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THE COST OF GENERATING POWER WITH DIESEL OIL ENGINES

STATISTICS FROM PLANTS AT SHERMAN AND CLEBURNE, OPERATED BY THE TEXAS POWER AND LIGHT CO.—ACCEPTANCE TEST AND OPERATING COSTS.

By GORDON KRIBS,

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THE Diesel oil engine was invented by Dr. Rudolf Diesel, the first working engine being produced in 1897. Since that time they have been gradually perfected until they have become a most reliable and efficient source of power. The demand for them has increased to such an extent that a large number of firms, including some of the largest and most reliable, both in America and abroad, are beginning their manufacture.

Up to the present time a considerable amount of information has been published relative to their operation and test, but accurate information as to the results to be accomplished by the use of Diesel engines over extended periods and under the varying conditions of actual practice, is mainly wanting. The Texas Power and Light Company are at present operating two Diesel oil engine plants, one at Sherman and the other at Cleburne, and it is the purpose of this article to set forth the actual operating results obtained under every-day operating conditions.

The Sherman plant consists of three 225-h.p., 3-cylinder, 4-stroke cycle engines, manufactured by the Busch-Sulzer Bros., Diesel Engine Company, of St. Louis, Mo., each engine being direct-connected to a 150-

Sherman Gas and Electric Company's 3—16—24 Diesel Engine No. 138.

Time	Volts	Amp.	Volts	Amp.	W-Mtr.	R.P.M.	Oil	O. Com. Gals.	Air-P.	K.W.
5 p.m.	242	640	247	650	4876.0	162	—	—	72 a.t.m.	—
6 "	238	635	245	640	4891.3	164	3 0	—	.2 "	153.3
7 "	242	635	243	650	4907.0	164	19.0	16.0	71 "	156.7
8 "	237	640	246	640	4922.4	164	34.5	15.5	71 "	154.0
9 "	240	655	243	665	4938.3	163	18.0	15.5	70 "	159.0
10 "	240	650	241	665	4954.2	163	14.5	14.5	70 "	159.0
11 "	243	620	240	675	4970.0	164	15.5	15.5	67 "	158.0
12 "	240	640	242	665	4985.8	163	14.5	14.5	69 "	158.0
1 a.m.	238	640	243	665	5001.7	104	13.0	13.0	—	159.0
2 "	240	640	242	662	5017.5	164	28.0	15.0	69 "	158.0
3 "	239	655	242	670	5033.2	163	14.0	14.0	69 "	157.0
4 "	240	650	242	670	5049.1	165	28.5	14.5	69 "	159.0
5 "	240	650	242	670	5065.2	164	14.5	14.5	69 "	161.0
6 "	240	655	242	675	5081.2	164	29.0	14.5	69 "	160.0
7 "	239	665	242	680	5097.2	164	14.0	14.0	69 "	160.0
8 "	238	670	241	690	5113.0	163	28.5	14.5	70 "	158.0
9 "	238	670	240	680	5129.0	163	14.0	14.0	70 "	160.0
10 "	239	665	241	680	5145.2	163.5	29.3	15.3	70 "	162.0
11 "	240	655	243	660	5161.25	164	13.5	13.5	70 "	160.5
12 "	238	665	241	675	5177.5	164	28.25	15.25	70 "	162.5
1 p.m.	238	665	241	675	5193.2	164	14.0	14.0	70 "	157.0
2 "	240	670	243	675	5209.5	162	29.5	15.5	70 "	163.0
3 "	242	660	244	665	5225.66	162	15.¾	15.75	70 "	161.6
4 "	246	655	{250 251	655	5242.4	{160 161	33.¼	19.5	72 "	167.4
5 "	243	675	245	685	5259.25	160	17.75	17.75	72 "	168.5
5.05	250	0	250	0	—	170	—	—	—	—

TOTAL KW. DEVELOPED DURING TEST.

Total hours run - - - - - - 24
Total K.W. developed - - - - 38325
Average K.W. developed per hour - - 159.6—232.4 H.P. at 92% Eff. of G.
Maximum K.W. developed in one hour - 168.5—245.0 " " "
Average air pressure - - - - - 70 atmospheres
(Oil consumption as shown averages 9.41 Gals. per 100 K.W. hours=6.46 Gals. per 100 B.H.P. hours.)

kw., 230-volt D.C. generator. These engines were installed January 1, 1905. They weigh about 100,000 lbs. and cost approximately $14,000 each.

The official acceptance test is given in the table shown on preceding page.

The oil consumption during the test averages 9.41 gallons per 100 kw. hours, which, with oil at 25 cents per gallon, is equivalent to 2.35 cents per kw.h.

During the year of 1910, 862,050 kw. hours were generated at a total fuel cost of $2,695.98, the fuel being the ordinary distillate as obtained from Texas crude oil, and costing $1.30 per barrel of 42 gallons, delivered. This oil has the following approximate characteristics:

Gravity, 37. Flash, 160. Fire, 190.

The operating expenses for the year were as follows:

Power plant wages	$3,014.00
Fuel for power	2,695.98
Water for cooling	37.07
Lubricants and waste	526.38
Miscellaneous supplies	63.78
Engine maintenance	411.12
Total	$6,748.33

Thus, for the year 1910, the cost per kw.h. for fuel was 3.1 mills, and the total cost per kw.h. was 7.1 mills. This, while not including interest on the investment, depreciation, or other so-called overhead expenses, is cer-

Diesel Engine—Operating Costs. 450 kw. Installation at Sherman, Texas. Cost of Production.

COST IN MILLS PER K.W.H. HR.

	Maintenance					Operation							
Month	Monthly Output K.W. Hours	K.W. Peak Load*	Load Factor Per Cent.	Engines	Total	Fuel Oil	Labor	Water	Lubricating Oil	All Other	Total	Total Cost Dollars per Month	Total Cost Cents Per K.W. Hr.
1912												$	
March	95,328	—	28.4%	None	—	2.20	2.80	0.02	0.39	—	5.31	—	—
April	77,915	—	24.0%	"	—	2.90	3.46	0.10	0.42	—	6.88	—	—
May	76,820	—	23.0%	"	—	2.50	3.51	0.06	0.63	—	6.70	—	—
June	70,230	—	21.7%	0.09	0.09	2.69	3.83	0.07	0.38	—	6.97	559.43	7.96
July	91,704	—	27.4%	0.03	0.03	2.53	2.94	0.06	0.32	—	5.85	738.20	8.05
August	85,105	—	25.4%	None	—	2.60	3.17	0.06	0.40	—	6.23	808.35	9.50
September	105,506	—	32.5%	0.03	0.03	2.71	2.56	0.08	0.36	—	5.71	621.48	5.83
October	117,360	—	34.7%	None	1.62	2.61	2.30	0.22	—	0.51	5.64	854.13	7.28
November	114,048	—	35.2%	"	0.81	2.46	2.00	0.24	—	0.44	5.14	733.92	6.43
December	117,499	—	35.1%	"	0.37	1.90	2.00	0.31	—	0.36	4.57	551.19	4.69
1913													
January	115,212	—	34.1%	"	0.40	3.00	2.10	0.17	—	0.37	5.64	717.26	6.22
February	101,300	—	33.5%	"	—	2.45	2.22	0.06	—	0.36	5.09	517.12	5.10
Total	1,168,027	—	—	—	—	—	—	—	—	—	—	—	—
Average	97,335	—	29.6%	0.05	0.478	2.54	2.74	0.12	0.40	0.41	5.81	—	6.78

* Total connected load, 1,553 k.w. No reliable record kept of peaks

PHYSICAL DATA.

H.P. Rating of Plant 675. No. of Engines 3. Size each 225 H.P.
Cost of Fuel Oil f.o.b. Plant per Bbl. $1.05. Per Gallon .025
B.T.U of Oil 18,000. Average Gal. Fuel Oil per K.W. Hr. .1020
Wages of men per day $9.00. 1 at $3.33. 1 at $2.17. 1 at $2.00. 1 at $1.50

Diesel Engine—Operating Costs. 450 kw. Installation at Cleburne, Texas. Cost of Production.

COST IN MILLS PER K.W. HR.

