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LACHINE CANAL DOUBLE TRACK SWING BRIDGE

THE LONGEST PLATE GIRDER SWING SPAN OF ITS KIND RECENTLY COMPLETED FOR THE C.P.R. NEAR HIGHLANDS, P.Q. — NOTEWORTHY RAPIDITY OF CONSTRUCTION—SOME UNUSUAL ENGINEERING FEATURES.

[NOTE:—In *The Canadian Engineer* for April 29th, 1915, a brief description appeared of the new C.P.R. bridge opened for traffic over the Lachine Canal on April 16th. Several photographic views of the bridge showing it in its open and closed positions were also given. The following article, prepared for this journal by Mr. P. B. Motley, Engineer of Bridges for the Canadian Pacific Railway Company, deals more in detail with its design and erection.—EDITOR.]

THE new double-track bridge which has been recently completed, replaces the old single-track bridge built in 1887. The original bridge consisted of one 240-ft. through truss span, and a 40-ft. deck plate girder span on the south end, to accommodate the highway, which is a continuation along the south bank of the Lachine Canal of St. Patrick Street, Montreal. The old bridge was built by the Atlantic & North Western Railway Company to carry its extension into Montreal over the canal, and has since served its purpose without trouble of any kind. The completion of the St. Lawrence River double-track bridge and the double track work between Montreal and Brigham Junction a year or so ago, however, left this bridge as the last remaining single-track structure, thus necessitating what is known as a "gullet track" or "gauntlet" over it, and slight consequent delay to trains owing to the converging tracks at both ends of the structure.

Last autumn, the Canadian Pacific Railway management decided on the replacement of the structure with a double-track bridge suitable for modern requirements, and the plans which were prepared embody some features which are considered to be unique in bridge engineering.

It was found possible to design a double-track swing bridge in such a manner as to utilize the old pivot pier, without decreasing the waterway for traffic on the canal. This is considered interesting as an engineering achievement, in view of the fact that two tracks are accommodated on the bridge instead of one as formerly. This has

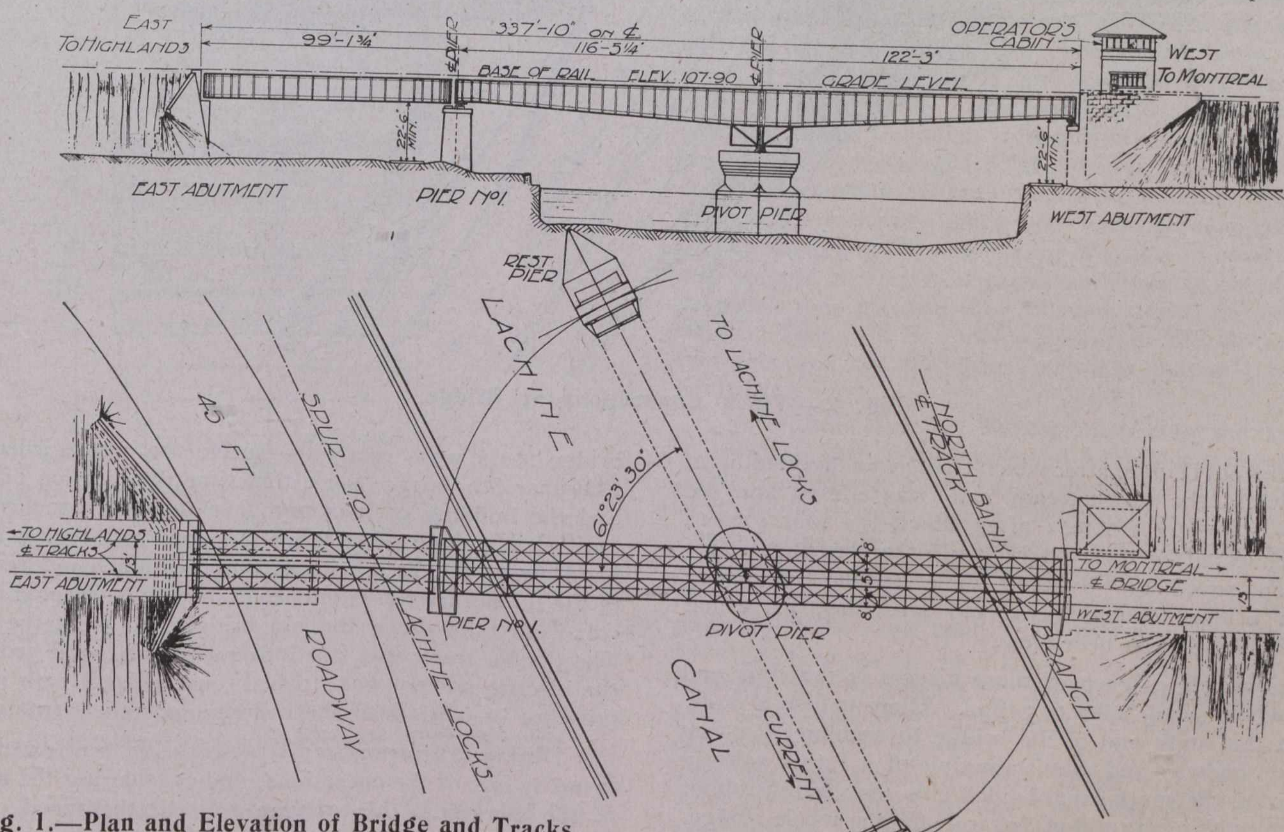

Fig. 1.—Plan and Elevation of Bridge and Tracks.

been done by the use of a type of bridge consisting of four deck plate girders instead of the original lattice truss construction, with the traffic running as it were, *through* the bridge.

This plate girder swing span is understood to be the longest plate girder span of its kind ever built, being 239 ft. 7 ins. long and 13 ft. 6½ ins. deep in the centre, reduced to 8 ft. ½ in. at the ends, measured from back to back of flange angles. The four main girders of which the structure consists were each shipped in three pieces from the Dominion Bridge Company's shops, which are near the bridge site, and were lowered into place by heavy derricks. When all the parts were accurately assembled, they were riveted up into their completed lengths, after which the operating machinery was installed. The use of four girders was especially dictated by the necessity of maintaining traffic while the demolition of the old structure and building of the new, was being carried on. By this plan it was possible to erect two girders on the upstream side of the old bridge, after which traffic was diverted upon them, while the downstream side was altered and the other two girders erected; after which the four girders were connected by their lateral and other bracing. This operation saved the building of a special temporary wooden bridge alongside the old structure, as would otherwise have been necessary.

The weight of each of these girders is 112 tons and of the whole swing span 615 tons. There is also a 90-ft. span at the south end of the bridge to accommodate the existing roadway and admit running of a future railway track along the south canal bank. This span weighs about 143 tons, making a total of 758 tons for the whole bridge.

The electric operating power is carried by submarine cables under the canal to the centre pier, and there supplied to duplex 30-h.p. motors, which are controlled from the operator's house on the north bank of the canal, and in addition, a spare 30-h.p. motor is kept on hand in the house in case of emergencies. This house itself is a handsome structure, built entirely of fireproof construction so as to remove the possibility of risk and delay to the canal or railway traffic by fire.

Not only is the design of the structure interesting, as above stated, but the rapidity of construction is also noteworthy. Work was started on the substructure on December 1st, 1914, which involved the demolition of the old south single-track abutment, and the building of a new double-track abutment behind it, likewise the removing of a certain amount of earth embankment and the widening of the old one to accommodate the new double track. It also included the extension of the two piers on the upstream side towards the Lachine locks, one of which (the pivot pier) required considerable subaqueous work and bonding into the old stonework. The north abutment was extended in the same direction to accommodate the double track, and also to act as the lower story for the operator's house.

This substructure work was carried out during the winter, working 24-hour shifts most of the time, until the bridge seats were ready to receive the steel girders on February 8th, 1915. Since that time the erection of steel and the building of masonry have gone on concurrently until March 31st, 1915, when the span was swung under hand power for the first time, thus making it independent of the temporary falsework which had to be erected in the canal, to take down the old bridge and erect the new. The double track was put into service on April 3rd, and the electric power was turned on on April 15th in the presence of officials of the railway and others interested.

During the progress of the work, no trains were delayed by any of the operations, and considering the nature of the work and the tonnage erected, the speed of the work is considered to be remarkable.

The bridge is protected by a 16-lever mechanical interlocking machine with power-operated home signals and electric track-circuit locking, so as to make it impossible for a train to approach before the bridge is properly closed and safely locked, and in addition, it is impossible for the operator to open the bridge for canal traffic until

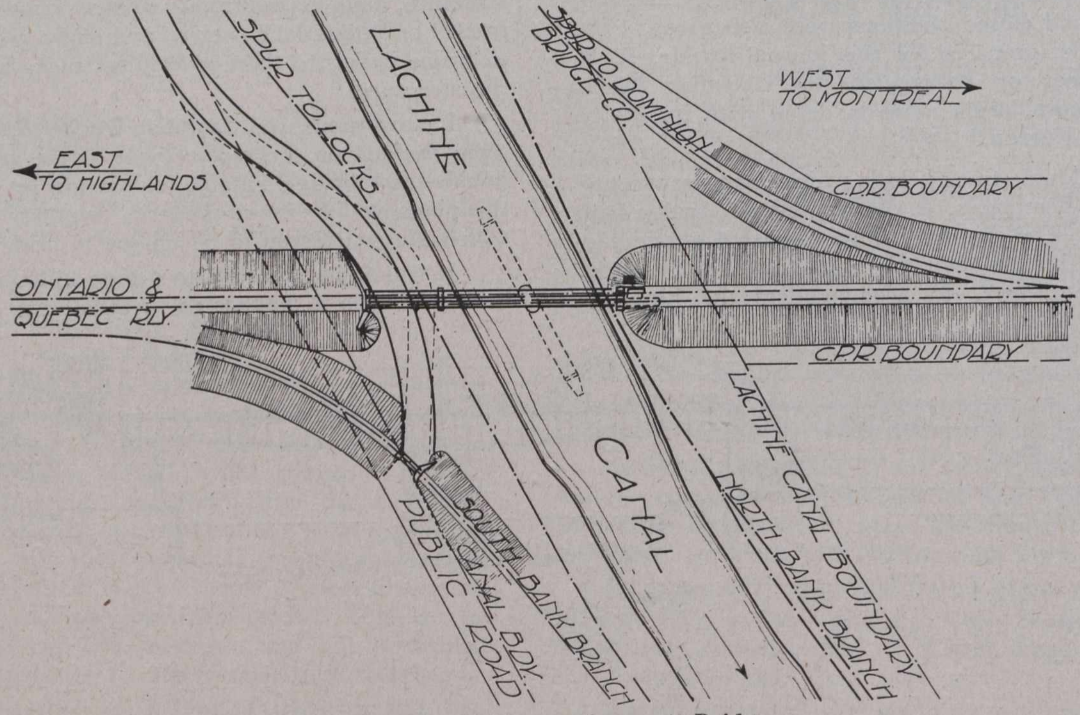

Fig. 2.—Track Connections at Bridge.

all railway traffic is stopped at a safe distance from the bridge—all of these operations being carried out from the signal tower, which commands a view up and down the canal even when trains are passing over the bridge.

The structure is also provided with a system of lights, as required by the Board of Railway Commissioners, for the protection of shipping on the canal. The new type of bridge gives a much clearer view along the track than formerly, as there is no overhead lattice work projecting above the rail level.

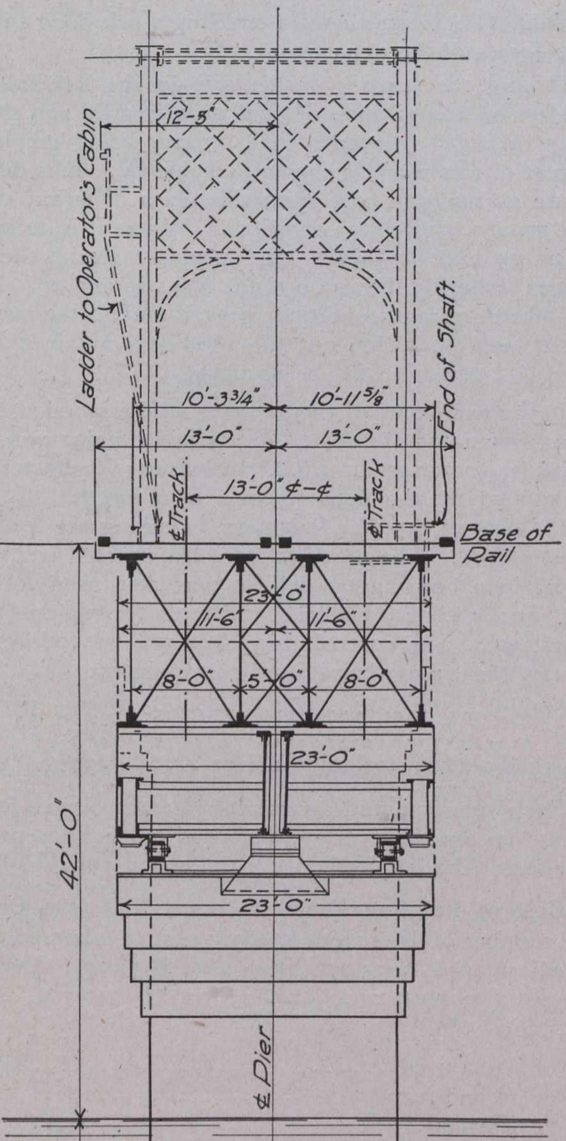

Fig. 3.—Sectional Elevation of New Bridge and Its Relation as Regards Height to Old Structure.

The bridge was designed by the railway company's engineers and the extensions to the substructure were carried out by the John S. Metcalf Company, while the steelwork was manufactured and erected by the Dominion Bridge Company.

STRENGTH OF SAND-LIME BRICK.

The strength of sand-lime brick depends upon a firm bonding of the sand grains through the agency of lime. A mixture of sand and lime is pressed into bricks, which are then subjected to the action of steam under pressure, for several hours. A chemical union takes place between the lime and the quartz of the sand, forming hydrated calcium silicate. The sand used should not be too coarse. That passing through a twenty-mesh screen and composed of grains ranging in size down to minute particles is desirable. In other words, the sand grains should be so graded in size as to leave very little interstitial space. The strongest bricks are made from sharp sand which is free from inert minerals, such as clay, iron oxide, mica, etc. The clay and iron oxide are particularly objectionable since they are liable to mask the grains of quartz and thus prevent the union of the lime and quartz. Ten per cent. of clay substance should be set as the extreme limit. Feldspar is less objectionable, but in large proportions is undesirable as it reduces the strength of the brick.

CANADIAN MECHANICS FOR BRITISH WORKSHOPS.

Last week Mr. George N. Barnes, M.P. for Glasgow, and Mr. W. Windham, of the Board of Trade, Great Britain, arrived in Ottawa to confer with the Dominion Government concerning skilled mechanics to go to the United Kingdom for employment in the manufacture of war munitions. Some 30,000 mechanics are needed, and the British Government comissioned these gentlemen to come to Canada and engage every qualified and skilled mechanic it was possible to secure, with the approval of the Canadian Government. It is proposed to pay the transportation of such men, and their return transportation also, if they remain six months. The men are wanted to handle metal and work lathes of all kinds and to engage in the assembling of parts. Those who go will be paid the highest wages prevailing in the districts to which they go, and they will only go to the best districts. They will be employed only in the Government factories and by the firms who are engaged on war contracts.

In an interview Mr. Barnes stated that the situation in England had vastly improved from the standpoint of production of war materials, though a great many men of all kinds were needed in the manufacture of gun carriages, arms, shells, etc. The laboring classes were as anxious as any to see the war brought to a successful and speedy conclusion, and were impressed with the importance of the work upon which they were engaged.

