chatham, N.B., was built by J. M. Ruddock, at the Miramichi Foundry's yard. She is 45 feet long; beam, 9 feet.

JAS. ROBINSON'S new boat "Irene," is now being fitted up at the Miller Chatham Foundry and Machine Works, Chatham, N.B. She is 36 ft. 3 in. long; 11 ft. 3 in. beam.

P. P. YOUNG recently launched his new steamer "Majestic," for service on Stoney Lake, Ont.; Capt. Scollard will sail the "Majestic," and Ed. Young will be mate.

THE Fort William *Journal* reports that J. Servais has placed the machinery in a new boat at Wabigoon. It is a flat-bottomed boat fifty feet long and drawing two feet of water.

THE new steamer for the Maritime Sulphate Fibre Company, being built by the Chatham Foundry and Machine Works, is approaching completion. She is length, 56 ft.; beam, 12 ft. 4 in.

A NEW steamer launched recently from Ross, Hall & Brown's wharf, Rat Portage, Ont., measures thirty-six feet in length and eight feet beam, and was built by the Degagnes for John Knight.

THE schooner "Sapphire," Capt. Wm. Cox, of E. B. Marvin & Company's fleet, one of the largest of the sixty sealing vessels that make Victoria, B.C., their headquarters, was completely destroyed by fire and explosions recently near Uclulet.

J. H. BALDERSON, Deputy Minister of Railways and Canals, has been superannuated, and will have leave of absence from first of June to first of July at his present salary. On the first of July he becomes superannuated at a salary of $690 a year.

THE double disaster which recently wrecked the steamers "Ruth" and "Gwendoline" of the Intercolonial Transportation Company, running between Jennings and Fort Steele, B.C., deprived the company of both its steamers, and leaves Fort Steele without any outlet to the south. This means a loss of $50,000 to the company.

THE "St. George" was launched recently from Hon. J B. Snowball's shipyard at Chatham, N.B. The new steamer is a side-wheeler and intended to be employed as a sea-tug in the work of towing Mr Snowball's barges between his mill at Tracadie and the loading berths at Chatham. She is 119 feet long; 25 feet beam and 12 feet 3 inches deep.

M. & N. K. CONNOLLY, who are now at work on a big dredging contract, at Philadelphia, have secured a contract from the Government of Uruguay, for the construction of a canal sixteen miles in length. The contract price is said to be over $10,000,000. They will start work almost at once, and the probability is that some Canadian workmen will be employed by them.

S L Long has been appointed city engineer of Rossland, B C.

G H Garden, C E, of Montreal, has gone to assume charge of a surveying party at Crow's Nest Pass for the C P R

A large pipe organ is to be presented to Zion Church, Berlin, Ont., by Mrs C Breithaupt, in memory of the late E C Breithaupt

James Hendrie, Winnipeg, a member of the Land Titles office staff, was drowned in the Winnipeg River, near White Mouth, recently.

Dougglass Gerrard, St Thomas, Ont., has been appointed assistant engineer of the T, H & B branch of the Michigan Central, at Hamilton

R W. Brock, M.A., acting lecturer on mining and assaying in the Kingston, Ont., School of Mines, has been appointed geologist on the Dominion Geological Survey

Andrew Anderson, for many years the cable underground manager of the Gowrie mine, has accepted a similar position with the North Sydney, C B, Mining and Transportation Company

Recently the employees of the Cornwall Electric Street Railway Company, Ltd., presented the secretary, F N Seddall, with a valuable smoking set and an umbrella, accompanied by an address expressive of their esteem

Granville Cunningham, general manager of the Montreal Street Railway, has returned to England to superintend the construction of the new electric railway system of Birmingham. During his further absence, Mr. Wanklyn, manager of the Toronto Street Railway, will have the oversight of the Montreal system James Ross, vice president of the Montreal Company, has accompanied Mr Cunningham to England.

FIRES OF THE MONTH.

May 4th.—J Harriman's planing mill, Niagara Falls, Ont.—May 11th—S Morley's flour mill, St. Ann's, Ont. Loss $8,000.—May 11th.—*Brown & Bogg's machine shop, Hamilton, Ont.* Pattern room destroyed, loss $1,500—May 13th—The Nova Scotia Lumber Co's mills at Sherbrooke, N.S. Insurance, $15,000, loss, $20,000.—May 14th.—J B Stringer's elevator, Haycroft, Ont. Loss $2 000—May 16th—*Waterloo, Ont., Mfg. Co.'s* foundry Loss $5,000—May 16th.—The premises of the Schlater Asbestos Co., Montreal—May 18th.—C P R. station at West Selkirk, Man.—May 19th—F W Galbraith's planing mill damaged $200 by incendiary fire—May 22nd.—C Norsworthy & Co s foundry, St. Thomas, Ont; damages fully insured—May 24th.—W A Simpson's planing mill, Queen st., Toronto. Loss, $12,000, insurance, $2,000.—May 27th—The Gartshore-Thomson Pipe Foundry Damages amounted to several thousand dollars