	Maintenance.						Operation							
Month	Monthly Output K.W. Hrs.	K.W. Peak Load*	Load Factor Per Cent.	Engines	All Other	Total	Fuel Oil	Labor	Water	Lubricating Oil	All Other	Total	Total Cost Dollars Per M'nth	Total Cost Cents Per K.W. Hr.
1912													$	
April	67,850	—	20.9%	None	None	—	3.08	4.79	0.40	0.38	0.07	8.72	—	—
May	74,330	—	22.2%	"	"	—	3.29	4.37	0.38	0.64	0.06	8.74	—	—
June	73,410	—	22.7%	0.14	"	0.14	3.19	4.42	0.46	0.50	0.07	8.64	587.57	8.00
July	80,020	—	23.9%	2.33	"	2.23	3.20	4.06	0.44	0.46	0.06	8.22	800.13	10.00
August	86,860	—	24.9%	0.47	"	0.47	3.09	3.74	0.49	0.72	0.06	8.10	650.20	7.48
September	89,130	—	27.5%	0.08	"	0.08	3.14	3.64	0.36	0.32	0.05	7.71	673.18	7.55
October	100,580	—	30.0%	1.32	0.16	1.48	3.03	3.11	0.30	0.43	0.05	6.92	878.55	8.73
November	107,379	—	30.9%	0.22	0.31	0.53	2.99	2.72	0.16	0.42	0.05	6.34	746.31	6.95
December	123,030	—	36.7%	2.03	0.03	2.06	3.03	2.59	0.42	0.38	0.04	6.46	951.53	7.73
1913														
January	127,170	—	37.9%	0.72	0.72	1.44	2.96	2.23	0.72	0.22	0.04	6.17	1102.97	8.67
February	98,430	—	32.5%	1.64	0.01	1.65	3.00	3.20	0.28	0.56	0.05	7.09	1010.52	10.26
March	106,270	—	31.7%	1.30	0.24	1.54	2.98	2.91	0.24	0.30	0.05	6.48	—	—
Total	1,134,459	—	—	—	—	—	—	—	—	—	—	—	—	—
Average	94,538	—	28.8%	1.02	0.24	1.17	3.08	3.47	0.39	0.44	0.05	7.46	—	8.37

* No record of peak loads available

PHYSICAL DATA.

H.P. Rating of Plant 675. Number of Engines 3. Size of each 225 H.P.
Cost of Fuel Oil f.o.b. Plant per Bbl. $1.25 to $1.64. Per Gal. .03 to .039
B.T.U. of Oil 18,000. Ave. Gal. Fuel Oil per K.W. Hr. .1020
Wages of men per day $10.83. 1 at $4.16. 2 at $2.50. 1 at $1.66.

tainly exceptionally low in cost per kw.h. for a plant of this size.

In the accompanying Table II. are given the results for the 12 months' period from March, 1912, to February, 1913. It will be noted that the total cost of production per kw.h. was 6.78 mills with fuel oil at $1.05 per barrel of 42 gallons.

The plant at Cleburne consists of three 225-h.p. units similar to those at Sherman, with the exception that each engine is direct connected to a three-phase, 2,300-volt, 60-cycle alternating current generator. It is worthy of note that no trouble whatever has been experienced in paralleling these machines.

In the accompanying Table III. we give the results of 12 months' operation at this plant.

In conclusion, the writer wishes to state that for small and medium sized plants, he believes the Diesel oil engine to be the most efficient prime mover available, and while the engine is now built only in comparatively small sized units, there is no doubt in the future it will be developed in large sizes and made available where a large quantity of power is desired. The first cost of the engine is high, and in some cases this may be a drawback.

It is also essential to have a good mechanic as head plant engineer, as the engine requires intelligent handling. They are, however, far from being the trouble-makers internal combustion engines are supposed to be, and are giving excellent service in both of the plants above mentioned.

SUITABLE ROAD SURFACES FOR VARIOUS KINDS OF TRAFFIC.

THE study of the effect of different kinds of traffic on roads and of the most suitable surfaces to withstand them, as carried on by the Massachusetts Highway Commission, was the subject of a paper entitled "Traffic Census of Roads in Massachusetts," by Mr. William B. Sohier, chairman of the commission, and presented at the convention of the American Road Builders' Association last December. The commission has come to the popular conclusion that roads used by large numbers of swiftly moving vehicles require special attention to prevent disintegration and rutting, and that such traffic cannot be carried on successfully over gravel or water-bound macadam roads unless amply protected. The results of the investigation in Massachusetts show that the use of some dust layer or binder is an absolute necessity. Where a road is subjected to traffic varying from light, swiftly moving vehicles to heavily laden trucks, the adoption of a surface to prevent excessive wear is arrived at by re-surfacing with some form of bituminous mixture to a depth of several inches of the road.

Motor-Vehicle Traffic.—Some oiled gravel roads are satisfactory and very economical, if they are constantly and properly maintained, even where there are large numbers of swiftly moving automobiles a day, at least, in the summer months, but where there are not many heavily loaded wagons. Some of these roads have 500 automobiles or more a day, and yet they are cheaply built and cheaply maintained. Roads built of sand and asphaltic oil also stand up well under heavy motor-vehicle traffic, but these roads have very little heavy teaming on them. Heavy wagons and many heavy motor trucks rut such roads quickly and soon wear them out.

Maintenance Costs.—When the motor vehicle appeared in fair numbers upon the roads Massachusetts had 600 to 700 miles of state highways (now over 900), and they were mostly water-bound macadam, with some few miles of gravel road.

These highways had been built from 1 to 14 years previously, very few miles had been resurfaced, and the Highway Commission had only $100 a mile a year to spend for maintenance and resurfacing, and not that much except for the last few years. The maintenance of these old roads was our problem in 1908, and has been ever since.

Automobile travel has increased 40% and the total traffic 14% a year, and these roads must be maintained, or the state's money, borrowed on long-time bonds, would be lost and wasted; the good roads would be gone, but the bonds would still remain to be paid.

The state doubled its appropriation for maintenance in 1908, giving the Highway Commission $200,000 a year instead of $100,000. The motor-vehicle fee was also increased, and the right to use the net fees for the maintenance of roads was obtained. These two sources of revenue for the last three years have provided about $500,000 a year, for maintenance; an average of $450 a mile a year, and we are at least holding our own.

Bituminous Binders and Dust Layers for Old Roads.—Many miles of old roads have been saved by spreading a coat of asphaltic oil, light or heavy, or tar over them. To-day some asphaltic binder or dust layer has been used on over 80% of our state highways. The only roads on which it has not been used are those located in the country districts where there is very light traffic.

During the year 1912 we used nearly 2,000,000 gal. of bituminous material in construction or maintenance. Over 800 of the 930 miles of our state highways received some form of bituminous treatment. We have resurfaced as many miles of road every year as we could; using, where the traffic was heavy, a bituminous macadam on the top 3 in.

Effect of Traffic on Bituminous Surfaces.—Massachusetts has four division engineers, on its highway work. They were asked the same questions relating to different tars, oils, asphalts, etc., and for their opinions of the relative merits or demerits of each.

The answers were all different. One had used tar on the surface successfully, another had not. One liked tar for penetration or mixing; another preferred an asphaltic compound. The same was true of the use of various asphaltic oils as a blanket coat, or as a dust-layer. One preferred a heavy cold oil, another a heavier hot oil. There was, however, if the traffic and other conditions in each case were carefully studied, a real agreement in all essentials.

Where Heavy Oils Fail.—We have a good many miles of old macadam road which have been saved and maintained by ½ gal. of hot asphaltic oil spread upon each square yard of surface and properly covered with sand and pea stone or gravel. Many of these roads have worn three years, and in their fourth year are still in good condition. A few miles have worn four years and are now on their fifth year. The patching has cost but little, from 1 to 3c. per sq. yd. a year.

These roads often have very heavy automobile travel, possibly over 1,000 cars a day. They often have large numbers of teams daily. One has over 500 teams and 1,000 automobiles, and a heavy blanket oil surface has worn reasonably well for three years, and will for a fourth year except in a few places. This same road also has an average of 55 motor trucks a day.

Near two traffic taking stations, where the teaming was heavy, for one-quarter of a mile in each place (out of four miles), the blanket oil failed. It crumbled, went into mud, developed holes and was disappearing. We have replaced the top 3 in. with an asphaltic bituminous macadam.

Heavy Horse-Drawn Wagons Cause Failure.—The traffic study shows that it is not the number of wagons, but heavy wagons—two or more horses and heavy loads on narrow tires—that cause the failure. The failure of roads treated with heavy oil has occurred on a few miles of road at certain places where it was clear that heavy horse-drawn wagons were responsible.

In two instances it was 50 to 75 ice-wagons a day, together with other wagons, carrying 3 tons or more each on 2½ to 3-in. tires which did the damage. In a month the oil surface began to crumble and break up on the side of the road on which the loaded teams travelled. The surface lasted three months on the other side of the road where these wagons came back empty. The same road, treated with the same oil, is still in good condition beyond the ice-houses. In one case for 3 miles, in the other for 15 or 16 miles, the oil surface is three years old and still needs only patching. Light cold oil has been substituted as a dust-layer and has proved reasonably satisfactory, though the stone of course is wearing out, and a bituminous macadam would probably prove economical.

In 1909 another important road, which had been covered with a hot oil blanket, was rutting and wearing out rapidly. A coal team was passing to some hotels three or four times a day during the summer (carrying 6 or 7 tons of coal on narrow tires). When a motor truck was substituted for the coal team the surface of the road, which had been oiled, was again in good condition. It has worn three years and now needs only patching.

Hot Oil Blanket Surface.—A hot oil blanket surface, made of a good asphaltic oil, will be economical and will carry large numbers of automobiles at high speeds (over 1,000 a day in summer) for several years, will carry large numbers of light wagons (500 a day), and quite a number of motor trucks (50 or so a day), but will be destroyed by a large number of heavy wagons, especially those with narrow tires. Fifty or more such vehicles daily, farm wagons, wood wagons, etc., will rapidly destroy the road surface. A surface coat of a good quality of tar will last satisfactorily under a large amount of automobile travel, but usually it has to be renewed more often than a good quality of oil.