This is borne out by a letter received by us the other day from Ed. Bennis & Co., Limited, London, one of the firms exempted from recruiting in consequence of being engaged on war contracts. A letter was addressed to each employee calling attention to the large contracts in hand for mechanical stokers, coal elevators, conveyers, ash-handling plants, etc., for a number of ammunition and powder factories that were being put up with all possible speed by the Government. These contracts amounted to about 80% of the work in hand, and were under stringent guarantees as regards delivery. Each employee was asked to attend to his duties regularly and consciously, avoiding broken time, and enabling the management in every possible way to execute the work within the times guaranteed. It was pointed out that the men engaged at home on the output of war munitions had as responsible and important duties to perform as had their brothers in the trenches, and it was only by their unselfish co-operation that the soldiers could be kept well supplied with ammunition so urgently necessary to bring the unfortunate war to a speedy and satisfactory end.

In the course of a week over 95% of the recruitable employees (between the years 18 and 38) applied for war badges and signed a guarantee in the matter of regular and diligent adherence to duties.

SOME ROAD MAINTENANCE COSTS.

THE work of the New York State Commission of Highways is carried out under nine divisions with a division engineer at the head of each. Under him are two departments, *i.e.*, construction and maintenance, in charge of the resident engineer and superintendent of maintenance respectively. In each county, or part of it, in case the mileage of improved roads is very large, the maintenance work is supervised by an engineer who reports to the superintendent. Monroe County with its 220.19 miles of completed state and county highways in 1914 was divided into two sections, east and west of the Genesee River. An article appearing in the Cornell Civil Engineer for May, and written by Paul Macy, C.E., of the maintenance department, has to do with the costs of a portion of the maintenance work done during 1914 in eastern Monroe County. In this territory in 1914 there were 99.303 miles of completed road of the following types of construction: Waterbound macadam, 14.594 miles; oiled waterbound macadam, 41.380 miles; bituminous macadam, 27.149 miles; amiesite pavement, 1.000 mile; asphaltic concrete, 9.940 miles; concrete-bituminous top, 4.250 miles; rock asphalt, 0.990 mile. Total, 99.303 miles.

The maintenance work in the field is done both by contract and by pay-roll system directly by the department. The latter includes minor repairs by the patrolmen and more extensive repairs by organized gangs. Each patrolman supplies himself with a horse and cart and necessary small tools and is provided with bituminous material and stone. His duties comprise the making of small patch repairs to the pavement; the cleaning of ditches and culverts; the mowing of weeds and grass along the highways and around the guard rail and culverts; and the general inspection of his beat. The average cost of the salaries of such men was $67 per mile in 1914.

The total amount of money spent in 1914 up to December 1st was $68,705.83, divided as follows:

		Average per mile.
Patrol	$ 6,589.00	$ 67.00
Repairing, painting and building guard rail	2,550.48	26.00
Maintenance material, stone and oil	6,013.49	61.00
Ordinary repairs	5,963.16	60.00
Oiling 40.669 miles	19,870.75	488.00
Resurfacing 1.45 miles bit. mac. mixing method type 2	23,007.77	15,867.00
Engineering and expenses	4,711.18	47.00
Engineering and inspection, 4.94%.		

Of the oiling work done during the year 32.244 miles were done by contract and 8.425 miles by the department directly. The cost of this class of work is itemized under Tables I. and II. respectively.

In the work shown in Table I. both the cover and bituminous material were applied by contract. The cost of cover as shown in this table is excessive, due to the fact that the cost as given covers all material bought and delivered upon the shoulders of the road. In the case of each of these contracts approximately 100 tons of cover per mile were applied.

In Table II. the bituminous material was applied by contract, cover being furnished and applied by the department. The amount of cover used was approximately 50 tons to the mile.

Table III. shows the cost of oiling work done entirely by the forces of the department.

During the season, particularly in the late fall, the shoulders on 22.075 miles of road were scraped and shaped up, an ordinary two-team road scraper being employed. The cost of this work is shown in Table IV. It is difficult to state an average cost upon this class of work, owing to the great variation in conditions. Where it is necessary to pick up and haul away the surplus material the cost becomes large, as shown on roads Nos. 16 and 19. However, where average conditions prevail and all the material may be used to widen out the shoulders a fair average cost of $25 per mile may be assumed.

In the early part of the summer all the wooden guard rail was repainted one coat. Ready mixed paint was used, costing $1.50 per gallon f.o.b. points near Rochester, and was applied by the department's own forces. In most cases a gang of three or four men, including the foreman, was employed. These gangs were transported from road to road in a box wagon which was also used to carry paint, brushes, oils, material and tools for making small repairs, etc. The cost of this labor was as follows, the driver of the wagon being used as a painter:

Foreman	$.50	per hour
Labor	.25	" "
Horse and wagon, including driver	.37½	" "

Each man painted approximately 300 linear feet of rail per day on the average and used 0.6 gallons per 100 linear feet. The itemized cost of this work was as follows:

Cost of Painting Wooden Guard Rail One Coat.—Total number of linear feet, 49,998; cost of labor, $478.50; cost of material, $475.77; total cost, $954.27. The average cost per foot was: Labor, .0096; material, .0094; total, .019.

Cost of paint used	$450.00
Cost of oil and turpentine	18.79
Cost of brushes	6.98
Cost of labor	478.50
Total cost	$954.27

Below is shown the cost of erecting new concrete guard rail. The cost of hauling 2¾ miles is included in the labor.

Cost of Concrete Guard in Place.

No. of linear feet	1,440
Total cost of labor	$ 237.00
Cost of rail and freight	1,053.76
Total	$1,290.76
Average cost of labor per foot	$0.164
Average cost of rail per foot	.732
Total	$0.896

Table I.—Application by Contract of High Carbon Tar—Cold Application.

Contract No.	Road No.	Bid Prices: Stone ton	Bid Prices: Cleaning old Macadam sq. yd.	Bid Prices: Bituminous Material gal.*	Bid Prices: Restoring Shoulders & Ditches lin. ft.	Cost per Mile: Oil & Manipulation including Cover	Cost per Mile: Cover	Cost per Mile: Total	Cost per Sq Yard: Oil & Manipulation including Cover	Cost per Sq Yard: Cover	Cost per Sq Yard: Total	Amount Bit. Mat. per sq. yd.	Number square yards	Average Haul mi.	Kind of Cover
A	1	3.00	.001	.10	.02	$252.48	453.57	706.05	.0357	.0656	.1031	.35	40534	4.00	Imported limestone dustless screenings
B	2 3 4	2.80	.001	.095	——	311.52	548.57	860.09	.0336	.0580	.0916	.35	58582	4.00	"

* Item includes furnishing and applying bituminous material, and applying cover.

Table II.—Application of Light Coat of Bituminous Material by Contract. Covered by Department.

Repair Contract No.	Road No.	Cost per Mile: Oil and Manipulation.*	Cost per Mile: Manipulation Cover	Cost per Mile: Cover	Cost per Mile: Total	Cost per Sq. Yard: Oil and Manipulation	Cost per Sq. Yard: Manipulation Cover	Cost per Sq. Yard: Cover	Cost per Sq. Yard: Total	Amount of Bit. Mat. per sq. yd.	Sq. Yd.	Average Haul mi.	Kind of Cover	Kind of Bit. Mat.
C	5	$220.01	14.76	48.40	282.17	.0220	.0014	.0052	.0286	.25	33844	2.80	local sand	Low Carbon Tar—Cold Application
	6	"	21.27	128.15	369.43	"	.0020	.0120	.0360	"	50840	1.90	imported plain limestone screenings	
	7	"	21.61	66.17	307.79	"	.0028	.0088	.0336	"	30880	1.45	"	
D	8	258.12	23.12	50.75	331.99	.0275	.0025	.0054	.0354	"	9371	1.66	local sand	High Carbon Tar—Cold Application
	9	"	6.35	41.40	305.87	"	.0007	.0048	.0330	"	8738	1.00	"	

* Item includes sweeping road; furnishing and applying bituminous material.

Table III.—Application of Bituminous Material and Cover by Department.

Road No.	Miles	Aver. Haul mi.	Sq. yd.	Cover: Kind	Cover: Tons per mile	Cover: Total tons	Bituminous Material: Kind	Bituminous Material: Amt. per sq. yd.	Bituminous Material: Total gal.	Cost per Mile: Bit. Mat.	Cost per Mile: Manip.	Cost per Mile: Cover	Cost per Mile: Incid.	Cost per Mile: Total	Cost per Sq. Yd.: Bit. Mat.	Cost per Sq. Yd.: Manip	Cost per Sq. Yd.: Cover	Cost per Sq. Yd.: Incid.	Cost per Sq. Yd.: Total
10	3.165	2.00	29760	Imp. Limestone Dustless Screenings	135	429.85	H. C. Tar, Cold	.30	9124	191	67	299	7	564	.020	.008	.031	.001	.060
11	1.030	3.25	9650	"	49	50.00	" and Cold oil	.25	2541	174[1]	71[2]	215[3]	1	461	.018	.008	.023	—	.049
12	2.430	2.75	22400	Imp. Limestone Plain Screenings	42	102.00	H. C. Tar, Cold	.25	5711	155	68	96	10	329	.017	.007	.011	.001	.036
13	1.800	3.00	16670	"	40	71.00	"	.25	4255	156	94[4]	93	5	348	.017	.011	.010	—	.038

[1] High cost due to use of maintenance tar costing .096 cents per gallon.
[2] Oil in barrels.
[3] Cover picked up from Road No. 10 and hauled by auto truck onto Road No. 11. Average haul = 3¼ miles.
[4] High cost due to long, hard hauls of oil distributor from tank car to road.

Cost of bituminous material f.o.b. delivery point, per gal.

Road 10 .... $0.066
Road 11 .... 0.0668 (C.O.) and 0.096 (tar).
Road 12 .... 0.066
Road 13 .... 0.066

Cost of labor: Foreman .... .50 per hour
Laborers .... .25 per hour
Teams .... .62½ per hour
Auto truck.... $25.00 per day.

Table IV.—Cost of Scraping Shoulders.

Road	Miles	Total Cost	Total Cost: Labor	Total Cost: Team	Average Cost per Mile: Total	Average Cost per Mile: Labor	Average Cost per Mile: Team	Remarks
14	3.165	$ 88.03	56.25	31.78	28	18	10	No material hauled away.
15	3.306	87.25	62.25	25.00	26	19	7	" " " "
16	2.430	137.50	100.00	37.50	57	42	15	¾ mi. av. haul.
17	1.819	47.00	42.00	5.00	26	23	3	No material hauled away.
18	4.019	157.50	102.00	55.50	39	25	14	30% of material ½ mi. av. haul.
19	1.000	64.50	40.00	24.50	65	40	25	All material ⅛ mi. av. haul.
20	1.576	35.25	14.00	21.25	22	9	13	No material hauled away.
21	2 960	138.00	103.00	35.00	47	35	12	" " " "
22	1.800	79.25	55.75	23.50	44	31	13	" " " "
Total	22.075	834.28	575.25	259.03	38	26	12	
		100%	69%	31%				

Cost of foreman, 50c. per hour; labor, 25c. per hour; team, 62½c. per hour.

SOUND STEEL RAILS AND INGOTS.

A COMPARISON of the properties of rails rolled in a mill from different types of ingot of substantially the same chemical composition, but cast by different processes, is a matter of interest and importance. It formed the subject of one of the papers read at the recent annual meeting of the Iron and Steel Institute in Great Britain. The paper was prepared jointly by Sir Robt. A. Hatfield, F.R.S., of London, England, and Dr. Geo. K. Burgess, of the Washington Bureau of Standards. The paper also compares in considerable detail the properties of a number of ingots made by a special feeding process, used by one of the authors, and an ingot of the usual type for rolling into rails. The investigation was made at the rail mill of the Maryland Steel Company and included a comparison between rails from somewhat imperfect ingots produced in the ordinary manner, and from ingots in which the material dealt with was free from blow-holes, piping and segregation. The ordinary piped ingot is unsound and unsuitable for rolling into rails for over half its length, whereas the ingot cast by the feeding method is sound throughout the whole of its length. Inspection indicates that a discard of 50 per cent. would be necessary for the ordinary ingot, but only about 10 per cent. in the case of the Hadfield ingot; that is, there would be practically no discard below the feeding head. A sulphur print taken of one-half face of the Hadfield ingot indicates very uniform distribution of the constituents in the metal, and practically freedom from segregation. As would be expected, the comparison ingot with its pronounced pipe shows marked segregation of carbon, phosphorus and sulphur in the piped region to a depth of 25 per cent. from the top of the ingot, and other regions of somewhat varying composition. The manganese shows but slight segregation anywhere. This examination shows the overwhelming superiority of the ingots cast by the feeding process, such ingots being physically sound and uniform throughout, also free from segregation. Drop tests on the rails from the Hadfield ingots show a high degree of uniformity of resistance to shock. The web, which is usually the part consisting of the poorest material, is practically uniform in the case of the Hadfield ingots with the remainder of the section.

Classification and Manufacture of Ingots.—Of the ingots used in this investigation there were eight made in Sheffield, also an ingot made and furnished by an American steel company, as a comparison ingot, and supposed to represent the usual type of ingot from which rails are made. Ten ingots were used. Four were cast large end up and fed by the Hadfield method in the usual manner with charcoal, the blast being continued until the molten steel had set on the top of the head, say, varying from 20 min. to 40 min. To three of these four ingots, ordinary rail steel was added 0.1 per cent. of aluminum, and 0.125 per cent. was added to the fourth, a nickel-chromium ingot. For the sake of comparison, there were also included two ingots, cast with the small end up, and fed by the feeding method; three ingots not fed, two of piping steel and one of rising or "unsound" steel.

Examination of Split Ingots.—At the Pittsburgh Laboratory of the Bureau of Standards two of the ingots were sawn in halves—one Hadfield ingot of the specially fed type cast large end up, and the comparison ingot from an American mill. That there is an exceedingly uniform distribution of the constituents in ingots made by the Hadfield method is evident. It is evident that there is freedom from appreciable segregation over 95 per cent. or more of the Hadfield ingot, which is also entirely free from piping or blow-holes, and is sound throughout. The comparison ingot, as would be usually expected with its pronounced pipe, shows marked segregation of carbon, phosphorus and sulphur in the piped region to a depth of 25 per cent. from the top, and other regions of somewhat varying composition. This comparison ingot, if rolled into rails, should have about a 50 per cent. discard, as shown from the visual examination, while the whole of the Hadfield ingot below the feeding head would be available. It has been shown by Dr. Stead, Mr. Talbot and others that an ingot of the ordinary type, such as the comparison ingot No. 10, may be somewhat improved as regards internal pipe by cogging while the centre is still fluid. Nevertheless, it is doubtful whether this treatment can be entirely relied upon, and in any case there are always evidences of segregation in the raw material. It is also stated by rail manufacturers, with what correctness we do not know, that such an ingot as the American, which is never allowed to become cold, may heal up in the interior during cogging, at least partially, whereas an ingot allowed to become cold will not, in general, weld together. Probably in no case will perfectly sound material be obtained—that is, if the original ingot is unsound. It would also appear safe to say that any surface which has been exposed to the air will not weld satisfactorily. Although an ordinary ingot may be undoubtedly improved over its condition as cast, nevertheless it would appear that considerable uncertainty always exists as to the actual final condition of such an ingot. The advantage of the special feeding process for ingots cast large end up consists in the certainty every time of producing an ingot free from pipe, blow-holes and marked segregation if sound piping steel has been used. It is, of course, evident that the securing of a completely solid ingot of uniform properties throughout its interior is in itself not sufficient to ensure the entire soundness of the resulting product, such as rails, rolled from such an ingot. For example, there are surface defects which may be present on the ingot; and the operations of re-heating, blooming and rolling may readily introduce serious imperfections. Nevertheless, in the Hadfield ingots the material is in the first case absolutely sound and free from blow-holes. Therefore the liability to such imperfections is much less. Not only are the qualities of the ingot improved, but these at once make themselves felt in the superior product obtained after rolling and forging. For example, when producing billets from ordinary ingots to be used for projectiles—that is, from ingots not cast by the sound method—it was found that there was no less than 6.2 per cent. of waster projectiles, owing to defects due to flaws and roaks, and arising from defects or unsoundness in the original ingots. In exactly the same class of article produced from ingots made from sound steel and properly fed by the method described in this paper, the total quantity of wasters reported was reduced to the figure of 1.4 per cent.; that is, wasters through seams, roaks and other causes were reduced from 6.2 to 1.4 per cent., a reduction of no less than 4.8 per cent.