In all cases it is assumed that holes and depressions will be filled before tar or oil is used, that the bituminous material is evenly distributed and is sufficiently covered and kept so that it will not be picked up on tires, and that all holes that develop are patched at once as soon as they appear.

Constant repairs, at a cost of 1 to 2c. a sq. yd. a year will save an expenditure of from 40c. to $1 a sq. yd. for the resurfacing of these bituminous surfaces if they are allowed to go to pieces; and they will do it in a year or two at the most, if not cared for properly.

When these surface treatments fail, as they will where the traffic is extremely heavy (heavy in weight of vehicles, not numbers of vehicles), then some more permanent form of construction must be selected and the road reconstructed as soon as possible. It will prove to be true economy in the end, and the end is not far off.

Light cold oils, water-gas tar, etc., used as dust-layers help to prevent the ravelling of roads. These materials may be economical and work satisfactorily for small wagon traffic (30 to 50 a day) and medium automobile traffic (50 to 100 a day), provided the road is not one where high speeds are usual.

They may also help to preserve the road from the effect of automobile traffic where the team traffic is too heavy, or the loads are carried on such narrow tires that a hot oil blanket surface will not wear satisfactorily, until money becomes available to resurface the top 3 in. with some form of bituminous macadam.

Conclusions Summarized.—The accompanying table shows as nearly as possible the results observed after four years of experience with bituminous materials, comparing these results with the traffic going over the road in 1909 and again in 1912.

It is fully realized that more experience will undoubtedly cause changes or modifications in some of the present opinions.

Table Showing Kinds of Road Surfacing Best Adapted to Different Classes of Traffic for a Standard Road 15 Ft. in Width, With a 3-Ft. Gravel Shoulder on Each Side.

	Average Daily Traffic			
	Light wagons	Heavy wagons one horse	Heavy wagons 2 or more horses	Automobiles a day
A GOOD GRAVEL ROAD will wear reasonably well and be economical with......	50 to 75	25 to 30	10 to 12	100 to 150
Needs to be oiled with.....				over 150
OILED GRAVEL fairly good either hot or heavy cold oil ½ gal. coating (cold oil must be used yearly)....	75 to 100	30 to 50	20	500 to 700
WATER-BOUND MACADAM will stand with..........	100 to 150	175 to 200	60 to 80 perhaps more	Not over 75 at high speed
Dust-layer will prove serviceable on such macadam with................				50 to 100
Macadam will then stand (but the stone wears, of course), with				300 to 500
WATER-BOUND MACADAM WITH HOT OIL BLANKET COAT will be economical with.....................	250 to 300	75 to 100	25 to 30	Up to 1400 and more with fewer teams
Will stand at least.........	50 motor trucks		probably more	
But will crumble and perhaps fail with over		100	50	
	(loaded farm wagons	on narrow tires	ice and wood wagons, etc.)	
WATER-BOUND MACADAM WITH A GOOD SURFACE COATING OF TAR will stand with.....................	30 to 50	25 to 30	10 to 15	1800

The quality of gravel or other material and the speed of motor vehicles in particular localities are important factors and account for the above minimum and maximum variations.

It has not yet been satisfactorily determined when the weight of traffic makes it more economical to use a bituminous macadam, either tar or asphaltic products by penetration with a sealing coat of tar or asphalt, or by the mixing method, but it is believed that some such method would be economical and desirable where the team traffic is so heavy (75 to 100 heavy wagons on narrow tires with two or more horses), that a heavy, hot oil blanket surface will not carry the traffic but fails within the year.

We have several such bituminous macadam roads which have stood for three or four years very well indeed, but time alone will determine the ultimate economy. In surfacing with a 3-in. bituminous macadam top the extra cost for such top has varied from 30 to 60c. a sq. yd., depending on material and methods used.

ARTIFICIAL ICE MANUFACTURE IN OTTAWA.

By Gerald L. Kirwan, B.A.Sc.
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THE provision of pure water and pure ice is a problem that has reached an acute stage in municipal affairs, and the satisfactory solution of it, at a popular price, will be heartily welcomed in numerous Canadian municipalities. Ottawa, Ontario, is trying out a system that promises to give the maximum of satisfaction, in so far as the purity of products and their price is concerned. The company (The Artificial Ice Company of Ottawa) has strong co-operation and support, and claim that they are in a position to meet any competitive selling price on the part of natural ice dealers, and still produce a much superior product. They have just started the production of about 5,000 gallons of double-distilled, re-oxidized water, in addition to the demands of their daily ice market. The plant is designed to turn out fifty tons of ice per day with provision for 75 to 80 tons in emergency weather. About 15 men comprise the working staff. Mr. P. D. Lyons, as manager, and Mr. R. W. James, mechanical engineer, had charge of the construction of the plant.

Briefly, the system may be outlined as follows:—

Evaporation.—City water is taken from the hydrant, and evaporated to steam in a boiler 54 ft. long by 6 ft. in diameter. The company (The Artificial Ice Company of Ottawa) owns, however, two wells, each sunk on their own property to a depth of 360 feet, forty feet of which are through clay, and the remainder through solid limestone—a formation that obtains largely under Ottawa. Hence, the water is a reasonably pure product at the beginning of the process. A small air compressor will be used to pump the water from the wells to the boiler, the pipe lines of which are being laid with all possible caution against the introduction of scale from the pipe itself, or of foreign materials from any source.

Condensation.—The steam from evaporation is introduced at 110 pounds working pressure into the first of eight Reilly multicoil evaporators—boilers about 7 ft. high by 2 to 3 ft. in diameter, and each one containing a vertical coil of pipe. Passing through this pipe-way from top to bottom, and thence to the next boiler, the steam condenses, each boiler providing steam at lower pressure for the next until finally the pressure has dropped to a 28-inch vacuum. This vacuum serves the beneficial purpose of removing most of the contained air from the condensed steam, air, in the finished product giving the ice a snowy, cloudy appearance which, in the popular mind, robs it of the purity associated with crystal ice. It also causes the ice to melt and check much more readily than the properly finished product.

As the condensed water from the boilers concentrates in a pump nearby it opens a steam valve on assuming at a certain head (about 12 inches). The pump, thus automatically opened or shut, accordingly as the head of water rises above or falls below the height required, pumps the doubly distilled water through a system of pipes automatically cooled by contact pipes containing running city water at about 55 or 60 degrees F.

Filtration.—The cooled, distilled product is pumped from bottom to top through four strongly riveted galvanized-iron boilers. Inside the true bottom of each, and a few inches above it, is a perforated false bottom. The space between each perforated pair of bottoms and tops is filled with finely divided, well-washed, hard maple charcoal, the function of which is to catch any possible sediment in the water that might get through from the distilling part of the process, (although the pipes and valves have been specially made and assembled with caution against such an occurrence). Each boiler is about 6 ft. high and 3 ft. in diameter, and the four will easily handle all the water the plant has capacity for, on account of the freedom from sediment of the distilled product.

Leaving the boilers, the water is pumped to a 3-ton storage tank, about 20 feet above the level of the floor. Here it is pre-cooled to about 35 degrees F., in order, by condensing its volume, to drive out the last remnant of air. It is now ready to be turned into ice in the "freezer"—the portion of the process which deserves special and continual attention, as it is the important phase of the operation. The details, however, have been so well attended to that it is doubtful if a shut-down of any considerable importance would ever be involved.

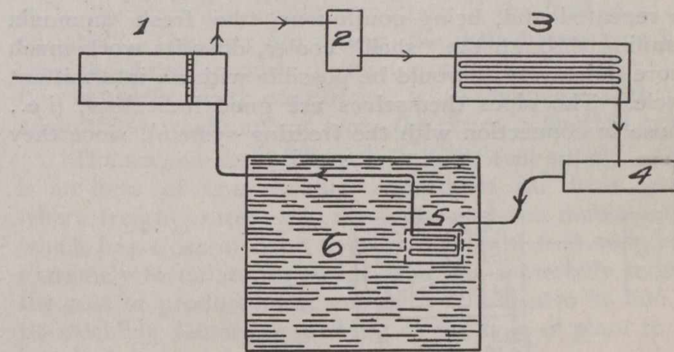


Fig. 1.—Details of Freezing System.
(1) Compressor; (2) de-oiler; (3) water-coolers; (4) condenser; (5) "shell" cooler; (6) "brine" tank.

The "Shell" Freezer.—In one compartment of the building is a tank 65 ft. long, 30 ft. wide, and standing 5 feet above the level of the machinery floor. Its floor and walls are of concrete, and its roof is a wooden structure possessing small trap-doors, each opening being about 2 feet by 1 foot—large enough to admit a can containing water from the storage tank to be frozen in the "brine" solution below this floor level. "Brine" is, properly speaking, a misnomer, as instead of common salt, calcium chloride, which has a more effective freezing action, is used, in the proportion of about 20 pounds to a cubic foot of water. The solution, kept in circulation by an electrically driven paddle, comes in proximity to ammonia in a cooling tank for the purpose of extracting its heat. This cooler is a boiler 15 feet long, 44 inches in diameter, and is situated in one end of the freezing brine tank, being equipped with an interior end-to-end series of pipes, very much like an ordinary steam boiler. Through these pipes ammonia flows, and they are surrounded by the brine solution in much the same manner as a furnace flame sweeps in and around the boiler-pipes. The purpose of the ammonia, as stated, is to extract heat from the brine, to reduce the temperature of the latter sufficiently low to freeze the distilled water in large cans placed in it.

To produce this freezing action, the following explanation and compression cycle is utilized: Gaseous ammonia, compressed to 150 pounds, ultimate working pressure, is discharged into an oil-settling tank, from which it flows through a condensing system of water-cooled pipes into a gathering tank. From here it passes through an expansion valve directly into the "shell" cooler, where it suddenly expands until its pressure drops from 150 to 15 pounds per sq. in. It proceeds at once in this state to draw heat from the surrounding brine in order to make up as much heat per unit volume of ammonia as it had before. Thus its temperature of vaporization is again attained, and in passing from the liquid to the gaseous state its excessive heat of vaporization is derived from the "brine," as it passes through the "shell" cooler and back again, to the compressor as a vapor. The ultimate result is that in the compressor the ammonia temperature may be well over 100 degrees F. and that of the "brine" in the tank approximately zero. Eight above zero is a good working temperature. Eight below, while producing ice much more rapidly than eight above, checks it, however, making it more brittle and cloudy. If, by any chance the "brine" reaches eight below, the compressor is generally stopped long enough to enable the system to rise fifteen degrees or so.

As the ammonia returns to the compressor, the cycle is repeated and, being continuous, the fresh ammonia running through the "shell" cooler, does its work much more quickly than would be possible with an intermittent cycle. The pipes themselves are good indicators, (i.e., those in connection with the freezing system), since they

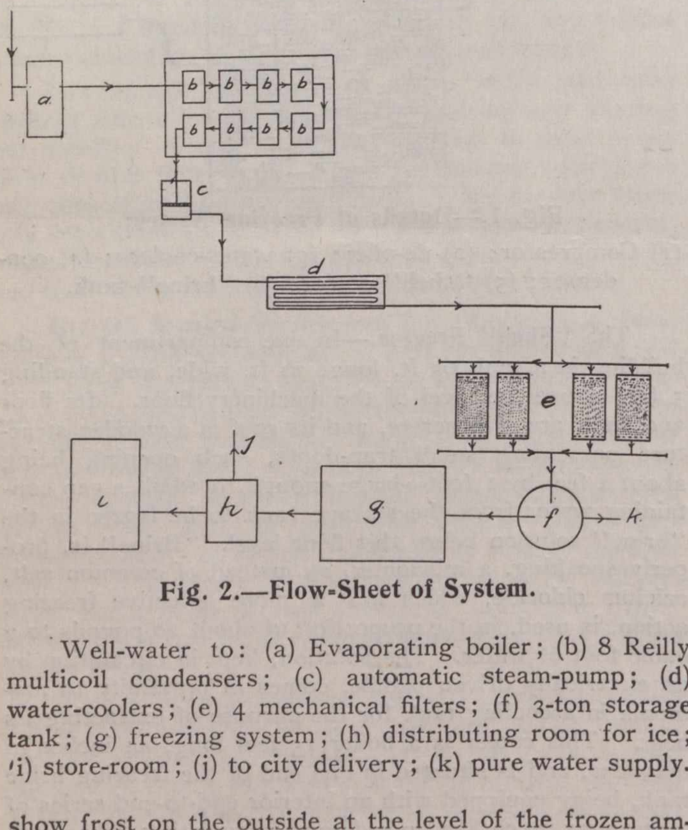


Fig. 2.—Flow-Sheet of System.

Well-water to: (a) Evaporating boiler; (b) 8 Reilly multicoil condensers; (c) automatic steam-pump; (d) water-coolers; (e) 4 mechanical filters; (f) 3-ton storage tank; (g) freezing system; (h) distributing room for ice; (i) store-room; (j) to city delivery; (k) pure water supply.

show frost on the outside at the level of the frozen ammonia liquor in the "shell" cooler, and of "brine" in the tank. It may be remarked in passing that the loss in ammonia is exceedingly small, very little replenishing being necessary in years.

The advantages claimed for this freezing system over the old systems are as follows: It costs, for a 50-ton-a-day plant, $1,000 less, saved chiefly in pipe installation. Also, the wear and tear is very small compared with the old system—as, for instance, the cans containing the freezing water lie in "brine" solution, without having to be jammed down among these old-fashioned coils of piping. It is also claimed that 33% more production is obtained, That advantages like these cannot be overlooked is obvious.

The actual freezing is carried out as follows: The water is led from the storage tank through rubber piping to the freezing-cans. These are 510 in number, and are each 8 ft. by 4 ft. by 1 ft. They are made of riveted galvanized iron, and are guaranteed for four years. When full, a can weighs 400 pounds. A patented automatic nozzle is attached to the feed-hose, and the operation of filling is as follows: The workman opens the feed valve, the water pours into the can; as the level rises, it pushes up a hood on the nozzle till, at a certain height, this hood catches a spring, releasing it, and closing the feed-valve. A can takes about 36 hours to freeze, and as fast as one is removed full of ice, a water-filled can takes its place in the brine. The ice-can is lowered into warm water a minute to loosen up the block of ice inside; then raised by compressed air and tilted on a shaft, opened, and the cake of crystal ice slid along a trough to a drained concrete chamber for cartage to customers, or for storing in a 350-ton store-room.

UTILIZING WOOD WASTE.

Perhaps the most interesting development in the manufacture of wood products has arisen in the increasing variety of uses to which wood-waste can be put. Beginning in the forest the closer utilization of the various wood-products can be traced through the saw-mills and large wood-working industries, right down to the firms working only on small specialized lines.

It is now commercially possible to reduce the fifty to sixty per cent. waste formerly left in the woods by the lumberman to no more than five per cent., by a combination of three well-developed chemical industries, namely, paper-making, wood-distillation (in a modified form) and the manufacture of resin oils. Practically all the valuable constituents from the stump, tops, branches and defective stems which would otherwise be left to rot in the forest are thus converted into useful commodities.

The utilization of mill waste is being made increasingly possible by the developing markets for odd and short lengths in lumber instead of a few assorted sizes. Many saw-mills use their waste products in the manufacture of laths, mouldings, pickets, roller-blinds and paving blocks. The manufacture of wood-pulp from the small waste-wood now being fed to the burner is also a commercial possibility. Even sawdust has its uses, and in countries where more intensive utilization prevails it is being successfully manufactured into a variety of products. Several plants have been erected in this country for its manufacture into ethyl (or grain) alcohol, sugar and briquets for fuel.

The bulletin now being issued by the Forestry Branch, Ottawa, on "The Wood-Using Industries of Ontario," throws considerable light on the utilization of wood-waste. Sash and door factories sell or use their short ends and trimmings for the manufacture of boxes, baskets, bobbins, butter-moulds, insulator pins, novelties, skewers, spindles, spools, stakes and woodenware. They bale their common sawdust and sell it for covering for the manufacture of composition novelties, and for cleaning screws. They sell shavings for bedding, packing and for drying wet land. Hickory and other hardwood dust is sold for smoking meats. In fact, wood manufacturers will soon be able to boast of using all the wood but the bark—and even that, in the case of some woods, such as hemlock, is of considerable value.

THE GENERATION OF ELECTRICAL ENERGY FOR SMALLER TOWNS

DATA CONCERNING CONSUMPTION OF LIGHT AND POWER — PLANT DUPLICATION FOR RELIABILITY OF SERVICE — FEATURES GOVERNING PLANT DESIGN AND EQUIPMENT.

By M. M. INGLIS,
Electrical Engineer, Yorkton, Saskatchewan.

IN a paper read at the eighth annual convention of the Union of Saskatchewan Municipalities, and entitled "The Generation and Distribution of Electrical Energy for Light and Power Purposes in Medium and Small Sized Towns," Mr. Inglis began by citing a few statistics covering a number of towns having generating units installed, and the degree of patronage extended to them, but his remarks were based largely upon the comparative suitability of the various types of prime movers, for small installations.

In towns of 1,000 to 1,500 population the average number of consumers is approximately fourteen per hundred.

In towns of 1,500 to 2,500 population the average number of consumers is approximately sixteen per hundred.

In towns of 2,500 to 3,000 population the average number of consumers is approximately thirteen per hundred.

The average consumption per capita in towns from 1,000 to 5,000 remains fairly constant, and from data collected that consumption is approximately 60 watts.

Thus in a town of 1,000 inhabitants the output required of the generating unit would be 60 kw., or taking the efficiency of the generator as being 90%, then the output of the prime mover would be approximately 90 b.h.p. Similarly with a population of 5,000 the output of the electrical equipment would require to be 300 kw., or with a generator efficiency of 92% the output of the prime mover would be approximately 440 b.h.p.

In order to maintain a thoroughly reliable service during the 24 hours of the day, it is absolutely necessary to duplicate the plant. Consequently, for a town of a thousand population the total generating capacity ought to consist of two units of 90 b.h.p. capacity. However, as most towns only run their plant during the lighting period, or approximately ten hours per day out of the twenty-four, on a yearly average, the question crops up as to whether it is necessary to install this duplicate unit. This question is usually decided by the financial position of the municipality and whether there is sufficient demand for power during the remaining fourteen hours of the day. In most cases only one unit is installed.