General Conclusions.—In all, nine ingots were used in this investigation, all but one of which had approximately the same chemical composition. The examination of the split ingots shows the great superiority of casting large end up and feeding by the special process, such an ingot being physically sound and uniform throughout and practically free from chemical segregation. The examination of the rails shows that for ingots cast by the Hadfield process, those cast large end up will give rails of uniform quality free from internal flaws of all kinds; those cast small end up may show a soft region in the web of the A rail, but are otherwise sound. Those cast in the ordinary manner from piping or otherwise unsound steel may or may not give sound rails depending upon the condition of the steel. In addition to the certainty of producing all sound rails by the special feeding process from ingots cast large end up, there is a great saving in metal and a consequent increase in percentage of sound ingot available for rails—in these experiments an average of 90 per cent. for ingots 2, 3, 4, as compared with about 50 per cent. for the piping ingot and an uncertain amount from the rising type. The physical and chemical tests to which rails or rail steel are usually subjected do not appear to give an adequate measure of the quality of the rails. For example, the results of the tensile and drop tests and chemical analysis would not separate the sound from all the unsound rails here examined. The metallographic examination is a valuable aid in determining the quality of the finished rails. The question may be asked, Is it not worth while to use in the manufacture of rails only sound steel which is cast and rolled in such a manner as to make practically every rail a sound and safe one? We believe this can be done without excessive cost. One of the authors was recently present at the casting of ingots by this system from a 16-ton heat, the fluid steel being poured into twenty-one 11-in. ingots, the time occupied being about fifteen to twenty minutes. By means of patching, the sand tops in this system can be used several times, in some cases three or even four times. It will be seen that no more time is required for the casting operation than for heats of steel poured into ingots made in the ordinary manner. The sand heads are produced very cheaply. The air blast attachment is fixed in the casting pit, and an ordinary laborer in a few seconds placed them in position for operating the blast on the upper portion of the ingot and sand head, after this is filled with fluid steel from the ladle.

PAN-AMERICAN ROAD CONGRESS.

The following have been included in the list of subjects decided upon by the executive committee of the Pan-American Road Congress: "The History and Future of Highway Improvement," "The Benefits and Burdens of Better Roads," "The Relation of the Road to Rail and Water Transportation," "The Responsibility for Road Conditions, and the Way to Secure the Improvement of Road Conditions," "Tree Planting and Roadside Aesthetics," "The Essentials of Proper Laws for Highway Work," "Highway Indebtedness; Its Limitation and Regulation," "Organization and System in Highway Work," "The Educational Field for Highway Departments," "System in Highway Accounting," "Uniformity for Highway Statistics and Data," "Engineering Supervision for Highway Work," "The Merit System in Highway Work," "The Determination of the Justifiable Outlay for Specific Cases of Proposed Highway Improvement," "Proper Road Location; Its Importance and Effects," "Road Drainage and Foundations," "Highway Bridges and Structures," "Roadway Surfacings," "Resurfacing Old Roads," "Street Pavements," "Convict Labor for Highway Work," "Equipment for Highway Work," "Motor Traffic; Its Developments, Trend and Effects," "Load and Tire Effect and Regulation," "Comparisons of Traffic and Their Economic Value," "Maintenance, Materials and Methods," "Dust Suppression and Street Cleaning."

TOWN PLANNING CONTROL IN ENGLAND—AND IN CANADA.

In the 1915 report of Mr. Thomas Adams, town planning expert to the Commission of Conservation, he refers to the great dissimilarity between municipal government in Great Britain and in Canada. The whole structure of municipal government in England is based on local autonomy plus supervision by a central department of the State and it is an essential part of the system that the finance and policy of the municipality shall come under the review of the State Department. They authorize loans, approve the character of the works for which loans are required, prepare model by-laws for adoption, examine local bills submitted to Parliament, confer urban powers on rural authorities and administer the provisions under the Public Health and Housing Acts which require a certain standard of sanitation in all dwellings. Since 1909 its powers have been extended to deal with the question of town planning and under the Act which was then passed the Local Government Board was made the supreme authority. Before a corporation can prepare a town planning scheme, it has to get permission from the Local Government Board, and having got this permission, it has later to obtain the Board's approval to the actual scheme. The supervision of the central authority is needed to secure practical and effective co-operation between adjacent authorities and arbitration on points of difference. It is of the essence of town planning that all municipalities in juxtaposition to one another should co-operate and agree on a harmonious system of development and control, and also that some independent authority should act as arbitrator in those cases where the common good comes in conflict with the interests of private property.

It follows that in proper town planning it is desirable to have a higher authority than the municipality to act as a sort of court of appeal and that such authority should be part of the machinery of the provincial government.

The position of the various provinces at present is as follows in regard to town planning legislation:

Nova Scotia—Town Planning Act passed May 3rd, 1912.

New Brunswick—Town Planning Act passed April 20th, 1912.

Quebec—No act.

Ontario—No town planning act but certain powers are given to the Municipal and Railway Board under the "City and Suburbs Plan Act" to supervise the subdivision of land within five miles of a city having a population of not less than 50,000 inhabitants.

Manitoba—No act.

Saskatchewan—No town planning act but power vested in the Highway Board to control subdivisions.

Alberta—Town Planning Act passed on March 25th, 1913.

British Columbia—No town planning act, but inspector of municipalities recently appointed under the municipal department of the province has certain powers of supervision, but these do not apply to approving subdivisions of land. Certain powers approving surveys into building lots are given to the city engineers and mayors of municipalities, but these can hardly be regarded as exceeding ordinary by-law powers in other provinces.

In addition to the above legislative powers gradually being obtained in the different provinces, independent action has been taken in several cities: Montreal, Ottawa, Winnipeg, Edmonton, Calgary, Berlin, Brantford, Banff, Vancouver, Toronto and St. John.

ENGINEERING LABORATORIES OF THE HYDRO-ELECTRIC POWER COMMISSION.

The Hydro-Electric Power Commission of Ontario has a very complete and extensive system of research and testing laboratories, the equipment of which, due to the rapid expansion of the Commission, has been greatly increased both in volume and in variety during the past year or two. The system includes laboratories for high-tension and general testing; cement testing; lamp testing; standards and meter testing, and an illuminating engineering laboratory; and also a photographic laboratory for the use of the various departments. These laboratories have been placed on a self-supporting basis by the adoption of a scale of charges slightly in advance of cost, which applies to the other departments of the Commission and to municipalities and others for whom tests are made. The following notes, from the Commission's 1914 report, indicates in some measure the nature of the equipment and of the work done:—

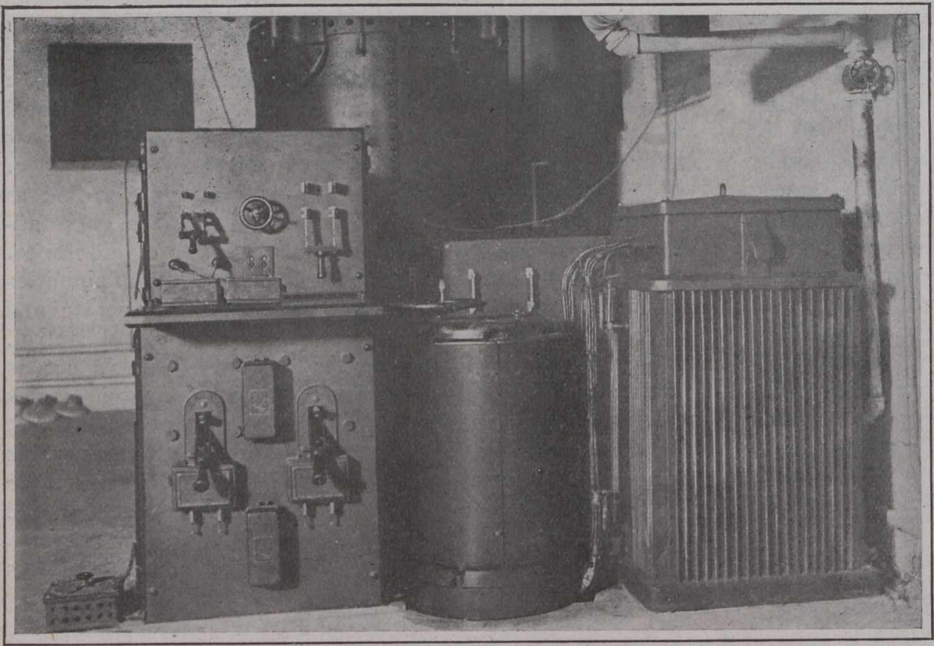

Fig. 1.—Control Board for High-Tension Testing Transformers, H.-T. Laboratory.

The electrical equipment necessary for widely differing classes of work done in the departments of the laboratories has been selected and installed with a view to promoting the greatest flexibility of use, thus enabling one piece of apparatus to be used for as many different classes of work as may be consistent with the accuracy required. The power used in the building is fed directly from the Strachan Ave. sub-station at 13,200 volts through an underground cable to transformers located in a special room in the basement of the laboratory building. The transformer equipment comprises three 50-kv.a. units so connected that three-phase power may be obtained from them at 220 or 110 volts. This power is carried through a set of interlocking oil circuit breakers to the laboratory switchboard, situated in another part of the basement. The switchboard, of special design, consists of seven panels, each for its own separate and distinct class of work, and includes, besides the necessary switches and circuit breakers for distributing power to all parts of the building, an arrangement whereby testing circuits in different departments of the laboratories may be interconnected, thus avoiding a large quantity of temporary wiring when special tests are conducted. This board also carries meters for indicating and recording all incoming power; contact making voltmeter and relays for the voltage regulator; and the terminal jacks of the storage batteries and other direct current circuits.

The battery charging set, and a 50-kv.a., 60-cycle motor generator set, for use with the high-voltage testing transformer are installed in the same room with the switchboard. The storage battery layout, located in a room near the transformer room, is made up of two separate sets, 70 cells each, of 80-ampere-hour "Tudor" cells. Provision having been made on the front of the main switchboard for any desired interconnection between these batteries, a wide assortment of direct current is available for all work where a source of steady potential is required.

High-Tension and General Testing Laboratory.—The high-tension section of the laboratories is equipped with transformers and connecting equipment suitable for making high potential tests at any voltage from 1,000 to 400,000 volts 60 cycles, and up to 225,000 volts at 25 cycles. Sixty-cycle power for this purpose is supplied by the 50-kv.a., three-phase alternator mentioned above. It is wound to give a normal voltage of 1,100 or 2,200, and is driven by a 75-h.p., three-phase, 220-volt induction motor. Excitation for the alternator is provided by the battery charging set. The high-tension testing set consists of two transformers wound to give 75,000 volts and 300,000 volts respectively.

This high-tension set is used for making dielectric tests on transformers, transmission line materials, series lighting fixtures, or any other high voltage electric apparatus. Considerable time and much study is devoted to high-tension transmission line troubles, especially of line insulators, both pin and suspension types, and much valuable information has been obtained. In several instances this has led to changes in design of insulators by the manufacturers, and, in a word, has had a salutory effect upon the manufacturers in causing them to exercise greater care in factory processes, in order to get a more perfect product.

Under this department, tests have been performed on several types of 13,200-volt power fuses under severe operating conditions, the tests being made with large generating and transforming capacity and 100 miles of 110,000-volt and 25 miles of 13,200-volt line in the test circuit. The ability of the fuses to open a "dead short" across the 13,200-volt bus was investigated, and observations taken of the attendant phenomena by means of the oscillograph and the camera.

A certain percentage of the small transformers purchased by the Commission are tested before being put into service, and this has led to frequent eliminations in the laboratory of transformers which would have broken down in service, and caused delay, dissatisfaction, and expense to the customer.

Mechanical as well as electrical tests are made on insulators, apparatus being at hand capable of subjecting them to a mechanical tension of 10,000 pounds, and, if desired, an electrical stress of 100,000 volts or more. This mechanical apparatus is available for any tension tests up to 10,000 pounds.

Many miscellaneous tests are carried out here for which special apparatus is designed in the laboratory workshop. Also, many tests, while not determining absolute values, do nevertheless determine comparative suitability of material for the work for which it is to be used. Among miscellaneous tests performed recently may be mentioned the following:—

Determination of the relative expansion of porcelain and various metals and alloys, glass and cement.

Determination of the relative heat conductivity of various patent car floorings and sidings as compared with wood and dead air space as a heat insulator.

Tests on hot galvanizing and sherardizing as a rust-proof covering for iron and tests to determine whether or not purchases of galvanized hardware will pass the standard four-dip test.

Connected with this section is the cement testing laboratory, in which four to five samples per day of cement may be tested. Samples are tested according to the specifications of the Canadian Society of Civil Engineers, for the following: Fineness, time of setting, tensile strength, soundness and constancy of volume.

Any sample not passing test, or which gives a doubtful test, is at once given a check test, reserve cement for such contingencies being labelled and stored at the time the cement is received at the laboratory. The reserve samples are preserved until the cement has been accepted by the Commission.

Meter and Standards Laboratory.—By the installation of improved apparatus, the scope of the work of the meter department has been greatly increased and a large amount of electrical testing extremely varied in its nature has been accomplished. The equipment has been chosen with a view to the widely varied classes of testing which are likely to come within the sphere of this department. Where extremely close voltage regulation is not required, 25-cycle power is obtained from the supply mains of the building; while 60-cycle power of the same class can be taken from the 50-kw. motor generating set installed for use with the high-tension testing transformer. For precision work, a specially designed motor-generator set has been installed. It consists of a direct-current variable speed motor driving a small alternator. From this alternator may be obtained two or three-phase potentials at any voltage up to 360, while by changing the speed of the motor, any frequency from 22 to 66 cycles can be maintained. Direct-current is taken from the storage batteries or from the charging generator.

Where electrical power is measured for sale, the necessity arises for accurate standards of measurement, against which may be checked the sub-standards used in calibration of station graphics and other power meters. With a view to leaving absolutely no room for conjecture as to the accuracy of measurements, a careful comparison has been made of the Commission's standard instruments with those of the Government at Ottawa, and also with the U.S. standards at Washington.

The "Hydro-Electric Meter Code" has been adopted as a basis of comparison of watt-hour meters, and a number of different types were submitted for comparison of their mechanical properties. A very close check having thus been obtained on the actual relative values of widely differing makes, a basis was established whereon to place large contracts for the instruments as required by the municipalities. The following meters have been submitted to these tests: Aron, Canadian General, Chamberlain and Hookham, Ferranti, Packard, Siemens, Sangamo, Westinghouse.

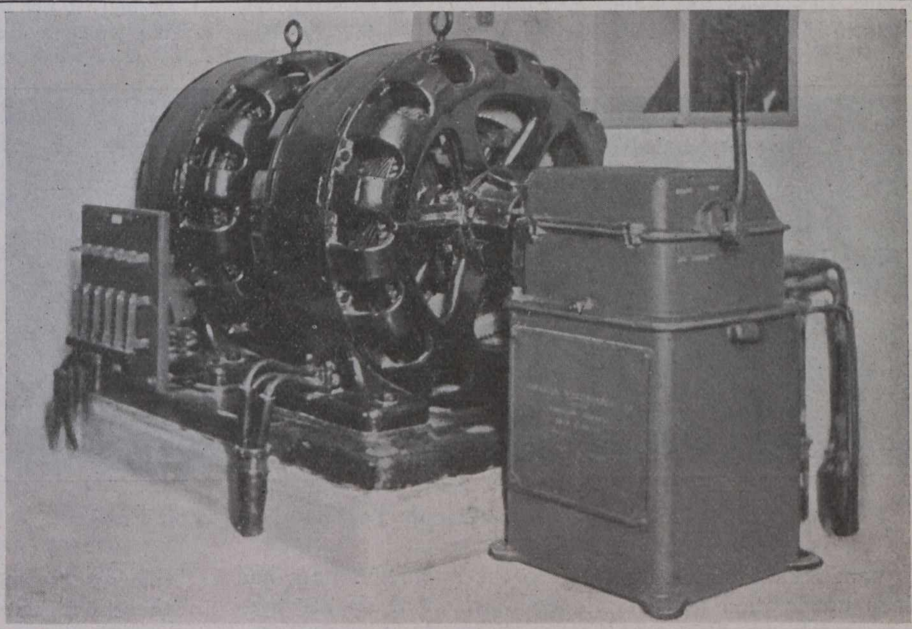

Fig. 2.—A 50-Kv.a. 60-Cycle Motor-Generator Set, H.-T. Laboratory.