Salient Points Governing Installations.—The most important items to be considered in locating small central stations are:—

(1) The method of driving the generators.

(2) The proximity of fuel supply.

(3) Pure water supply.

(4) Railroad facilities and the possibilities of later expansion.

Although I have numbered these items, I have by no means attempted to place them in their order of importance, because they will each affect to a more or less degree the different type of plant which it is proposed to install. The first mentioned, namely, the method of driving the generators, from an engineering point of view, seems of primary importance. Considering the two types of drive universally used, namely, the belt drive and the direct connected drive, experience has shown that the belt-driven plants are less efficient and much less reliable than the direct connected unit. This is due principally to belt troubles. Much more floor space is also required for the belt-driven type of plant, consequently a larger building is required in which to house them. As important as any of these drawbacks is the inferior regulation which is very apparent when no automatic regulator is connected in the electrical circuit, especially if the load is at all variable. The only advantage the belt-driven type has over the direct connected type is a lower first cost, but this is hardly worth considering when compared with the advantages which accrue from the direct connected type.

The second item: The proximity of fuel supply. This is an item of considerable importance in these parts where freight rates are so high, and the municipality which has close at hand a good source of fuel supply is extremely fortunate, in so far as it will materially reduce the cost of production of energy. It will also be one of the deciding factors in arriving at the type of plant to be installed.

The third item, namely, pure water supply, will also be a deciding factor, as all the prime movers in use to-day use water to a more or less degree, either in the direct process of generation or as a cooling medium.

The last item, but none the less important, is that of railroad facilities and the possibility of later expansion. The railroad facilities we are all familiar with for the handling of the fuel supply, but the possibility of later expansion is one that cannot be given too much consideration, as not a few instances can be seen where inadequate provision has been made for future extensions. If the proper precautions were taken in deciding upon the best type of plant for each individual case, and provision made for future extensions, then a great deal of time and money would be saved as well as greater possibilities obtained of supplying energy at a lower rate in the future.

Taking the case of one unit being installed, and for instance, say, a 100 b.h.p. unit, this is equivalent to an electrical output of approximately 68 kw., taking the efficiency of the generator at 91%. Assuming the plant to run on an average ten hours per day during the period of one year or, say, three thousand hours, then the maximum number of units generated would be 204,000. This is only true if the plant is run on full load during the entire period. In actual experience, however, the total units generated approximate a yearly average 15% of the maximum, which is equal to 30,600 units. Assuming the cost of energy to be 15 cents per unit with no allowance for distribution loss, then the yearly revenue would be equal to $4,600. Knowing the principal and interest payable yearly on the debenture issue, as well as the fuel and operating expenses, with a liberal allowance for depreciation, it is an easy matter to determine whether or not the cost per unit, namely, 15 cents, is sufficient to meet this expenditure. In this manner it is possible to figure out a rate at which the undertaking will be self-supporting. With small plants the biggest items of expenditure are usually the fuel bill and wages. In order to keep these to a minimum it is necessary that the most efficient and reliable plant be installed combined with simplicity in operation.

Steam, Gas and Oil Engines.—The steam engine in favor to-day for small central station work is the vertical compound high-speed engine, fitted with piston valve, automatic governor and having forced lubrication throughout. This type has proved itself very suitable in so far as reliability and speed regulation are concerned. The operation of the same is simplicity in itself. There are, however, other items to contend with in a steam installation just as important as the engine itself. One of these I have previously mentioned, namely, pure water supply. In connection with this, all are familiar with the difficulties attending an impure or shortage of supply. These call for proper and costly treatment on the one hand, and an unreliable service is the result on the other hand, attended with loss of revenue from the sale of energy. There are also injectors, pumps and boilers, which are often more troublesome than the actual prime mover itself. The whole of these difficulties may not be met with, but there is one difficulty attending all small steam installations and, to my mind, a very important one, that is *the stand-by losses*. These ought to be given due consideration when it is intended to install a generating plant. Take the case of a plant running only ten hours out of the twenty-four; for the other fourteen hours there is quite an appreciable loss for which there is absolutely no return, besides there is also the cost of labor looking after the boiler equipment during the non-working hours. Taking this loss of fuel, in addition to the actual fuel consumed during the generating period and with a load factor of 15 per cent., the consumption of coal will be approximately six to seven pounds per unit generated at the switch-board. Taking this lower consumption and coal at the price of $7 per ton, this is a generating cost of 2.1 cents per unit.

Of the gas engine plants the suction gas producer equipment seems to hold the field. These plants are proving themselves more and more reliable and are very suitable for small stations. They are, however, less reliable, although more economical than the steam engine. The greatest difficulty in connection with these plants is usually met with in the gas producers, and in spite of the statements to the contrary, it requires an experienced man to care for the producers, to obtain the best results and keep the plant in first-rate condition. The principal troubles are the keeping of the combustion zone within the proper limits, the removal of ashes and clinkers, and the effects of impurities in the gas. This first trouble is usually caused by the fuel not being kept consolidated during operation. The second due to improper regulation of steam which causes high combustion temperatures, if there is sufficient steam with consequent fusing of incombustible matter. When the ashes and clinker are being removed, and especially in the smaller sizes of producer, little or no provision is made to exclude the air from entering, thus causing an irregularity in the quality of the gas produced. This, you can understand, will naturally affect the running of the engine.

Let us consider the cycle of operation in the engine. During the first stroke, a mixture of air and gas is drawn into the cylinder. On the second stroke this mixture is compressed. At the end of the compression stroke the mixture is ignited by means of an electric spark from a magneto or some such apparatus, thus we have explosion and subsequent expansion during the third stroke. During the fourth or exhaust stroke the products of combustion are set free to the atmosphere. This completes the cycle of operation. The combustion of the gases is accompanied by the formation of a carbon deposit in the cylinder and it sometimes happens even though due precautions are taken, that this carbon, which is at a high temperature, is sufficient to prematurely ignite the fresh mixture during the next cycle of operation. This premature ignition sets up undue strains in the mechanical parts of the engine, which are liable to cause trouble. It is thus found necessary to withdraw the piston in this type of engine at approximate intervals of three months, in order that the carbon deposit does not interfere with the working of the engine. There are also the stand-by losses to be considered, but these are not of the same magnitude as with a steam equipment. In a suction gas plant of the same capacity as that quoted in connection with the steam plant, and under the same conditions, the consumption of coal would be approximately four pounds per kw. generated at the switch-board. Taking coal at $8 per ton, this would mean a cost of approximately 1.6 cents per unit.

In considering the oil-burning engines, I might just mention that it has been a recognized fact both theoretically and practically, that the higher the compression in the internal combustion engine the more efficient would it become. One reason for the keeping of this compression at a moderately low figure has been due to the excessive temperature caused by the compression and the likelihood of this high temperature igniting an explosive mixture such as is compressed in the ordinary gas engine. This difficulty, however, has been overcome in one type of internal combustion engine which is considered one of the foremost prime movers on the market to-day, that is the Diesel crude oil engine. The cycle of operation may be described as follows: During the first or suction stroke, air only is drawn into the cylinder. On the second stroke this air is compressed, and at the end of the compression stroke the fuel oil is sprayed in finely divided particles into the cylinder. The air temperature, being high, as the result of compression, the finely divided oil burns as it enters the cylinder. This spraying of oil is continued during a considerable portion of the outward stroke, and during the remainder of this the third stroke, the products of combustion and the surplus air expand. During the fourth or exhaust stroke the products of combustion are driven off to the atmosphere. This completes the cycle. It will thus be noticed that air only is compressed and not a mixture of air and combustible vapor or gas: consequently, whatever the pressure of compression and whatever the temperature, premature ignition cannot occur, there being no fuel to ignite. Therefore the greatest economical advantages of high compression can be utilized. There is, however, the disadvantages of high compression, which are all more or less of a mechanical nature, but these difficulties of a recent development are being largely eliminated. The Diesel engine, like all other prime movers, is not immune from trouble. It may be the sticking of a fuel valve, the hanging up of a compressor valve, or a leaky exhaust valve. All of these defects may be of little or no importance, and may cause a shut-down of only a few minutes, yet there is that interruption in the service which always means a loss of revenue. To my mind the only great disadvantage in connection with the Diesel oil engine is a possible shortage of fuel supply. So far as I know there is no decrease in the actual production of oil, yet there is that ever-decreasing demand for the finer and crude oils. Up till the present there has been no difficulty in obtaining fuel oil, but the price has increased almost fifty per cent. during the past twenty months. It might also be interesting to know that the freight on fuel oil to Saskatchewan is approximately equal to the cost of oil in its home market. Under the same conditions as that of the steam and gas producer plants before mentioned, the oil consumption is approximately .12 of a gallon per unit generated at the switch-board. Taking the price of fuel oil at 12 cents per gallon, this gives a cost of 1.44 cents per unit.

Comparing the three types of prime movers discussed we have:—

Steam, with coal at $7 per ton, 2.1 cents per unit.

Gas, with coal at $8 per ton, 1.8 cents per unit.

Diesel, with oil at 12 cents per gallon, or approximately $27.60 per ton, 1.44 cents per unit.

In concluding the generating part of this paper, I might say that the labor costs are highest for gas engines and lowest for Diesel engines, with steam plant taking a position about midway between the two.

ENGLAND'S EXPORT TRADE.

According to the Board of Trade the following are the values of produce and manufactures exported by the United Kingdom to the leading countries and self-governing dominions:—

Germany	£40,362,767
Australia	34,840,701
United States	30,065,806
France	25,585,681
Canada	23,531,311
South Africa	21,420,912
Holland	14,281,668
Belgium	12,193,306
New Zealand	10,390,334

GRANITE AND TRAP-ROCK IN CANADA.

The production of granite and trap-rock in 1911, according to returns from forty-seven active firms reporting, and contained in the statistics given in the annual report on the mineral production in Canada, by John McLeish, B.A., was valued at $1,119,865, as compared with a production by thirty-three firms, valued at $739,516, in 1910; showing an increase of $380,349, or 51.4 per cent. There was a particularly large increase in the value of granite used for building purposes and in the production of crushed stone.

Quebec province was again the largest producer, the value of sales in 1911 being $462,678, as compared with $356,257 in 1910. The value of sales in British Columbia in 1911, however, approached very closely to that of Quebec, being $460,851, as against $244,767 in 1910. Ontario produced granite to the value of $131,816 in 1911, as compared with $109,678 in 1910. Both New Brunswick and Nova Scotia showed an increased production, the value of the New Brunswick output being $37,994. Much of the rough stone quarried in New Brunswick, as well as stone imported from Redbeach, Maine, and Mt. Johnston, Que., is worked up into finished monumental and ornamental stone at mills at St. George, the value of the finished product here in 1911 being $86,658.

BRIDGE FLOORS REPLACED WITH CONCRETE

Mr. L. C. Smith, engineer for the Michigan State Highway Commission, in the fourth biennial report of the commissioners, advises the use of concrete wherever possible in the replacing of floors on old steel or wrought iron bridges, even though this may necessitate the laying of new steel stringers.

This plan has been followed for assumed load specifications and computing stress in truss:

(1) Concentrated wheel load of five tons on area 12 inches by 28 inches on floor slab.

(2) Concentrated wheel load plus weight of slab on two stringers spaced not more than 28 inches apart.

(3) Distributed ten-ton load plus dead floor load on floor beams.

(4) Ten-ton concentrated load tried on each panel joint plus dead load of whole bridge for the trusses.

In no case have concrete floors been recommended where the stress in the steel would be above 17,000 pounds, and in wrought iron above 13,000 pounds.

The following general specifications are used:

Steel.—Steel stringers shall be spaced not more than 28 inches nor less than 24 inches centres.

For panel lengths, from 12½ feet to 14 feet and width of roadway 16 to 18 feet. Eight-inch 18-pound I-beams shall be used for three centre stringers. On each side of these, two 7-inch, 15-pound I-beams, and, in place of side channels, 6-inch 12¼-pound I-beams shall be used at each edge. All stringers shall be long enough to reach two panel lengths, and be laid so as to break joints. Stringers shall be bolted to floor beams securely with one-half inch bolts at each intersection. Stringers shall be connected at ends with two three-eighths inch fish plates 14 inches long and wide enough to fit snugly between flanges. Fish plates shall be bolted with eight one-half inch bolts in each plate. Not more than one-quarter inch, nor less than one-eighth inch shall be allowed between ends of stringers.

All abutment and pier ends of stringers shall be bedded in Portland cement mortar mixed 1:3.

All floor beams, sway bracing stringers and connections shall be coated with two coats of linseed oil paint. Tops of stringers must not be painted.

Forms.—Forms shall be placed between stringers tight up under top flange. Tar or builders' paper must be used on forms to make them tight.

Curb forms shall be securely fastened in place before any concrete is placed.

Reinforcing.—Expanded metal No. 40—3-inch U.S. or Kahn rib metal No. 3 wire reinforcement, having the same area of cross-section per foot width, shall be used. Reinforcing shall be laid with main members, running at right angles to stringers. Ends of reinforcing shall be bent up three inches into curb. Strips shall be securely wired or clipped together. Reinforcing shall rest on top flange of stringers and be not more than one-half inch nor less than one-quarter inch from forms.

Concrete.—Gravel shall be from forty to sixty per cent. pebbles by weight, no stones larger than one-inch. An approved brand of Portland cement shall be used. Concrete shall be mixed in the proportion of one part cement to three parts gravel, wet mix. A batch mixer or very careful hand mixing shall be used.

Concrete shall be spread uniformly 3½ inches thick over tops of stringers. On account of stringers being of different depths, finished roadway will be crowned two inches.

Concrete must not be trowelled, but smoothed off with a template. Curbs must be poured at same time as roadway.

Expansion Joints.—On top of every other floor beam an expansion joint shall be placed. This joint shall consist of two thicknesses of heavy tar paper.

Work shall not stop in laying the floor at any place except at an expansion joint.

Surface shall be covered with sand or sawdust and be kept wet during first five days of drying.

Forms shall not be removed in less than three weeks. No traffic shall be allowed on floor until four weeks after completion of concrete work.

Tar Top.—A skin coat of bituminous binder, mixed with sand, shall be spread on the concrete surface not to exceed one-quarter inch in thickness.

A bridge floor was replaced at Montrose, Michigan, following the above plan. The cost of doing that work, without any allowance for superstructure, was as follows:

Cost of Montrose Bridge 150-Foot Span, 16-Foot Roadway.

New 8-inch steel stringers	$ 595.00
Removing old floor	15.00
Punching and erecting new steel	60.00
Lumber for concrete forms	65.13
Labor placing forms	10.00
Cement on the job	90.00
Gravel on the job, ½-mile haul	18.00
Mixing and laying concrete	70.00
2,400 square ft. expanded metal	112.90
	$1,035.03

Itemized Cost of Concrete Per Cubic Yard.

Form lumber	$1.19 per cu. yd.
Labor on forms	.34 per cu. yd.
Cement 1:3 mix	3.03 per cu. yd.
Gravel	.60 per cu. yd.
Mixing and laying	2.36 per cu. yd.
Total	$8.52 per cu. yd.

New oak floor would cost $50 per thousand, including laying, or for a wood floor 3 inches thick, the cost would have been 15 cents per square foot, or $360. To this must be added the steel stringers needed in either floor, which makes $360 plus $595 or $955. The difference in cost of the two floors would only be $80, without any consideration of the most important item, namely: How long will it last? The concrete floor will continue to grow stronger with age, and on the other hand, the wooden floor would need repairs in five years. The concrete would tend to stiffen the whole bridge and distribute the concentrated loads over a larger area, and the wood floor is at best a springy, shaky, rough-riding and expensive proposition. An ordinary plank bridge floor weighs about 30 pounds per square foot, while the concrete floor weighs 60 pounds per square foot, both weights including steel stringers.

"When a new bridge floor for an all-steel or wrought iron bridge is needed," says Mr. Smith, "a competent bridge engineer should inspect the trusses and abutments and determine whether or not the bridge is sufficiently strong to carry a concrete floor. If the bridge is worth it or can be reinforced to make it sufficient to carry a reinforced concrete floor, it is by far the best."

THE APPLICATION OF OZONE TO WATER PURIFICATION.

In a recent report by Russell Spaulding, consulting ozone engineer for the State Department of Health, New York, the application of ozone to water purification is treated as a process that is quite feasible commercially. The report, just issued by the Department, is very enthusiastic about the ozone process as compared with filtration which it pronounces efficient, but more or less cumbersome and not always practical; and with rapid filtration for dirt and subsequent treatment with chemicals, of which the most promising is chloride of lime.

The use of ozone as a purifying agent has received such varied publicity that the history and development of the gas needs but brief attention.

A Dutch physicist, Van Marum, in 1783, while studying the behavior of gases in the path of electrical discharges, noted that oxygen gave a decided odor. But not until 1840 was this peculiar form of oxygen recognized as a distinct gas. In that year Friedrich Schoenbein, a German chemist and professor at the University of Basel, Switzerland, showed that oxygen, after being subjected to electrical stress, possessed peculiar chemical properties. To this gas he gave the name "ozone."

The gas remained more or less of a scientific curiosity for a number of years, and the study of its properties seems not to have been attempted for practical ends until Berthelot took it up in 1890. He was followed by a long line of experimenters, most of them Europeans.

Only a few of the army of experimenters made definite contributions to the advancement of the art of producing ozone in large quantities on a commercial scale and with a minimum expenditure of power.

Ozone is a form of oxygen in which the atoms of the molecule have a different arrangement from that of ordinary oxygen. It is very unstable and will revert to oxygen in a very short time if left to itself. When, therefore, it is put into water it will speedily assume the condition of oxygen and be quite beyond the possibility of polluting water. Consequently its use is beyond any criticism which may be directed at the chemical treatment which may remain as an impurity. Ozone could not be an impurity in water, for it changes instantaneously. It owes its efficiency in acting on bacteria to the fact that it cannot remain in the condition of ozone, but breaks up and forms free oxygen, which is an extremely powerful oxidizing agent. This oxidization destroys bacteria with incredible rapidity in the purification of water by ozone, which in turn leaves no trace of itself.