The peculiar characteristics of the demands of rural customers, which now form a rapidly increasing percentage of the Commission's power load, has called for special types of metering apparatus to replace or to be used in conjunction with the ordinary watt-hour meter. Experiments have been conducted on various metering principles which might answer these requirements, and a number of types of excess and maximum demand meters now being given actual service tests to further determine their characteristics.

In the past year, the oscillograph has often proved its usefulness in investigating phenomena which would have otherwise been impossible of examination. The wave forms of currents and potentials obtained from the high-tension testing transformers were made the subject of a series of oscillograms, the object being to determine the behavior of the insulators tested, under the attack of a potential having a steep wave front as compared with its action when an approximately sinusoidal voltage is applied. This instrument has also proved invaluable in special investigations, among which may be mentioned: A series of tests to determine to what extent the triple frequency currents present with certain polyphase transformer connections, might be utilized for lighting and other purposes where a 25-cycle voltage is not desirable; the action of high potential fuses, and starting currents of incandescent lamps.

There has been done under the direction of this department, much work in the repair, adjustment, design, and re-design of apparatus used by the operating, municipal, and demonstration departments. Under this head may be mentioned: Portable load banks for meter inspectors and stationary load banks for municipalities, relay switches for remote control of street lights in scattered districts and a number of special attachments for portable and station meters.

Illuminating Engineering Laboratory.—Street lighting with its varied problems has occupied the major portion of the attention of this department. Investigations with a portable photometer have enabled us to obtain data, the arrangement of which clearly indicates the improvements that could be made, and portrays the existing defects. Illumination diagrams have been made; exercise of considerable care in arranging the important data has been undertaken to facilitate comparison of similar systems. By judicious use of these diagrams, new installations may be erected to give better satisfaction than could otherwise be obtained. The type of installation depends primarily upon two factors—the density of traffic, and the economy necessitated by the character of the district.

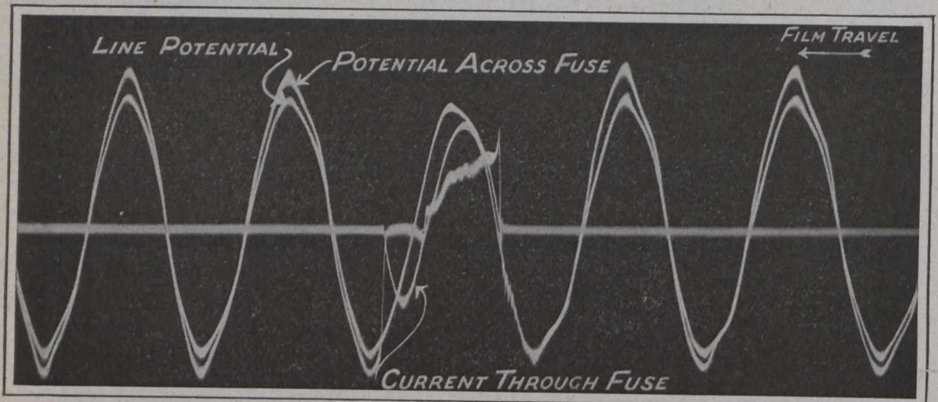

Fig. 3.—Oscillogram of Short-Circuit Test on 13,200-Volt Fuse.

Owing to these factors, several systems are employed. A large majority of towns use the series system of distribution, and use sixty to one hundred-watt lamps, equipped with radial wave reflectors. Most of the fixtures are mounted at a fair height, but the spacing depends on that of the power or telephone poles which preceded their erection. Five-lamp clusters were very prominent a few years ago, due principally to their artistic appearance, and the difficulty of obtaining incandescent lamps of high intensities at satisfactory rates for the purpose. This type of fixture gave way to the magnetite and flame arcs, which were used to secure high intensities; but the advent of the nitrogen-filled tungsten lamp with its numerous advantages, both from the standpoint of operation as well as maintenance, is likely to supplant it. This new lamp is destined to be an important factor in the future development of street lighting.

Out of the vast development now taking place in this field of exterior illumination, arises the need of a suitable line of dependable auxiliary devices, principal among which are reflectors, diffusers, and refractors. The high intrinsic brilliancy of the source requires some efficient reflector, combined with a suitable diffusing medium, and the large flux of light requires that means be provided for its proper distribution. To be assured that the complete unit satisfies the above conditions, photometric analysis should be insisted upon, otherwise the quality of the unit for the purpose for which it was designed is never known, and as a result its effectiveness is likewise a mystery.

Assistance has been rendered municipalities in securing data, the interpretation of which served to improve existing or tentative systems. New fixtures submitted as samples have been tested to determine their usefulness in the proper distribution of light. Nitrogen-filled tungsten lamps necessitated the design of new fixtures; the requirements and difficulties that would be encountered were presented to manufacturers, with the result that the suggestions hastened the appearance of satisfactory fixtures. The abolition of the five-lamp cluster brought out the problem of how to utilize the existing standard, and increase the height of the proposed unit. A design was submitted and the suggestions adopted. Many similar suggestions of less importance were given out, but the mention of these few serve to convey the idea of the service rendered, and scope of the work along this line.

An extensive series of tests was also made on types of diffusing glassware, to determine the quality with a variation of constituents as well as weight.

Lamp Testing Laboratory.—The equipment of this laboratory includes a 100-inch photometer with Bunsen and Lummer Brodhun screens; a complete life test outfit, including regulating devices to keep current and voltage constant, by which the life performance of series and multiple lamps is investigated; besides other apparatus for conducting more scientific researches. A complete set of standards is kept, and these are periodically checked against those of the leading standardizing laboratories in America.

DOMINION GOVERNMENT EXPENDITURE ON RAILWAYS IN FORTY-SEVEN YEARS.

The total Government expenditure on railways prior to and since Confederation (July 1, 1867) up to March 31, 1914, amounts, on capital account, to $328,265,788.28, including expenditure on the Quebec Bridge, and also the sum of $25,000,000 granted to the Canadian Pacific Railway Company for its main line; also the amount, $660,683.09, expended on the Annapolis and Digby Railway. In addition, there has been expended from the consolidated fund a total of $277,062,106.49, covering the operating expenses of the Government roads, and $67,566,152.69 subsidies other than the main line of the Canadian Pacific Railway, making a total expenditure of $605,327,894.77. Of this amount, the sum of $13,881,460.65 was expended prior to Confederation, namely, on the construction of portions of what is now the Intercolonial Railway system, $10,766,725.54, and on the construction of the Prince Edward Island Railway, $3,114,735.11.

THE RELATION OF MATHEMATICS TO ENGINEERING.*

By Prof. A. Ranum.

HOW can we reconcile the fact that many a successful engineer uses very little mathematics in his work with the further well-known fact that the profession of engineering rests to a large extent on a mathematical foundation? This question has many phases, one of which we can answer by pointing out that there is a vast difference between developing the mathematical theory that applies to an engineering problem and merely making use of the theory after it has been developed and put in tabular form by someone else. The latter process does not require very high mathematical attainments, but it is sufficient for many practical purposes. In order to gain more light, however, on this and other similar questions, let us try, if possible, to determine precisely what contributions mathematics has made to engineering; by looking back into the past perhaps we shall discover some general law that will enable us to peer a little into the future.

Engineering has been defined as the art of directing the great sources of power in nature for the use and convenience of man. Now, power implies energy, force, motion. Modern science has shown that all the phenomena of nature, including heat, light, and electricity, are manifestations of energy, modes of motion. In order to direct the forces of nature we must know how they act; we must understand the laws underlying the different kinds of motion, molecular as well as molar. Mechanics is, then, the fundamental science on which engineering depends. The other branches of physics reduce, in the last analysis, to mechanics. Now, in the case of a moving body, molecule, or electron, the first thing we want to know is its velocity, and the next is its acceleration. Both of these are rates of change or derivatives. Hence it is the most natural thing in the world to introduce the calculus into mechanics. The mathematical notion of a derivative is not something imposed upon mechanics from without; it belongs to the very essence of the science. Every waterfall, every bird on the wing, every ray of sunlight, every flash of lightning, when interpreted in mechanical terms, speaks the language of the calculus.

We must guard, however, against the error of supposing that mathematics can furnish us with any of the facts on which the laws governing physical phenomena are based. These facts can only be found by observation and experiment. But when once a precise physical law has been discovered, the function of mathematics is first to provide it with a language adequate to express all its complex and delicate content, and, second, to interpret its hidden meaning and derive the consequences that flow from it, when the other known physical laws are taken into account. This means that the mathematician builds on the given foundation of experimental laws a logical structure, which often contains new theorems of far greater physical significance than the original ones from which they are derived. It is in this sense that mathematics has been described as the master-key that unlocks the secrets of nature. Sometimes, moreover, a mathematical development of this kind leads in the most unexpected fashion to important practical applications. The delicate and exhaustive experiments and far-reaching generalizations of the physicist, the profound and searching analysis and rigorous thinking of the mathematician, the ingenious and practical resourcefulness of the inventor, are all three necessary factors in the progress of engineering. The influence of the last of these, the inventor, although more direct and more easily understood than the others, is not therefore necessarily the most important. On the contrary, his work is often a mere corollary of the scientific research which has prepared the way for him. The history of science furnishes countless illustrations of this. The development of electricity in general, and the discovery of wireless telegraphy in particular, are striking examples which I cannot better describe than by quoting from Whitehead's recent "Introduction to Mathematics":

"The momentous laws of electric induction were discovered by Michael Faraday in 1831-32. Faraday was asked: 'What is the use of this discovery?' He answered: 'What is the use of a child—it grows to be a man.' Faraday's child has grown to be a man, and is now the basis of all modern applications of electricity. . . . His ideas were extended and put into a directly mathematical form by Clerk Maxwell in 1873. As a result of his mathematical investigations, Maxwell recognized that under certain conditions electric vibrations ought to be propagated. He at once suggested that the vibrations which form light are electrical. This suggestion has since been verified, so that now the whole theory of light is nothing but a branch of the great science of electricity. Also Herz, a German, in 1888, following on Maxwell's ideas, succeeded in producing electric vibrations by direct electrical methods. His experiments are the basis of our wireless telegraphy."

We shall appreciate the important place which mathematics occupies in practical affairs if we try to imagine what would happen if all the contributions which mathematics has made, and which nothing else could make to the progress of engineering, were suddenly withdrawn. The result would obviously be terrific; it would mean nothing less than the total collapse of all industry and commerce, and indeed the complete annihilation of all the external evidences of our material civilization.

"But why," asks the practical man, "do mathematicians and physicists concern themselves so much about certain fields of research which can never, in all likelihood, lead to practical results?" Two good reasons can be given. First of all, truth is one and indivisible; every part of the structure of truth has some bearing on every other part. Sometimes the most theoretical investigation is nearest to the most practical application. Nothing could at first have seemed further removed from the concerns of our daily life than the study of the radiant energy connected with Crooke's tubes, on the one hand, or the use of the so-called imaginary numbers, on the other, and yet look at the practical value of X-rays and of alternating currents, the latter depending essentially on these same imaginary numbers.

Moreover, certain branches of mathematics are no less important because their influence is indirect. In order to gain a thorough understanding of alternating currents we must study the properties of Fourier's series; and, to understand Fourier's series, we must study the theory of functions and of differential equations. These latter, again, depend on various other disciplines, like the theory of equations and the theory of groups. We can never know too much about the space in which we live; hence the practical value of the modern developments of geometry, projective and metrical, analytic and synthetic, algebraic and differential, Euclidean and non-Euclidean, and even *n*-dimensional,—because from one important point of view our ordinary space is four-dimensional.

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* Sibley Journal of Engineering.

But a more fundamental reason why truth should be pursued for its own sake is the simple fact that man is endowed with a divine curiosity, a desire to penetrate the secrets of nature. He wants to understand, among other things, the outer physical universe in which he is immersed, and also the inner universe of logical thought revealed by mathematics. Are not the wonders of non-Euclidean geometry and non-Newtonian mechanics sufficiently valuable in themselves, without any reference to their practical bearing? The recent discovery that the atom, formerly thought to be indivisible, is really a complete world in itself—a sort of solar system, so to speak—is surely of immense interest to every thinking person, merely as affording a glimpse into one of the hidden recesses of truth.

Although the sciences of mathematics and physics are very closely related, they have not always kept perfect step with one another in their development. This is due partly to insuperable difficulties on the one side or the other, and partly to an unfortunate lack of co-operation between mathematicians and physicists. For instance, the physicist has sometimes come to the mathematician for the solution of a problem, but has been compelled to wait a long time for the proper theory to be developed. A classic instance is the problem of three bodies in astronomy, which still awaits a general solution, although an enormous amount of labor has been expended on it, and particular solutions for various special cases are constantly being discovered. Many other physical problems could be cited which resemble this in the fact that they lead to differential equations whose solutions cannot be found except in terms of new transcendental functions whose properties have not yet been investigated.

More often, however, the mathematician develops a body of doctrine, and only after a long interval does it turn out to have important applications to physics or engineering. The pure mathematics of one epoch becomes the applied mathematics of a later epoch. Maxwell's theory of electricity, before referred to, is a case in point; the mathematics he used depends essentially on principles which had been known for a long time. This discovery of the calculus was due to the attempt to find the lengths and areas of curves; later its immense significance in the science of mechanics was realized. The conic sections were investigated by the Greeks over two thousand years ago; and even to-day we are constantly finding fresh uses for them. Logarithms were discovered three hundred years ago, and the logarithmic function (or the compound interest law) now proves to be one of the commonest and most important laws governing the phenomena of nature. The elliptic functions were first invented as pure mathematics, and then applied to the motion of the pendulum and other physical problems. The theory of groups has found a most unexpected application to the problem of determining the different types of crystal structure. Very recently the principle of relativity has appeared on the scene, and threatens to revolutionize the science of mechanics; but its natural geometric interpretation turns out to be a non-Euclidean geometry that has been known for thirty years or more.

The history of Fourier's series is a fine illustration of the mutual dependence of mathematics and physics. Originally due to the solution of a problem in the flow of heat, it soon acquired a position of capital importance in pure mathematics as the general expression for a simply periodic function. But since periodicity is a well-nigh universal law of nature, Fourier's series soon returned to the physical camp, where it now serves as the appropriate vehicle for expressing a large number of different kinds of periodic motion, including sound waves and alternating currents.

Can we make any prediction as to the future prospects of engineering? If progress continues along the lines followed in the past, one thing, at least, we can foresee with great confidence—the pure and applied mathematics of to-day, with its enormous and ever-growing body of splendid achievements, will surely lead, sooner or later, to a variety of practical applications and new inventions that will startle the world. The material and utilitarian progress of to-morrow will depend largely on the scientific progress of to-day. Moreover, the increasing demand for accuracy and efficiency in engineering can be met only by broadening and strengthening its mathematical foundations. Many an engineering student of to-day will live to see the time when those engineers who are leaders in their profession, who are capable of meeting novel conditions where originality of thought and action is required, will be men who are better equipped on the scientific side than we think necessary to-day; they will be men who are thoroughly trained in the use of many of the higher branches of what we now call pure mathematics.

LARGE STEEL CASTINGS FROM SMALL CONVERTERS.