The utility of ozone as a bactericide, through its marked oxidizing properties, was pointed out by de Meritens in 1886 and Froelich about 1890.

To-day there is little question of the efficacy of ozone as a commercial chemical and sterilizing agent but there are questions of practicability, related mostly to the cost of production and utilization, and to the ease of maintenance of generating apparatus. By the improvement and refinement of the generators, the cost of production has become a small part of the cost of any complete process for using ozone for purifying or bleaching. This condition arises largely through the expense of forcing contact between the ozonized air and the material to be treated.

The process about which most interest centres, naturally, is the purification of water. There are elements in the proposition to kill all bacteria and to get rid of organic contamination by introducing "electrified air" that appeal to the popular imagination as no proposal to filter or chemically sterilize water can. It has been demonstrated that ozone is a simple and effective sterilizing agent and leaves no residue in the water repugnant to the public mind as use of chemicals would. Whether or not an ozone plant is the best thing for a given location often simmers down to a question of the costs, and these depend to a very large extent on local conditions, so that results obtained in one place are to be applied with caution to another place and only under the advice of competent engineers.

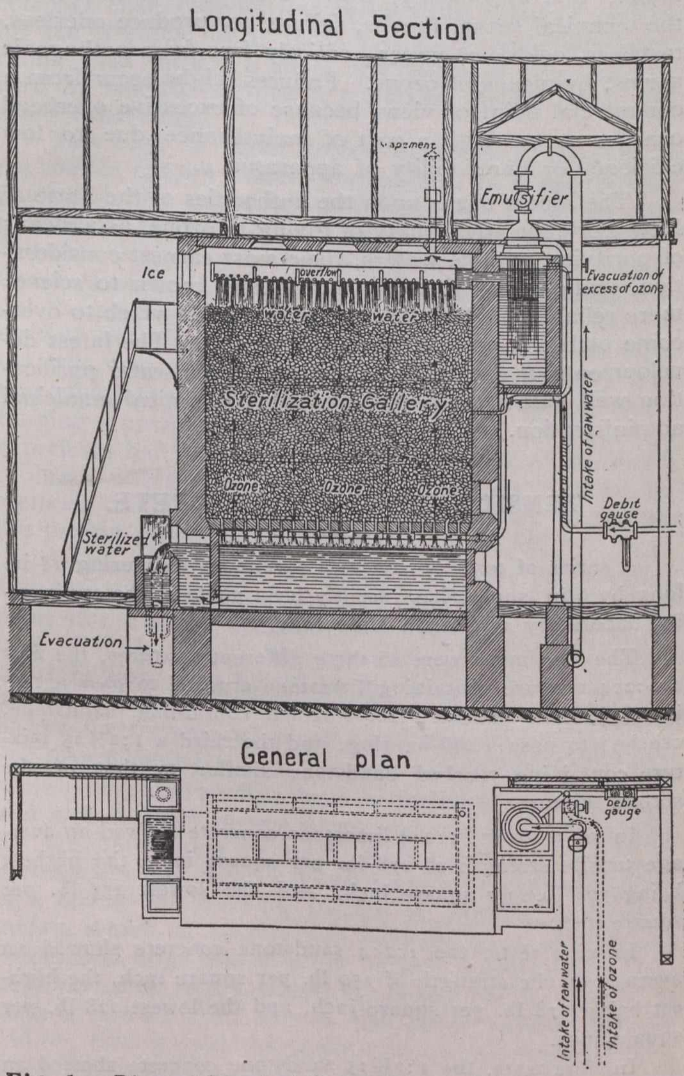


Fig. 1.—Plan of Plant at Saint Maur; Capacity 1,012,500 Gallons Per Hour.

The earliest attempt to produce and utilize ozone on a commercial scale was that of Baron Tindal at Oudshoorn in Holland, in 1893. Since then great improvements have been made in ozone-generating apparatus, both from the point of view of reliability and of economy. Baron Tindal's first apparatus yielded about 2 grammes of ozone per kilowatt hour, whereas the plants now in use in Europe produce from 40 to 50 grammes per kilowatt hour. Even this efficiency can be improved on, and the United States may soon redeem itself for its slowness in adopting a system already so well developed in Europe by outstripping the old world in the production of economical apparatus. Baron Tindal was followed by such men as De Frise, Schneller, Vandersleen, Vosmaer, Otto, Abraham, Marmier, Siemens, Gerard, each contributing to the improvement of apparatus and application. Among the European installations the systems of Otto and Siemens are giving very satisfactory service and are mentioned in the report as the best so far attained.

The list of European plants contains 26 plants in France, 4 in Roumania, 7 in Germany, 5 in Italy, 3 in Russia and 1 in Spain. Three South American plants are also mentioned. These plants range in daily capacity from 32,400 gals. for the Ravenna, Italy, plant, to 24,300,000 gals. for the St. Maur, France, plant. A brief description of several plants follows:—

Saint Maur (Paris), France.—This plant is the largest one in France, and is diagrammatically shown in Fig. 1. It was enlarged in 1910 to its present capacity of 24,300,000 gals. per 24 hours. This plant is situated near Paris on the River Marne. The water pumped from the river is first filtered through sand and then sterilized by means of ozone.

This ozone is drawn into the water by Otto aspirators. The water then trickles down through gravel contained in a sterilizing tower, meeting an ascending current of ozone which further sterilizes it. From this tower the sterilized water runs into a large reservoir, from which it is pumped into the city of Paris proper.

Nice, France.—Early in 1904 the municipality of Nice, in southern France, entered into a contract with the French Ozone Company for the erection of an ozone sterilization plant near the reservoir of Bon-Voyage. This plant, with a capacity of 6,480,000 gals. daily, was completed in 1905. The general arrangement is shown in Fig. 2.

Following are some of the requirements made by the city, translated from the official contract: 1. Capacity of sterilization, regular and continuous, 6,480,000 gals. per 24 hours. 2. Maximum allowance for upkeep $5,000 per annum. 3. The city will furnish free hydraulic power—13,157 kilogrammes on the axis of the turbines. 4. The Ozone Company guarantees that the treated water will not contain any pathogenic bacteria. 5. The maximum harmless bacteria not to exceed 10 per c.c., exception being made for B. Subtilis. 7. The Ozone Company guarantees that the chemical qualities of the water will not be altered except they be improved, that they will not introduce in the water any harmful foreign substance, and that no trace of ozone will remain in the treated water as it emits from the reservoir of Bon-Voyage. 8. The Ozone Company further guarantees the absolute innocuousness of the process. 9. The Ozone Company will be responsible for any abnormal corrosion of the conduits. 10. Price of entire installation to be $48,167.

The success of this installation is evidenced by the fact that in 1909 the community of Nice ordered installed a second plant at Rimiez with a capacity of 3,700,000 gals. per 24 hours.

Paderborn, Germany.—As a result of the experimental plants installed at Berlin in 1896 and at Martinikenfeld in 1898, it was decided to build an ozone water-purification plant on a large scale, in order to determine whether or not it would prove reliable, efficient and economical in a municipal plant.

The town of Paderborn in Germany was chosen for the initial plant. The plant was erected and officially turned over to the municipal authorities in the month of August, 1902.

The plant has a capacity of 500,000 gals. of sterilized water per 24 hours. It has been operating uninterruptedly since 1902, never once failing to perform its duties in an entirely satisfactory manner. Bacteriological examinations are made regularly and at frequent intervals each day. Since the day the plant started, in 1902, these examinations have shown an entire absence of pathogenic bacteria. A duplicate of the Paderborn plant was erected in 1903 to supply the town of Wiesbaden. The plant is located near the River Rhine at Schierstein, and the sterilized water is pumped over to Wiesbaden.

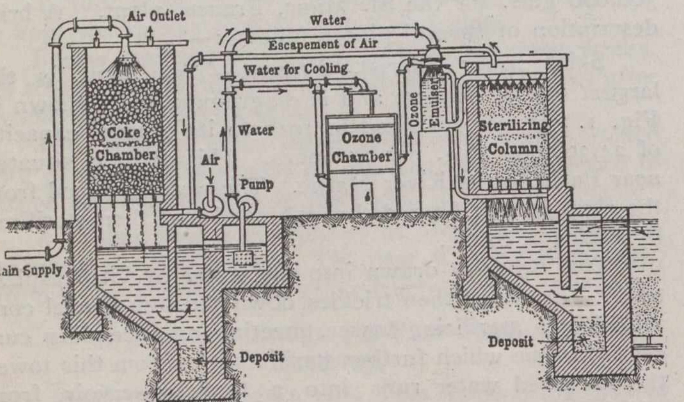


Fig. 2.—Arrangement of Plant at Nice, France; Capacity 27,000 Gallons Per Hour.

St. Petersburg, Russia.—The city of Saint Petersburg in Russia is dependent on the River Neva for the major portion of its municipal water supply. These waters were contaminated by typhoid and cholera bacteria.

After a thorough investigation of all available means for the purification of water, investigations which extended over a considerable period of time, the authorities of the city of Saint Petersburg decided that the most reliable and effective agent was ozone. Researches made at the Pasteur Institute in Paris were made the final basis of the Russian authorities.