Steel foundries having small converters can very readily undertake the turning out of large castings. This is accomplished by uniting several heats, the first blown heats being held in the ladle under a covering of slag until the required weight is reached. A whole series of heats can be successfully united if a mixer or collector of proper construction is used that is well preheated. This method is in operation at a foundry at Milan, Italy. In 1894 several castings up to 6 tons in weight were made, a mixer being used, and since then the weight has been increased to 25 tons, a larger mixer having been built. Experience has shown that the quality of the steel is greatly improved by its long holding. Purification takes place similar to that noticed in the case of pig-iron mixers. Recently castings of 30 tons have been made, weighing 45 tons with the casting heads. More steel than this must be made, due to a possible skulling in the mixers during the long wait. The steel-making capacity consists of three 1-ton converters, two open-hearth furnaces of 3 to 4 tons, one open-hearth furnace of 6 tons (at the most 8 tons), and a Stassano electric furnace holding about 1 ton. Only one converter can be blown at a time, owing to insufficient blast, so that as fast as one is turned down another is turned up. Also only two open-hearths can be run together. There are two mixers, one holding 15 and the other 20 tons. The converters were blown for four hours, and in that time made 40 tons; one open-hearth furnace 8 tons, another 5 tons and the electric furnace 1 ton, altogether 53 tons. This large excess of 8 tons was to counterbalance skulls in the mixers, which amounted to 6 tons. The steel, nevertheless, cast all right. The experience gained with this first large casting was used several weeks later when a second was made; 34 tons of steel was blown and 4 and 7 tons respectively were obtained from two open-hearth furnaces. No skull was left in the mixers. The cupola charge for the converters consisted of 50 per cent. hematite with very high silicon and 50 per cent. steel scrap with 0.2 per cent. silicon. The castings were annealed by building a furnace around them in which a coke fire was used.

FOREST RESERVES IN ONTARIO AND THEIR RELATION TO WATER POWERS.

THE present area of forest reserves and parks in Ontario is 22,574 square miles, or 14,447,360 acres. This area, while large in itself, is not great in comparison with reserves and parks in Quebec; nor is it large in proportion to the total area of non-agricultural lands in Ontario which must always be chiefly valuable for the production of timber. There are many millions of acres of cut-over or burned-over forest lands in this province, belonging to the Crown which are now practically without fire protection, but which contain a great deal of young growth and much timber at present below merchantable size, but which, if protected from fire, would ultimately become merchantable.

The present annual revenue from woods and forests in Ontario is in the neighborhood of $2,000,000. Hon. Clifford Sifton, chairman of the Commission of Conservation, in his annual address presented last January, states that if this revenue is to be maintained new areas must be continually opened up for lumbering, and this in turn necessitates the protection of the non-merchantable areas and the young growth, in order that when the time comes, they may contain merchantable timber ready for cutting. Any other policy means the sacrifice of a large future revenue, in order to avoid much smaller present expenditures.

The problem is undoubtedly a difficult one, since the expense of protecting the large areas of young growth during the necessary period of many years would in the aggregate be heavy, while there is at the same time a strong demand for the surplus revenues for purposes of general governmental administration. It seems probable that the situation could best be met by the adoption of a definite policy which would result in the reservation and placing under protection each year of a limited but definite area of young forest growth found upon examination to be most suitable for this purpose. An excellent step in this direction was the addition last year of 2,000 square miles to the Mississaga forest reserve, and 811 square miles to the Algonquin national park; but this constitutes only the beginning of what should be adopted as a definite and continuing policy.

The necessity for further protection of important watersheds must be considered. Waterpower development is now a vital factor in the industrial life of the provinces, and this importance is bound to increase tremendously in the future. For the intelligent protection of this great interest forest protection is absolutely essential. A concrete example of this relationship was brought to the attention of the Commission of Conservation at the annual meeting in 1914 by Mr. J. B. Challies, superintendent of the Dominion Water Powers Branch. As a result of the representations made by Mr. Challies, a resolution was adopted by the Commission, favoring the establishment of a forest reserve on the upper waters of the Winnipeg River and especially on the watershed of the Lake of the Woods. So far as known, however, there has been no action taken by the Ontario Government.

A shipment of 6,000 tons of zinc ore from Australia is being smelted in the southern Kansas and Oklahoma smelters. The shipment comes as a result of the war in Europe, which has closed most of the big European smelters. The Broken Hill district in Australia, from which the shipment of 6,000 tons has come, produces about 400,000 tons of zinc a year.

AVOIDING DEFECTS IN CONCRETE WORK.

Failures and defects in ordinary concrete work are invariably due to one or other of the three following primary causes, alone or in combination: (1) Inadequate design, (2) inferior materials, (3) inferior workmanship. Consequently, it may fairly be said that the most effectual way of avoiding failures is to secure the services of a thoroughly qualified designer, and to employ none but experienced contractors. The wisdom of this procedure becomes evident on consideration of the most frequent contributory causes, which include:

(1) The use of inferior cement imported from abroad.

(2) The employment of unsuitable aggregates, consisting of perishable stone, coal residues, slag, and the like.

(3) The acceptance of aggregates inadequately graded, or containing an undesirably large proportion of earthy matter.

(4) The adoption of inadequately graded sand containing an excessive proportion of foreign matter, or of fine stone chippings containing quarry refuse.

(5) The use of impure water.

(6) Want of care in proportioning and mixing concrete.

(7) Using concrete which has commenced to set.

So far as reinforced concrete is concerned, there have been very few actual failures in this country, but these and the more numerous mishaps which have occurred abroad point to the following causes of failure:

(1) Inadequate design, including miscalculation and unscientific disposition of reinforcement.

(2) The misplacement or omission of important parts of the reinforcement.

(3) The use of inferior concrete, and poor workmanship or carelessness in depositing concrete.

(4) The inadequate construction and temporary support of moulds and centering.

(5) The premature removal of moulds and centering, or of temporary supports.

The last mentioned is by far the most frequent cause of failure, but represents a mistake not at all likely to be made by experienced contractors. Inadequate design may result from lack of experience, and is most unfortunately encouraged by the pernicious system of inviting competitive designs. Errors in the application of reinforcement and in the preparation and placing of concrete are obviously preventible by efficient supervision on the part of the contractor and the clerk of works or resident engineer.

One particularly suggestive characteristic feature of reinforced concrete work is that no failures have been known to occur after the completion and hardening of the concrete. This point constitutes definite proof of the fact that the comparatively few mishaps so far recorded have been the result of errors or carelessness in construction.

Equal proportions of stone, brick, timber and steel structures have failed during or immediately after construction for similar reasons. Moreover, many structures of these classes have collapsed at varying intervals after completion, and as the result of gradual decay.

On the other hand, the history of reinforced concrete gives the assurance that when a properly designed and carefully built structure has once been completely finished it is perfectly safe, and will go on increasing in strength and durability from year to year.—(Ferro-Concrete.)

DUST ON COUNTRY ROADS.

By Henry J. Scott, Toronto.

IN a consideration of the dust problem it is necessary to differentiate between the dust on country roads and town or city dust, as the latter must be dealt with from the standpoint of public health as well as of public convenience.

The former, to the highway engineer or superintendent, means the disintegration of his roads and the consequent necessity of repair. In this respect, the old macadam road has stood the test of many years, and its utility would be still excellent were it not for the introduction of a new feature in the shape of automobile traffic, both heavy and light, slow and rapid. The loads now carried on the public highways are far heavier and the rate of speed much higher than heretofore, and in consequence a comparison between the tonnage and speed ten years ago and that of the present day would be interesting. A modern road has to be stronger in order to resist the extra weight, but the principal strain it has to be built to resist is that due to the speed of the heavy automobile. These strains are practically in inverse ratio to the power necessary to propel the car along a road at the speed at which it travels.

This force, acting as a shearing strain on the surface of a road, produces a grinding together of the particles of which the surface is composed beyond that which is due in the case of slow-moving traffic. In the latter case the strains are almost vertical and therefore the crushing force is the only one to be considered.

Another most important factor is the suction which takes place from the broad rubber-tired wheels after their passage. Any dust produced by the grinding action does not have a chance to pack into the interstices of the material, but is drawn out of the surfacing so that a road subject to this class of traffic does not become more compact and firmer as it used to do under the old traffic.

For a new country road tar macadam, in the writer's opinion, nearly fulfils the present requirements, and for the following reasons: (1) The binder distributes the strains due to rapid and heavy traffic over a greater area because of the adhesion of the integral parts to one another. (2) The lubricating property of the binder minimizes the friction between the particles comprising the surface. (3) Any pulverizing of the material is, to a great extent, taken up by the tar and the dust is retained and becomes part of the binder itself.

The laying of a tar macadam road has been dealt with in several recent articles in *The Canadian Engineer*. The best method of dealing with ordinary macadam roads, however, is at the present time one of the most important subjects. There are many well-made macadam roads suffering from rapid disintegration and various dressings have been tried in the hopes of getting a binder which will prevent this. Among those which have come under the writer's notice are: (1) Oil; (2) tar; (3) glutrin; (4) sea water. Oil fulfils many of the necessary requirements if properly applied. In the majority of cases, however, an oil sprinkler is sent down a dusty road just once, and that is all. Temporarily this has a very beneficial effect as far as keeping the dust from flying in the air, but unless properly applied it has little protecting value to the surface of the road itself. In order to get the full value of this particular method, it is necessary for the oil to penetrate the surface as much as possible. In order to do this, a road should be brushed clean of dust before an application is made and a second and third application made after an interval of a few days. A road thus treated will not only be fairly dustless but the surface itself will be preserved by the reduction of the friction between the particles.

Tar has been applied in a variety of ways, and is certainly an effective means of preventing dust. As a preservative of the road surface, the writer has not found it quite so efficient as oil because its penetration below the actual face is not as great. It does not act as a lubricant between the particles and so prevent disintegration.

Glutrin has been somewhat extensively used and its method of application, mixed with water and applied with an ordinary watering cart, is very simple. It should be made after the road is brushed as in the case of oil, and several applications are necessary in order to get a maximum of penetration. In this latter particular it forms a slight cement with the dust with which it comes in contact and forms a fairly dustless road and one which wears equally as well as an oiled road. It has a somewhat objectionable smell at first but this is not perceptible after a few days.

Sea water has been used on coast roads but of course cannot be considered as a general proposition. It is good, so long as the weather is very dry, but as the salt is deliquescent and takes up the moisture of the atmosphere a road so impregnated is almost permanently damp and soft, and consequently wears badly.

REMOVAL OF RUST BY CHEMICAL REAGENTS.

In a paper on this subject before the Iron and Steel Institute, Messrs. J. Newton Friend and C. W. Marshall point out that for many purposes of both technical and purely scientific importance it is eminently desirable to find some method or chemical reagent that will readily remove rust from iron. In many cases, as, for example, in cleaning structural steel work prior to painting, the loss of a little iron along with the rust is not a matter of serious moment. In the cleansing of museum specimens, particularly when attempts are made to read partially obliterated inscriptions, it is important to lose as little iron as possible; whilst in scientific investigations it is essential that the loss of unoxidized metal involved in removing the rust shall be reduced to the absolute minimum. Electrochemical methods have frequently been suggested. Scraping with knives and polishing with sand or emery-paper is very disagreeable and fatiguing. In the literature on this subject different investigators have frequently alluded to dilute solutions of sodium citrate as suitable media for loosening rust without dissolving any iron. The authors' experiments show, however, that solutions of sodium citrate are not suitable media for investigations involving the quantitative removal of rust. Also they are extremely slow in their action, as is evident from curves given in the paper.

Various other chemical reagents were tried, but none of them proved as useful as boric acid, and it did not appear possible to find a reagent that would remove rust quantitatively without also dissolving some of the iron.

The National Transcontinental Railway viaduct over Little Salmon River, near Grand Falls, N.B., is a plate girder structure 100 ft. high, 4,000 ft. long and containing 7,000 tons of steel.

APPRAISAL OF PUBLIC UTILITY PROPERTIES.*

By Wm. G. Woolfolk
Sanderson & Porter Engineering Staff, New York.

THE control of public utility enterprises through regulatory bodies is still in a somewhat experimental stage, although broadly stated, the present preference of the public inclines towards private ownership and public regulation, rather than towards the purchase of these properties with public funds and their operation by public officials.

The whole structure of commission regulation is built upon the foundation that private ownership shall be required to furnish adequate and satisfactory service at reasonable rates, and shall be allowed to earn a reasonable return upon the fair value of the property dedicated to public use.

It would, therefore, seem that for the present, aside from the matter of character of service, this whole proposition resolves into the two questions—

(*a*) What is a reasonable return?

(*b*) What is a fair value of the property?

At a time when rates of return and even the fundamental elements constituting the value of the property are apparently in such a state of controversy, it is not surprising that the large majority of the papers on valuation written by men eminent in their respective lines of endeavor, should be devoted almost exclusively to the discussion of the basic principles involved and arguments on the broad issues at stake.

Rate of Return.—A fair and reasonable rate of return may well be defined as that rate which will not only attract funds from investors but allow as well for a reasonable excess for surplus, contingencies and normal hazards. No conservatively managed company can afford to pay out all its income, neither can it issue securities to raise money unless the investor who buys such securities knows there is a reasonable margin earned over that required to pay interest and dividends.

The determination of the amount of return which utility investors are to be allowed to earn upon the fair value of the "used and useful" property can hardly be considered as purely an engineering problem. The percentage factor, called rate of return, is not susceptible of exact mathematical determination. On the contrary, as those who are constantly seeking new money to provide for required improvements and extensions know from practical experience, the rate of return is governed by broad and fundamental economic considerations.

Broadly speaking, money is raised by utilities through the sale of two classes of securities—bonds or "senior securities," where the protection is better and the rate of return relatively low, and stock or "junior securities," which, due to their more speculative nature, require a higher rate of return. It is impossible to finance a utility throughout with bonds, and seldom possible to finance with stocks alone, and thus in raising money for utility needs, it is necessary to finance in part with senior securities and in part with junior securities, and while the theoretically ideal way of financing is through the sale of profit-sharing junior securities, it is always difficult and frequently impossible to prevail upon capital to invest on this basis, even when exceptional inducements are offered.

All investors do not bring to the security market the same point of view, but all of them are influenced by the following principal qualifications of an investment:

(*a*) The security of the investment;

(*b*) Its marketability;

(*c*) Its rate of return.

Every intelligent investor will make these three his principal considerations in weighing the difference and comparative advantages of one industry over another, or of a "senior" over a "junior" security, or in passing upon the relative merits of two different securities of the same class.

It is not intended to suggest that the regulating body should undertake to state any standard of financial plan which should be adopted by utilities as a basis for raising money, but in fixing rates of return, however, it would seem that commissions must possess a broad knowledge of and have a due regard to the controlling economic laws, and after weighing the difference existing between utilities and other enterprises in different communities and the various risks involved, so fix rates of return that the utilities can successfully compete for new money with other industries.

Utilities are not finished. They are in a constant state of extension and construction which continually calls for new capital. These demands must be met by inducing investors to furnish the necessary funds or the utilities will stagnate and our communities will suffer accordingly.

It is cold comfort to the prospective investor invited to enter an unseasoned property in a small though growing community, and worse for the party who has already made such an investment, to be told that the Federal Court has decided that anything less than a six per cent. return on the enormous and thoroughly well-established gas business in New York City is confiscation, and at the same time to hear the inference drawn that anything which just falls short of confiscation is ample profit.

Because the legal rate of return in some States is six or seven per cent. on well secured loans or safe real estate mortgages, and the courts hold that anything less than six or seven per cent. is confiscatory, it does not follow that capital can be induced to invest its time and money in the utilities in any State for any such rate. On the contrary—capital maintains that the gap between confiscation and a reasonable and fairly well secured rate of return is very wide; that the legal rate is the minimum to be considered, and that an additional amount for profit, surplus and contingencies must be allowed to compensate for the risks assumed before it will go into public service and subject itself to commission regulation.

Thus it follows that the investor at large will ultimately have to be reckoned with as a strong controlling element in fixing the required rate of return, for although commissions may rule and courts may decide, the investor with funds will continue independent and will put his money in those enterprises where the permitted profit is made commensurate with the risks involved, with a further profit representing participation either in savings effected by high efficiency, or exceptional earnings secured by competent and aggressive management.

So, while the rate of return required to attract capital to any individual utility is not susceptible of exact mathematical determination, and that each case must be decided upon its individual merits, the whole matter is governed by broad and fundamental economic laws which cannot be disregarded with impunity.

It is not sufficient to avoid plain confiscation of the values which investors already possess in the public utility

*From a paper read before the 7th Annual Convention of the Indiana Gas Assoc., March, 1915.

business, but it is also essential that other investors be induced to regard public utilities not only as safe, but also as reasonably remunerative investments. Nor can commissions, often having authority equal to or exceeding those of a board of directors, themselves escape the full responsibility involved in exercising those powers and their share of the responsibility in raising funds to provide adequate and extended service to the public, thus averting stagnation of utility enterprises.

Determination of Fair Value.—A determination of the fair value of the property involved is a far different and far more complex proposition. That it is of paramount importance to have this work, which constitutes one of the fundamental factors involved in rate-making, well and efficiently done, is beyond question. Not only are the interests of the individual investing citizens at stake, but also the interests of the general consumer whose industrial and commercial welfare is now recognized as inseparably linked with that of the utility serving the community in which he resides.

One of the most difficult of the problems to overcome is a partly excusable scepticism of the average business man towards engineering estimates of the cost of public utilities. The average man of commerce does not know that for every dollar of utility gross earnings produced, four, five and not infrequently over six dollars of capital must be invested, and that out of every dollar of utility gross income taken in over the counter, from twenty-five to thirty-five cents must be paid out for interest alone, to say nothing of an allowance for replacements and renewals and the other costs of doing the business. Measured by the standards of ordinary business where the invested capital is "turned over" once, and possibly several times in a year, this appears to him as a preposterous proposition on its face, and it is no mean task for the appraisal engineer to produce proof convincing enough to overcome this rather pardonable incredulity.

Engineers, and men with engineering training who have been so closely identified with and who are so largely responsible for the creation and expansion of these properties, seem to me especially qualified to pass upon the value of such utility properties.

There is a time-honored complaint regarding the impossibility of getting two engineers to agree in their estimates. It has been my observation that such disagreements arise largely from different definitions of terms and from using different assumptions as a foundation. Where the estimates are put upon a comparable basis and the same methods of valuation are used, these differences largely disappear.

Functions of Appraisal Engineer—In making a valuation of public utility property, broadly speaking, the appraisal engineer, whether representing the public at large or the private investor, has two independent and essential functions to perform, and he may be called upon to exercise one or both of these functions which may be generally described as follows:

(*a*) To collect and collate in orderly form a description of the physical property of the utility, and to prepare schedules of facts and all other collateral information having a bearing upon the determination of the value of the property.

(*b*) To express a balanced and expert opinion of such value after considering all the facts in the case.

In preparing a valuation to be presented to a commission, appraisal engineers are always confronted with the first of these two tasks, even though the second is handled by the utility corporation or by a commission. When acting in the capacity of advisers to bankers and present or prospective investors, the engineers are in almost every case compelled to perform both of these functions.

After a somewhat extended experience in this class of work, the writer is lead to the conclusion that even the first of these two tasks instead of being a simple one to be entrusted to competent clerks and necessitating but little ability and experience, requires as high a degree of engineering skill and calls for as much originality in design and conscientiousness of performance as the design, estimates of cost, and erection of a generating plant and distribution system.

It seems to have been assumed in many quarters that the mechanics of taking a correct inventory of the multitudinous items of physical property going to make up a utility, requires no special care or pains to produce a perfect or exact piece of work. It would no doubt cause considerable surprise were it generally known that those of us who have put in years on this class of work still recognize that engineers are confronted with a problem of considerable complexity.

This work must be done with painstaking and faithful care, as it forms the very foundation upon which the entire superstructure of the valuation rests. A house built upon sand will fall, and many a valuation has failed to sustain its claim to accuracy because built upon a defective foundation.

The cost of inventory work frequently involves large sums of money, and for the sake of economy, if for no other reason, it seems most desirable that this work should be done but once. It is not at all uncommon that independent inventories of the same property are made by the engineers of the commission, the engineers of the city, and the engineers of the company. This triplication of labor and cost can be largely overcome if the inventory notes are prepared and kept in such a way that they can be readily checked by the commission and city engineers while the work is in progress, or after its completion. One of the most satisfactory pieces of inventory work with which I have ever been identified was in Indiana, where such an arrangement was effected and where the work was prosecuted in co-operation with the engineering staff of the Commission. Errors were corrected, differences were ironed out on the job, and after the work was completed, both engineering staffs had the satisfaction of knowing that they were pricing the same inventory.

Mechanics of Taking an Inventory.—Probably everyone has been struck by the numberless printed, typewritten and mimeographed forms which have been designed to cover the inventorying of every kind of equipment. While many of these forms show great and surprising differences in their make-up and contents, a very large number, in fact a large majority, appear to have been inspired in most of their essentials by forms that were already in existence and were perhaps many years old. Yet the subject of appraisal is of such recent growth that methods which were considered satisfactory five years ago may prove wholly insufficient under the present close scrutiny to which public utilities are subjected.

Possibly some of this lack of care in designing inventory forms and methods arises from the belief that inventory and appraisal work requires but little ability and experience. But there is another point, and possibly a point of sharp divergence of opinion, which appears to be involved in this habit of copying any supposedly satisfactory standard set of inventory forms with the view of employing them for any and every appraisal which may have to be made.

Some of us whose work deals largely with public utilities are reaching the conclusion that there is no single ideal system of inventory forms and methods which can be applied to each and every appraisal. We believe that there are certain factors which should influence the selection of forms and methods, and that these factors will be found to vary widely in their degree and in their influence with each particular case. Here are some of them:

1. The speed with which the inventory has to be made;
2. The number of men available for the work;
3. The familiarity or unfamiliarity of the inventory men with the company's equipment;
4. The familiarity or unfamiliarity of the inventory men with inventory work;
5. The methods by which it is proposed to summarize the work;
6. The kind and condition of the records which the company has kept in the past;
7. The special conditions and regulations imposed by public service commissions or regulating bodies;
8. The classification of accounts according to which the appraisal is to be set up.

These factors, and others, make it a mistake to try to adopt any one set of forms or inventory methods. There are variations in each case which are unavoidable if the work is to be properly and economically executed, and if it is attempted to fit the conditions to the forms instead of fitting the forms to the conditions, the results will be injurious both to the quality of the work and the interests of the company whose property is being appraised. It is a cardinal point, that each and every inventory and appraisal is a problem by itself, standing on its own bottom and calling for careful and individual selection and creation of the best methods by which to carry it out.

Compiling the Inventory.—Many are unaware of the existence of the necessity of compiling the work, yet it involves a considerable part of the total cost of an inventory and requires considerable skill in devising labor-saving methods. Why does an inventory have to be compiled at all? Why are not the field sheets sufficient? It has to be compiled because a commission or the company's auditing department must finally be given the results of an inventory or appraisal according to some classified system of accounts. The man in the field who takes the original inventory cannot possibly so subdivide the equipment at the time he is listing it. It is not practicable for such an inspector to do much more than list all he sees on some simple set of forms for field use. We have learned to be content if he will do that much, or even 90 to 95 per cent. of that much without mistakes. When he turns in his field sheets the data on them has to be taken to pieces and set up again in such fashion that it can be assembled to conform to the accounting system adopted.

These summarizing sheets vary as widely as the field inventory sheets from job to job. They are, of course, an intermediate step, out of which are evolved the final inventory sheets arranged according to whatever system of accounts is called for.

From this intermediate step we pass to the final stage of the inventory, that is, the stage where the equipment is listed according to the company's or the commission's accounting system, and is a simple "bill of material" readily susceptible of pricing. The forms upon which the inventory is set up in its final stage are simple and do not generally exhibit the striking variations of field forms.

To digress at this point for a moment, the question may well be raised—

Why is all this elaborate and minute detail necessary; why not use some "short cut" method of approximation, thus reducing the cost of the inventory and appraisal work?

Under the theory of commission regulation of rates and earnings based on valuations, the market value of the property, which is established by the net earnings, will be in direct proportion to the valuation upon which the fair return is figured and allowed. On this basis it is just as important to the owners who are interested in earnings and market values only, that every dollar of property be found. From their standpoint, a thousand dollars found and included in the inventory and valuation is as real and valuable as one thousand dollars cash in the bank, which would be available to buy more such property or for use as working capital.

Therefore, from the owners' standpoint, if the cost of taking inventories were balanced against the values found, it would be a mistake to stop the detail work much short of a point where the field crews were finding property at a rate sufficient to pay their time and expenses.

This class of work necessarily involves large expenditures, but from the owners' standpoint, money saved in the cost of the inventory and appraisal work would be poorly saved indeed, if it caused the owners to lose each and every year much more in values and in return upon their investment.

Checking the Inventory.—It may be safely stated that no inventory of a public utility's property ever is or has been absolutely correct. In the first place, the appraisal manager must either use men who, although skilled in inventory work, are strangers to the territory and the equipment itself, or else use the company's own employees. While these latter may be fully acquainted with the company's equipment, they are seldom experienced in taking an inventory. In the second place, even assuming skill in inventory work or acquaintance with the equipment, or both, there is a normal percentage of error in every human undertaking. But while in other affairs such errors may be compensating—the plus off-setting the minus, therefore negligible in the aggregate—in inventory work practically all such errors are on the minus side.

It is rare that an inventory inspector makes a note of two units where he has inspected but one. It is equally rare that his inventory lists two generating sets where but one is installed. Much more frequently the inspector misses the equipment because it is difficult of access, or because he is unaware that it is company property. Sometimes, and this is a peculiarly frequent and embarrassing source of error where the field man is a company employee, he is so profoundly convinced that his knowledge of the equipment is exact and complete, he deems it unnecessary to go out in the field and check his records against the facts. Unfortunately for many appraisal engineers, this latter difficulty is apt to be experienced with those very companies who are led to assume, by reason of the elaborate nature and excellent clerical quality of their records, that these superficial qualities are a proof of their accuracy—rendering it unnecessary to check them in the field.

Limitations of an Inventory.—Apart from all these human and inevitable mistakes and omissions, there is another range of items which cannot enter into the inventory proper as taken by field crews, because the items themselves are no longer evident. Yet they may have involved large capital expenditures and have truly constituted a part of the equipment without which the company could not have reached its present state of development.

Movements for civic betterment compel changes in and often the scrapping of equipment where only a fraction of the useful life has been consumed. Changes in street grade are a potent source of expense to gas, water, telephone and other utilities having equipment buried under the surface of streets. Often the installation of a sewer calls for extensive and costly alterations in the mains of a gas company apart from the expense and burden put upon the operating department in maintaining service free from interruption.

And, as all operating men know, such work frequently involves not only the discarding of equipment which is still of one hundred per cent. service value to the community, and the installation of new equipment, but also the added expense of temporary lines whose use will be discontinued as soon as construction is completed and the new and permanent mains are installed.

Those of you who have recently been in New York City and have observed the construction work for the new subways, have noted the enormous extent of the temporary mains installed on the surface of the streets, and in many cases upon elaborate and costly trestle work erected over the sidewalks. Assume that an inventory of these mains is made after the subways have been completed and put into operation. The field man will put on record only the mains as he then finds them. His inventory will contain no mention of the former mains in excellent operating condition which were discarded when the subway construction was commenced, nor will it contain any mention of this entire system of temporary mains which to-day arrests the attention of every visitor to the city.

An inventory is a list of the property which an observer actually discerns at the time of making his physical count. He does not and cannot take account of such changes or duplications of equipment. When the field inspector's inventory is turned over to another department to be priced, if this department has no note of the past history of the company, then the dollars which will be placed to the company's credit as representing the capital cost of this equipment, will be far from covering the total expenditure which the company was forced to make.

These are some of the defects and omissions in inventory work, even when it is reasonably well done. There are other defects, each of which is serious, sometimes so much so as to gravely affect the value of the inventory when presented as evidence, and to seriously impair the utility owners' chances of sustaining before a court or commission the actual expenditures made upon the property.

Summing up an inventory, even when taken with intelligent care, is liable to the following defects among others:

(1) The inventory is invariably less than complete;

(2) It is not infrequently so set up as to be incapable of segregation in accordance with the state commission's or the company's classification of accounts;

(3) One of the entire property of a large corporation covering much territory, cannot always be correctly described as complete as of any one specific date;

(4) It may be so taken and so set up that additions thereto or withdrawals therefrom cannot be intelligently and correctly made;

(5) It may be so taken, particularly in large appraisals, that it is not always possible to fasten the responsibility for each detail of the work upon the inspector who actually made this portion of the inventory;

(6) It may be so set up as to convey the impression that the physical property when inventoried represents all the property the company ever had, and that its valuation at reasonable figures represents all the dollars the company ever spent or is entitled to credit for.

USE OF CYANIDE IN NORTHERN ONTARIO.

In the treatment of gold and silver ores in the Porcupine and Cobalt camps, the supply of cyanide, which had ordinarily been obtained from Europe, caused no small concern at the outbreak of the war. It was feared that those mines using cyanide might have to curtail their output, because much of the world's production of cyanide was of German manufacture. As a matter of fact, it was found on inquiry that all the mines of the district, with two exceptions, were using cyanide manufactured in Great Britain by the Cassel Cyanide Company, Ltd., of Glasgow. The British Government, realizing the importance of the production of gold and silver, particularly at the present time, asked the Cassel Company to sell no cyanide outside the British Empire until the gold and silver mines within the Empire had been supplied. The Cassel Cyanide Company sent a special representative into Northern Ontario to confer with the mine managements. The company proceeded to make large additions to its plant so as to be able to carry its increased production load.

Owing to increased cost of raw materials, due directly or indirectly to the war, the price of cyanide has risen to 18 cents per pound, which is a rise of three cents above the price immediately before the war.

The offer that the Cassel Cyanide Company made to the mines was to keep them supplied with cyanide on the following terms: 18 cents per pound to June, 1915; 16 cents per pound to the end of 1916; and 15 cents, or the normal price, during 1917, providing that the mines on their part give the company an exclusive cyanide contract for two years, giving an estimate now of what their requirements were likely to be during that time.

At the close of the year, according to the recently issued T. & N. O. report on the mining industry of the district, the companies using cyanide were:

In Cobalt—Buffalo, Dominion Reduction, Nipissing and O'Brien. In Porcupine—Dome, Hollinger, McIntyre, Porcupine Crown and Vipond.

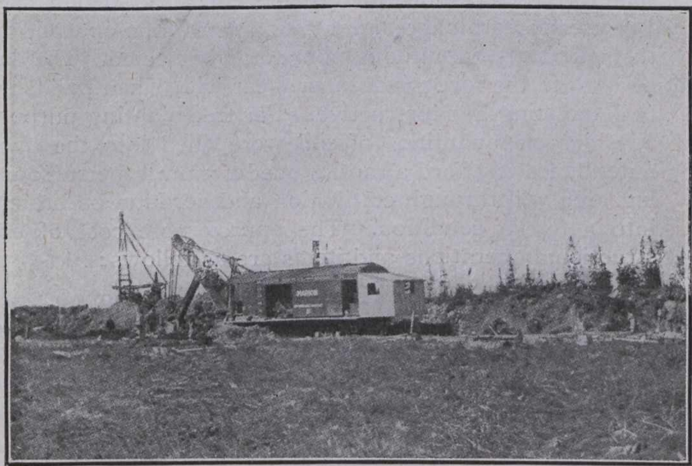
Those likely to be added in 1915 were: Cobalt Reduction at Cobalt; Tough Oakes at Kirkland Lake, and Schumacher at Porcupine.

TRAIN DESPATCHING BY TELEPHONE ON G.T.P.

The telephonic train despatching system has now been installed over the whole of the main line of the Grand Trunk Pacific. Portable telephones are carried on each train, placing the train crew in touch with despatchers at all times and places.

PROGRESS ON THE HUDSON BAY RAILWAY.

THE Dominion Government Railway from Le Pas, Man., to Port Nelson, on Hudson Bay, will experience its most extensive development this season. The line, the location of which is shown on the accompanying map, will be 416 miles long and its construction will involve considerable expenditure on terminals, chiefly at Port Nelson. It is stated that over 2,500 men are at present employed.



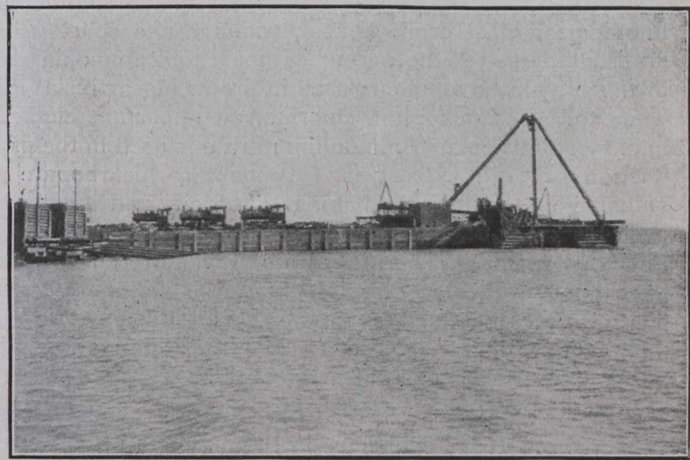
Marion Steam Shovel at Work, Port Nelson.

Grading started this spring at about 290 miles east of Le Pas. Track-laying operations commenced at Mile 214. It is expected that at the close of the season the rails will be down to within 40 miles of Port Nelson. A steel cantilever bridge over the Nelson River, near Manitou Rapids, will also be built this year. The Canadian Bridge Company have the contract.

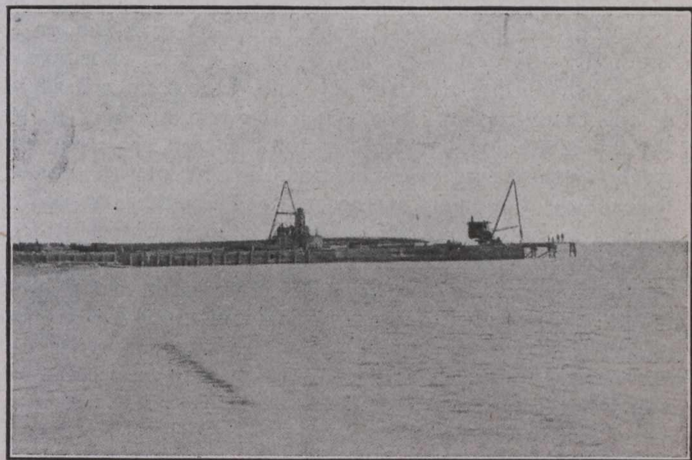
Harbor and terminal facilities at Port Nelson will be materially developed this year. Tenders have been called for necessary supplies and material to be delivered at Halifax before the end of June. A fleet of freighters with these supplies will leave Halifax for Port Nelson during the first week in July.

The season's operations will consist chiefly of dredging the channel and building greater dockage. Owing to the presence of boulders in the channel, dredging operations are somewhat retarded.

No announcement has been made regarding elevator facilities, but plans have been prepared and it is stated that the buildings will be ready by the completion of the railway and harbor.

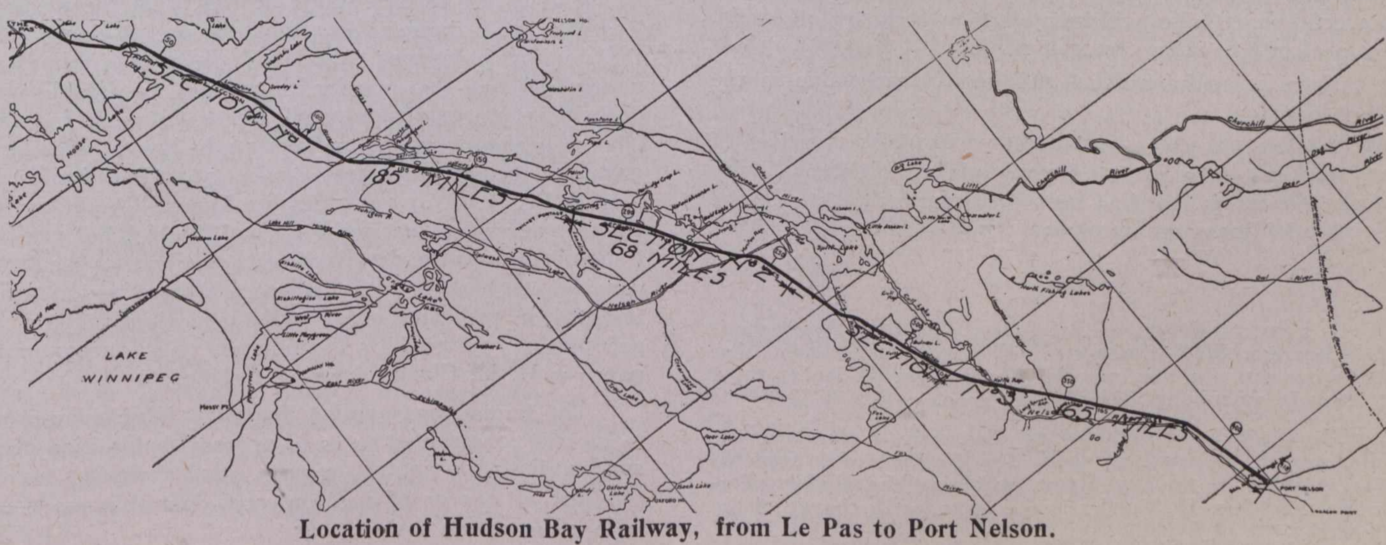


Hudson Bay Railway Wharf No. 2, Port Nelson.



Hudson Bay Railway Wharf No. 3, Port Nelson.

The Hudson Bay Railway and terminals are being constructed by the Department of Railways and Canals, Ottawa. Hon. Frank Cochrane, Minister; A. W. Campbell, C.E., Deputy Minister; W. A. Bowden, Chief Engineer; J. W. Porter, Assistant Chief Engineer, and D. W. McLachlan, Engineer in Charge.



Location of Hudson Bay Railway, from Le Pas to Port Nelson.

BY-PRODUCTS OF COAL.

In the exhibit of the Barrett Manufacturing Company at the San Francisco Exposition an enormous block of soft coal is shown surrounded by its innumerable children. The first generation consists of ammonia, illuminating gas, crude benzol, coal tar and coke. The crude ammonia is the parent of household ammonia and of the anhydrous ammonia used in producing artificial ice. Then there is ammonium chloride, an important element in electric batteries. Ammonium nitrate is used in the production of high explosives. Ammonium bicarbonate is valuable in the modern baking of food, and most important of all is ammonium sulphate, a powerful soil-nitrifying agent. Plants of various kinds are shown that have been grown with and without the ammonium sulphate under identical conditions, exhibiting a striking difference in the strength of the crops. Illuminating gas burns up in a blaze of light and leaves no heirs.

From crude benzol come the beautiful analine dyes. It is also of great importance in the manufacture of automobile tires and in the production of artificial leather. Then there is toluol, a basis for modern high explosives and now much in demand.

Coal tar produces Tarvia, a bituminous binder for building automobile-proof roads, Barrett specification roofs, consisting of tarred felt and pitch, and a long list of the ready-roofings for barns, felt and building papers for walls, and waterproofing felts, which are used with pitch for the lining of excavations, basements and tunnels to exclude dampness of the soil. Then there is paving pitch used in the joints of block pavements for city streets. Creosote oil which can be impregnated into wood thereby makes it proof against decay and gives us wood block street pavements, durable piling and long-lived fence posts and mine timbers. Creosote alone is worth $25,000,000 a year to the country in its ability to prolong the life of fence posts.

In addition, coal tar is the parent of innumerable chemical and medical products, especially phenol or carbolic acid, an indispensable medical disinfectant with innumerable industrial uses, including the process of manufacturing phonograph records.

Naphthalene, or coal tar camphor, is useful in keeping moths out of clothing.

Among the by-products in the carbolic branch are picric acid, a high explosive, and a long list of bactericides and disinfectants, including Pyxol, twenty times as powerful as carbolic acid and death to germs of all kinds, yet perfectly harmless to animal life.

Coke is useful as fuel and has special value in the steel industry.

All told, coal has the largest variety of derivatives of any mineral. The Barrett Company's exhibit shows many of the processes and has been well planned. It is in the Palace of Mines and Metallurgy.

In a recent interview, Brig.-Gen. Bertram, chairman of the Canadian Shell Committee, is quoted as stating that shell contracts for the Imperial Government so far awarded in Canada amount to over $154,000,000.

The Jeffrey Manufacturing Company, Columbus, O., announce the removal of their New York branch from 99 Warren Street to 50 Dey Street, adjoining the Hudson Terminal. Mr. Geo. H. Mueller is the manager in charge of the office.

COST OF TREE PLANTING, QUEEN VICTORIA NIAGARA FALLS PARK.

In the report for 1913 of Mr. John H. Jackson, superintendent of the Queen Victoria Niagara Falls Park, it is stated that in connection with the planting operations an experiment was started on the sections of stiff clay where the ordinary methods were likely to prove unsuccessful, the soil being so impervious as to prevent drainage, proper aeration, and the ramification of roots. Holes dug with the spade were useless and dynamiting was, therefore, resorted to, the 40 per cent. grade being used. Fissures for drainage and aeration were thus opened, and the soil shattered, although not actually ejected. The data relative to the foregoing experiment will, when published, be interesting and instructive. For tree planting purposes considerable quantities of soil were filled into the dynamited holes to afford a rooting medium until the surrounding area will through cultivation and aeration be brought into a fertile condition. The approximate cost of constructional operations and items are as follows:

Filling, grading, harrowing and seeding during the year 1913	$14,000.00
Four miles were completed, the cost per mile being	3,500.00
Planting, staking, mulching and pruning trees	3,000.00
Trees (2,000 planted)	1,000.00
Average cost of established tree	2.00
Initial cost of each tree	50
Four miles of boulevard were planted, the average cost of ornamentation per mile being $4,500, or a total for four miles of	18,000.00

For the year 1913 the cost of maintenance of the sections ornamented in previous years amounted to $1,800. This, however, must not be used as a criterion of the cost of subsequent years as with the completion of the work of ornamentation in sight, the expenditure will decrease on capital account, and increase on maintenance, for as the trees, shrubs and lawns approach maturity they must be properly cared for, otherwise dilapidation will ensue.

EXPLOSION-PROOF MOTORS FOR MINING WORK.

Among its investigations dealing with the means of lessening such dangers as attend the use of electricity in the mining industries, the U.S. Bureau of Mines has undertaken one that has for its purpose the establishment of permissible explosion-proof motors for use in places where an electric spark or flash might ignite inflammable gases or dusts. Technical Paper 101, "Permissible Explosion-Proof Electric Motors for Mines; Conditions and Requirements for Test and Approval," which has just been issued, mentions the details of construction that the bureau considers essential for satisfactory service and describes tests of an explosion-proof mining-machine motor and accessories approved by the bureau. The author of this paper is H. H. Clark, electrical engineer.

The bureau has applied the term "Explosion-proof" to motors constructed so as to prevent the ignition of gas surrounding the motor by any sparks, flashes, or explosions of gas or of gas and coal dust that may occur within the motor casing.

Editorial

THE TORONTO-OSHAWA ROAD.

The Toronto-Oshawa road scheme has awakened from its winter sleep and once more ventures into the open. It was last heard of in October, when a strong deputation from the municipalities interested asked the provincial government for a survey and an estimate of the cost. The proposal was approved of by the Premier and was promised an investigation.

The return feature of the home-and-home series came off on Tuesday last, June 1st, in the town of Whitby, where a gathering took place of all interested in the improvement of the Kingston Road between Toronto and Oshawa. At the meeting W. A. McLean, C.E., chief engineer of highways for Ontario, presented his report on the finished survey, the suggested improvements and a proposed apportionment of the cost. Hon. F. G. Macdiarmid, Minister of Public Works, was also in attendance, representing the Ontario Government. Details of the meeting will probably be available in time for insertion in the Construction News section of this issue.

The Kingston Road is one of the oldest roads in Ontario. It has been put in good order from the city limits of Toronto to the crossing of the Grand Trunk Railway, about three miles west of Highland Creek. If the improvement is continued as far east as Oshawa it will prove an excellent beginning for the Toronto-Montreal highway, a proposal which should not remain a proposal many years longer.

RUBBER ROADS AGAIN.

While it is fully understood that rubber-paved roads are not practicable at present, and although little has been said of them of late, due perhaps to the universal division of attention to the European crisis, the London Daily Telegraph is credited with the remark that they are almost certain of ultimate adoption. It is admitted, however, that a great deal of missionary work will first be necessary. The article points out that the chief problem is not what a rubber road would cost to build, but what would be the cost of up-keep; how long would it last under varying conditions of climate and traffic? It is for the purpose of obtaining information on this latter point that the Rubber Growers' Association has made a free grant of 1,000 tons of plantation rubber and has offered an additional 1,000 tons at the nominal price of 25 cents a pound during the next five years. The rubber will be used in the first instance on difficult roads in order definitely to ascertain its merits.

An experimental rubber roadway has been laid, and in use some time now, in the Old Kent Road, London. It is made of wood blocks, with a surface cushion of rubber, held tightly in position by dovetailing. The blocks are readily movable—an advantage in these days of frequent excavations for pipes, conduits, etc. They interlock perfectly and give an absolutely watertight joint. This protects the foundation from the injurious effects of moisture.

The section in the Old Kent Road, after carrying for 295 days some of the heaviest traffic in London, amounting to ninety tons per square foot per hour for twenty-four hours, was not perceptibly worn, whereas an adjacent pavement of modern and approved type lost ½ inch in thickness in the same time under the same load.

The fact that thinner foundations can be used with rubber roads may be set against the extra cost of the rubber blocks. Even then, should the cost not be equal, the life of the rubber road may be expected to be so much longer as to more than compensate for the extra cost, apart from the great advantages of silence and the prevention of skidding and side-slip of vehicles—for it has been proved, contrary to all expectations, that the sections of rubber road referred to are most effective "non-skids."

No doubt further experiments with rubber for road-surfacing will be watched with deep interest. As soon as its now apparent merits have been proved conclusively, we should be within a reasonable distance, if not of the universal rubber highway, at least of the rubber road for special traffic conditions.

NIAGARA POWER.

There is a somewhat complex situation along the Niagara River. Much energy has been devoted to procuring hydro-electric legislation applicable to the Niagara River. The purpose of this legislation is to bring about a condition of affairs under which the surplus of Canadian power will be taken by export to the United States so that a vested claim, if not a vested right, may be acquired to the continued export of such power even after it is required on the Canadian side. There have been discussions by public men and public bodies which make it clear that there is a considerable shortage of power in the State of New York, that there is an insistent demand for further development and that the authorities of the State of New York do not regard it as a reasonable exercise of Canadian sovereign power to prohibit the export of such power after it has been used upon the American side and industries have been built up which depend upon Canadian power for their existence. As observed by Hon. Clifford Sifton, chairman of the Commission of Conservation, the case is one which requires the utmost caution and foresight upon the part of those who are charged with the care of our interests, such foresight being required as well to preserve the material interests of Canada as to avoid the possibility of international complications in the future.

DOMINION GOVERNMENT SURVEY WORK.

The Topographical Surveys Branch, Department of the Interior, has sent into the field this year about seventy surveyors, in addition to a few other parties still to be made up. Of them, 12 will be engaged exclusively in stadia work, chiefly in the prairie provinces, in portions of country where bodies of water which were at one time lakes of considerable size have become greatly diminished, owing to evaporation and the clearing up of the country.

Surveys under the Dominion Observatory, Dr. King director, have assigned to them a number of field officers in various parts of the Dominion. Six officers are now engaged in precise levelling operations. These are Messrs. N. H. Smith in Alberta; D. McMillan in British Columbia; A. J. Rainboth in North-Western Ontario; H. P. Moulton in Central Ontario; G. F. Dalton in New Brunswick, and J. J. Dalton, D.T.S., who is conducting a boundary survey to the east of Rainy Lake on the Ontario-Minnesota boundary.

The British Columbia-Alberta boundary survey and the International boundary survey are also at work.

COST PER FOOT OF WATER MAINS.

The following table of comparative costs of water pipe of different diameters is from a paper by Nicholas S. Hill, Jr., newly elected president of The American Water Works Association. It is pointed out that in planning a pipe distribution system the engineer must decide upon the future period for which the improvements are to serve without duplication or enlargement. This period will bear no relation to the useful life of cast iron pipe, which depends largely on the service for which it is used and may exceed 100 years. It would be impossible to predict the amount or direction of a city's growth for so long a period as 100 years with any degree of certainty. It is possible, however, to predict with sufficient accuracy, both the extent and distribution of population growth, upon which the future demand for water will in great measure depend, for a period of 20 to 30 years to come.

The reasons for predicating estimates on results which are expected to obtain so far in the future are not that one can undertake to forecast the future with mathematical exactness even for this limited period, but rather because it is the safest and most rational way in which to make reasonable provision for future needs.

Failure to make such provision frequently results in a high capital investment in mains. It is cheaper to lay a main which is too large for present needs than to lay one which must be reinforced within a few years. To show the expense which a company or city incurs by pursuing such a policy, Mr. Hill presents Table I., which shows the comparative cost of different pipe sizes to give the same service.

The costs given in the table do not and, of course, cannot take into consideration the damage to improved streets, and the additional cost of maintaining them, which results from continual tearing up, nor can they take into account the inconvenience, annoyance and the disturbance of traffic which results from repeated removal of the street surface. They further do not include the additional cost of repairs due to the increased main mileage which results from duplication of mains and the increased liability of having to excavate for repairs, nor any consideration of the enhanced pumping costs ensuing from greater main leakage resulting from an increase in the number of pipe joints. The table clearly shows that even where the period of usefulness of the first main laid is 18 out of 26 years, the saving in favor of two mains in most cases is not sufficient to offset the other losses incurred.

TABLE I. COMPARATIVE COST PER FOOT FOR DIFFERENT WATER PIPE SIZES TO GIVE THE SAME SERVICE

		*			Relative annual costs per foot under following plans. Plan 1. Immediate installation of single pipe of size given in Col. (1).			Plan 2. Immediate installation of single pipe of size given in Col. (2) to be followed after expiration of period given in Col. (5) by installation of second pipe of same size.			Capitalized annual cost. Plan 1.	Plan 2.			Saving in favor of plan 1,—the immediate installation of larger pipe.	
(1) Diameter of pipe required to supply the service for period of 26 years.	(2) Number and size of smaller pipes required to give same service as single pipe opposite in Col. (1).	(3) Single pipe of diameter given in Col. (1).	(4) Single pipe of diameter given in Col. (2).	(5) Assumed number of years during which a single pipe of diameter given in Col. (2) will suffice.	(6) Interest on initial cost at five per cent. =(3) ×.05	(7) Annuity required to amortize capital investment at end of 70 year life at 4 per cent. =(3) ×.00274	(8) Total annual cost per foot. =(6) +(7)	(9) Interest on initial cost of one pipe at 5 per cent. =(4) ×.05	(10) Annuity required to amortize capital investment at end of 70 year life at 4 per cent. =(4) ×.00274	(11) Total annual cost per foot of one pipe. =(9) +(10)	(12) Total annual cost per foot as given in Col. (8) capitalized at 5 per cent. =(8) ÷.05	(13) Total annual cost per foot of first pipe as given in Col. (11) capitalized at 5 per cent. =(11) ÷.05	(14) Present value of total annual cost per foot of second pipe as given in Col. (11) when capitalized at 5 per cent. =(11)÷.05 reduced to present value.	(15) Total =(13) +(14)	(16) Amount in dollars per foot. =(15) −(12)	(17) In per cent. of cost of plan 1. =(16) ÷(12)
ins.	ins.	$	$		cts.	cts.	cts.	cts.	cts.	cts.	$	$	$	$	$	%
24	2.05-18	4.61	2.87	6	23.05	1.26	24.31	14.35	0.79	15.14	4.86	3.03	2.26	5.29	0.43	8.8
				12	23.05	1.26	24.31	14.35	0.79	15.14	4.86	3.03	1.69	4.72	—0.14	—2.9
				18	23.05	1.26	24.31	14.35	0.79	15.14	4.86	3.03	1.26	4.29	—0.57	—11.7
16	2.05-12	2.42	1.59	6	12.10	0.66	12.76	7.95	0.44	8.39	2.55	1.68	1.25	2.93	0.38	14.9
				12	12.10	0.66	12.76	7.95	0.44	8.39	2.55	1.68	0.94	2.62	0.07	2.7
				18	12.10	0.66	12.76	7.95	0.44	8.39	2.55	1.68	0.70	2.38	—0.17	—6.7
8	2.05-6	0.96	0.69	6	4.80	0.26	5.06	3.45	0.19	3.64	1.01	0.73	0.54	1.27	0.26	25.7
				12	4.80	0.26	5.06	3.45	0.19	3.64	1.01	0.73	0.41	1.14	0.13	12.9
				18	4.80	0.26	5.06	3.45	0.19	3.64	1.01	0.73	0.30	1.03	0.02	2.0

* Initial cost, Class C pipe, at $25 per ton in medium digging with labor at $1.75 per 10-hour day.

COAST TO COAST

Halifax, N.S.—A new dry dock 1,150 ft. long, 120 ft. wide, with 38 ft. over the sills is contemplated for Tufts' Cove.

Ottawa, Ont.—A strong deputation waited on the board of control last week to urge the construction of the proposed Ottawa-Prescott road.

Hamilton, Ont.—The government dredge resumed operations last week at the east end of the harbor. Dredging will shortly be commenced also at Wabassa Park.

Toronto, Ont.—The new Central Technical School, a structure costing $1,400,000, exclusive of equipment and site, has just been completed and turned over to the Board of Education.

London, Ont.—Mr. C. R. Somerville, chairman of the local board of health, favors the construction of large intercepting sewers along the river banks to dispense with the emptying of sewage directly into the Thames.

Haileybury, Ont.—Work was started on May 24th on the Lorrain Road, upon which $8,000 will be spent this year. It is the intention to have the road cut through to Silver Centre and a number of bridges constructed.

Edmonton, Alta.—Construction work was resumed by the Canadian Northern Railway on the Oliver-St. Paul de Metis line, according to Mr. Alan T. Fraser, district engineer. Mr. D. F. McArthur has the contract for the grading, about 14 miles of which he completed last fall.

Kamloops, B.C.—The Canadian Northern Pacific Railway ballasting is well advanced between here and Lytton and should be completed by July 1st. Ballasting on sections north of Kamloops is practically completed, and it is expected that a start will soon be made on the erection of stations.

Peterborough, Ont.—The council is planning to extend the street paving of the city and hopes to proceed with considerable new work this year. At present Peterborough has approximately 56,500 square yards of pavement with concrete base, the cost of which is in the neighborhood of $138,000, exclusive of drainage.

Quebec, Que.—Now that the new C.P.R. freight sheds have been completed, the work of demolishing the old ones will proceed, prior to the erection of the Union Station. The plans for the latter provide for 12 passenger tracks and about 50 freight tracks. The contract was awarded recently to the Downing and Cook Company.

Ottawa, Ont.—The Provincial Board of Health has approved of the plans and specifications of Mr. J. B. McRae, C.E., for an overland pipe and high-lift pumping station to cost $459,000. The way is now open for the waterworks committee to call for tenders for the pipe, and it is expected that this move will be made without delay.

Windsor, Ont.—On May 27th the new government dock, the construction of which was commenced last year, was opened for service. It has cost $65,000 and is built of concrete throughout. It length is 655 ft. and it carries a warehouse 300 ft. long and of fireproof construction. The undertaking included dredging to a depth of 20 ft. in the Detroit River in front of the dock.

Vancouver, B.C.—Barnett, McQueen & Co., the successful contractors for the construction of the $690,000 government elevator, are starting work this week. As soon as the foundation and cribs are completed it is expected that work will proceed immediately on a large government dock which forms a part of the grain terminal scheme.

Victoria, B.C.—The city engineer, who is not in favor of installing laterals prior to laying pavements, with the exception of business streets, reports that there are about 15,500 sewer and surface drains and over 5,000 water laterals not in use, but the value of which is depreciating yearly. The cost of constructing these unused laterals amounted to approximately $400,000.

Petrolia, Ont.—Gravel rates was the subject of controversy at a meeting held here last week when the Dominion Railway Commissioners discussed the question of cheaper transportation from the St. Clair River for good roads purposes. It was pointed out that the present high rate on St. Clair gravel largely prohibited its use, and the applicants wanted to have the rate fixed at 1c. per ton per mile, with a minimum charge of 15c. per ton.

Calgary, Alta.—The Provincial Government has expended $140,000 assisting rural municipalities in the construction of roads and proposes to spend about $70,000 more in like manner. Hon. Charles Stewart, provincial minister of municipalities, states that the government is not undertaking a huge programme this year, but that a number of comparatively small jobs are to be looked after. Calgary itself is spending $270,000 on municipal improvements.

Vancouver, B.C.—The Pacific Great Eastern Railway has secured from the Dominion Government the balance of its $5,000,000 advance for the construction of the line. This balance amounts to $2,300,000. At present 120 miles of the line are in operation, while the bridge across the Fraser River at Lillooet has been completed. It is expected that by the end of the year over 100 miles more will be in operation, while considerable bridge construction will also be finished.

Calgary, Alta.—The city proposes to effect a saving of about $30,000 in its power costs by discontinuing the regular operation of its civic power plant and using it only in case of emergency, the regular supply to be obtained from the Calgary Power Company's hydro-electric plants at Kananaskis and Horseshoe Falls on the Bow River. The new arrangement will increase the business of the company with the city from $150,000 to about $190,000. Last year coal cost the city $44,000 and labor $25,000 in connection with its steam plant.

Prince Rupert, B.C.—Mr. W. T. Donnelly, the New York consulting engineer on the Grand Trunk Pacific dry dock and shipbuilding plant at Prince Rupert, states that the harbor is the finest natural harbor in the world. The dry dock, when completed, will be the largest in North America, capable of accommodating ships of greater size than any now in the trans-Pacific trade. It is of 20,000 tons lifting capacity. The 12 pontoons supporting the dry dock have been completed, and the American Bridge Co. is at work on the steel superstructure. The cost of the G.T.P. dock, with buildings, is $2,500,000.

A Sulzer Diesel engine, built for Messrs. Harland and Wolff, for generating electricity in that firm's shop at Belfast, is stated by "Gas and Oil Power" to be the largest Diesel yet constructed to a definite order. It is of the two-stroke cycle, single-acting type with six cylinders, and was designed to develop 3,750 b.hp. at 142 r.p.m., though on trials 4,500 b.hp., or about 750 b.hp. per cyclinder, was maintained for a long period. The cylinder dimensions are approximately 30 in. bore by 40 in. stroke.

PERSONAL.

R. A. BLACK has been appointed resident engineer at Edmundston, N.B., of the National Transcontinental Railway.

J. C. ROSS is secretary of the Engineering Society of Queen's University, succeeding Lieut. P. Earnshaw, who is with the Sixth Field Company Canadian Engineers.

R. G. LYE, B.A.Sc., has succeeded Mr. J. E. Ritchie as general secretary of the University of Toronto Engineering Society and managing editor of Applied Science.

W. A. FITCH has become assistant superintendent at Moncton, N.B., and C. W. Price, assistant superintendent at Sydney, N.S., Canadian Government Railway.

GEORGE HODGE, general superintendent of the C.P.R. eastern division, was promoted on June 1st to the position of assistant general manager of eastern lines, and was succeeded in his former position by Mr. A. E. Stevens.

JAMES H. KENNEDY, assistant chief engineer of the Victoria, Vancouver and Eastern Railway, for the past fourteen years, is retiring from active service. Mr. Kennedy graduated in 1882 from the School of Practical Science, Toronto. He is a member of the American and Canadian Societies of Civil Engineers.

OBITUARY.

The death occurred in Vancouver last month of Mr. W. C. E. Moberly at the age of 83. He was one of the pioneer engineers of Canada, particularly of British Columbia, where he went in 1858 as superintendent of public works. Six years later he became surveyor-general, and did some valuable exploration work in the southern part of the province. In 1871 the government appointed him to take charge of survey work for the Canadian Pacific Railway west of Eagle Pass, which he had discovered some years previously. He was later chief engineer of the Manitoba South Western Railway. He constructed Winnipeg's first system of sewers, and did considerable work for the Hudson Bay Co. He was the author of a number of books and publications, chief among which is "Rocks and Rivers of British Columbia."

On May 23rd death came suddenly to Mr. M. E. Duncan, vice-president and general manager of the Canadian Car and Foundry Co. Mr. Duncan was born in New York in 1862. He joined the executive of the company three years ago, previous to which he was general sales agent of the American Car and Foundry Co.

EDMONTON BRANCH, CAN. SOC. C.E.

The Edmonton Branch Canadian Society of Civil Engineers held their special meeting for the election of officers for the year 1915-16 on the 19th of May. The ballot resulted in the election of the following members: A. T. Fraser, chairman; A. J. Latornell, vice-chairman; L. B. Elliot, secretary-treasurer; C. A. Robb, J. Chalmers, W. R. Smith, J. L. Cote.

A number of those present made short addresses, including the retiring chairman, Prof. W. Muir Edwards, J. Chalmers, J. H. Larmonth, and others. This is the last meeting to be held till the annual meeting in October. The members look forward confidently to as promising a season next year as has been the case during the season just closed.

INTERNATIONAL ENGINEERING CONGRESS, 1915.

The materials of engineering construction will receive special attention in the proceedings and discussions of the International Engineering Congress to be held in San Francisco, September 20-25 next. The field will be treated under 18 or more topics, covering: Timber resources; preservative methods; brick and clay products in general; life of concrete structures; aggregates for concrete; waterproofing; volume changes in concrete; world's supply of iron; life of iron and steel structures; special steels; status of copper and world's supply; alloys; aluminum; testing of metals, of full sized members, and of structures. Some 25 papers are expected for this volume, prepared by authors representing five different countries. The list of authors includes many of the most eminent names in this field of engineering work throughout the world. These papers, together with discussions contributed by leading American and foreign engineers, will be published as volume 5 of the transactions.

INSTITUTE OF MARINE ENGINEERS (GREAT BRITAIN).

The honorable secretary of the Institute of Marine Engineers announces that the institute has been removed from the old premises in Romford Road, to those on Tower Hill. All letters and communications should therefore be addressed to: The Secretary, Institute of Marine Engineers, The Minories, Tower Hill, London, E.

COMING MEETINGS.

NATIONAL CONFERENCE ON CITY PLANNING.—June 7-9. This year's Conference to be held in Detroit, Mich. Secretary, Flavel Shurtleff, 19 Congress Street, Boston, Mass.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—Annual meeting to be held at the Iowa State College, Ames, Iowa, June 22nd to 25th, 1915. Secretary, F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Annual meeting to be held in Atlantic City, N.J., June 22nd to 26th. Secretary, Prof. E. Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—Annual convention to be held in San Francisco, Cal., September 16th to 18th, 1915. Secretary, Charles Warren Hunt, 220 West 57th Street, New York.

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

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

Between Moncton and Winnipeg on the line of the National Transcontinental Railway, Canada, now being operated by the Dominion Government, there are 200 bridges having an aggregate length of 11 miles and a weight of 61,000 tons of steel. They cost more than $6,000,000. The majority of them are plate girder bridges.