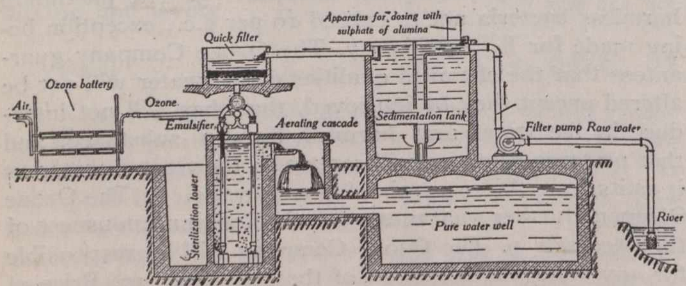


Fig. 3.—Plant at Saint Petersburg.

Work on the plant was started in 1910 and was completed in November, 1910. The water after being pumped from the river is first treated with sulphate of alumina as a coagulant; it is then filtered through rapid filters. Careful bacteriological examinations show that both before and after filtration the water contains an abundance of typhoid and cholera bacteria, whereas after ozonization there is invariably a total absence of these and all other pathogenic bacteria. The gross cost of purification, including filtration, is $15 per 1,000,000 gals. The net cost of ozone sterilization is $7.50 per 1,000,000 gals. Fig. 3 is descriptive of the installation.

In concluding his report Mr. Spaulding states that the most desirable mechanical factors to be used in connection with the generation of ozone are: 1. A supply of alternating electric current at low cost. 2. An efficient transformer to obtain high tension. 3. Ozone electrodes that do not generate enough heat to—(a) Disrupt the dielectrics; (b) Cause reversion of ozone to oxygen; (c) Require external means for cooling. 4. Ozone electrodes that will approach the theoretical efficiency much more closely than the various systems now in use.

The only failures in ozone water purification plants that have so far occurred have been due to a failure in breaking up the water in sufficiently fine particles and in properly contacting these small particles with ozone. The two failures which he mentions are those at Ann Arbor, Mich., and at Lindsay, Ont. He refers to failures in the technical sense, that is, failure to produce odorless, tasteless, colorless water, entirely free from pathogenic germs, by means of ozone. Failures might occur from a commercial point of view, because of excessive overhead charges or too high a cost of maintenance due to low efficiency or unreliability of apparatus.

The report urges upon the authorities of the State of New York the advisability of giving to ozone, as a means of purifying potable waters, their most earnest consideration, stating that there is no means known to science more reliable or absolute than ozone, with which to overcome pollution and protect public health. The latest developments of the art have brought ozone water purification well within the boundaries of economical municipal administration.

TENSILE TESTS OF CONCRETE.

A series of tests on concrete specimens measuring 18 in. long by 6 in. square has recently been made in the engineering laboratory at Cornell University.

The specimens were of three different mixtures, the first a 1:2:4 mixture containing limestone crushed to pass a 1½-in. ring, the second a 1:2:4 mixture containing sandstone, crushed to pass a 2½-in. ring, and the third a 1:2½:5 mixture containing crushed sandstone similar to that of the second mixture.

In six tests the 1:2:4 limestone concrete showed an average tensile strength of 278 lb. per square inch, the highest being 308 lb. per square inch, and the lowest 253 lb. per square inch.

In nine tests, the 1:2:4 sandstone concrete showed an average tensile strength of 150 lb. per square inch, the highest being 178 lb. per square inch, and the lowest 128 lb. per square inch.

In nine tests, the 1:2½:5 sandstone concrete showed an average tensile strength of 129 lb. per square inch, the highest being 179 lb. per square inch, and the lowest being 97 lb. per square inch.

It is worthy to note that in many instances particles of sandstone were split in two in the plane of the fracture instead of breaking the bond with the mortar; this was particularly so in the case of red sandstone, and illustrates the importance attaching to the selection of aggregates for employment in concrete work.

Boring for oil in Sicily has been vigorously prosecuted for the last 18 months, according to "Daily Consular and Trade Reports," of recent issue. It appears that there are large quantities of oil near Nicosia in Catania, containing considerable quantities of bitumen, about 40 to 55 per cent. of petroleum, and free from sulphur.

WHY SOME MUNICIPAL ASPHALT PLANTS FAIL.

By H. B. Pullar, Assoc. Am. Soc. C.E., of Pullar & Enzenroth, Engineering Chemists, Detroit, Mich.

Many cities throughout the United States and Canada now own and operate their paving plants. A majority of these paving plants have proven a success, but a number of them have been unsuccessful. It is not the intention in this paper to discuss the advisability of municipal paving plant ownership, but to show, in a manner, why some municipal paving plants fail to accomplish their purpose and prove to be a losing venture for the city that owns them. As facts are more interesting than theory, a short description of the methods used by one city owning a municipal paving plant may prove interesting.

This city, of about 50,000 inhabitants, situated in the middle eastern States, purchased a municipal paving plant and the necessary equipment for laying its own pavements, the initial capital expense amounting to about $10,000. According to the usual custom, the plant manufacturers offered the services of a so-called expert to get the plant in running order and demonstrate its economical qualities. This so-called expert, as is too often the case, was not familiar with the paving industry, and was absolutely incapable of organizing and properly running a paving plant. The city engineer, whose paving experience had been largely that of supervising the laying of brick pavements, justly became disgusted with the methods of this so-called expert and decided to operate the paving plant according to his own ideas.

Without intending to unjustly criticize the engineer and other officials in charge of this municipal asphalt plant (for without question they were running it to the best of their ability), the operation of this plant under the conditions was bound to result in a failure for the municipal plant, which eventually would disgust the taxpayers with municipal plant ownership.

The concrete foundation was laid according to the same grades and profiles used for laying brick pavements, and was in most places rough and uneven. The laying of the foundation to such grades naturally made it necessary to put down a bituminous pavement consisting of a binder and wearing surface of between 5½ and 7 inches, which, of course, was contrary to all correct and recognized principles of sheet asphalt construction. The engineer gave as his excuse for laying the foundation in such a manner that, should the sheet asphalt prove a failure, then it could be easily torn up and replaced by a brick pavement.

The paving plant was in charge of an employee who had had some previous experience in plant work, but who was not familiar with the present-day methods, and who was certainly not running the plant in an economical way. The plant site was too small, and was carelessly laid out, making it impossible to run the plant efficiently.

On account of there not being any satisfactory stone in the near vicinity, gravel was used for binder. It was used just as it came from the pit, and contained a considerable percentage of round, smooth boulders, varying in size from ½ to 2 inches in diameter. Of course, it was absolutely impossible for the binding material to hold and bind these boulders together in any satisfactory way. While this unsuitable gravel was run into the mixer from one side of the plant the asphalt cement was run into the mixer from the opposite side, the melting and mixing going on simultaneously. This is contrary to the best practice, and much better results could have been accomplished at a very small expense by having a separate kettle for melting the asphalt cement. After the mix had been running for what the foreman considered a satisfactory period it was dumped into wagons. By the time the last of the mix was out of the mixer the temperature was about fifty degrees higher than the first that came out, the result being that there was usually a part of the load that was either too cold or else overheated.

The binder was then taken to the street and laid by inexperienced men (as will later be described), to a thickness of between 3 and 4 inches. After there had been laid what was considered a sufficient amount of binder, the plant was stopped and changes made in order to run the surface mixture. No system was used in making these changes from running binder to surface mixture, and there were many useless and expensive delays.

The surface mixture consisted of sand, marble dust and asphalt cement, the sand and marble dust analyzing as follows:—

Sand.

		Per cent.
Passing mesh	200	0.0
" "	100	0.0
" "	80	0.5
" "	50	12.5
" "	40	14.0
" "	30	28.0
" "	20	11.5
" "	10	13.5
" "	4	20

Marble Dust.

		Per cent.
Passing mesh	200	80.6
" "	100	12.4
" "	80	6.0
" "	50	1.0

The marble dust was of good quality and satisfactory for filler. The sand, which was to comprise 80 per cent. of the pavement, and which is too often considered of little importance, was poor and very unsatisfactory for high-grade sheet asphalt work. As will be noted by the grading, it was entirely too coarse, and especially so when the heavy traffic of the street was taken into consideration. Sometimes it is necessary to make the best possible mix out of the available materials, but in this instance a suitable sand could have been obtained at a very small increase in cost. This poor quality of sand, mixed with too low a percentage of marble dust, was run into the mixer at the same time as asphalt cement, and, as was the case with the binder, all the materials were heated and mixed simultaneously. After the mixture had been heated for what was considered a satisfactory length of time it was dumped into wagons, the same deviation of temperature occurring during the discharge. The wearing surface after having received this improper treatment at the plant was taken to the street and carelessly laid and rolled to a thickness of between 2½ and 3½ inches.

The inefficiency exhibited by the street crew was even worse than at the plant. This crew did not contain a single man who was experienced in the laying of sheet asphalt pavements. The rakers, tampers and smoothers were merely laborers picked up in the city and knew nothing whatever about paving construction. The roller-man was inexperienced in paving work. He knew nothing at all about proper compression or the proper time to start rolling the hot material, and he considered the pavement sufficiently rolled when it looked fairly smooth. Even a good rollerman would have had difficulty in rolling and getting the proper surface and compression to a bituminous pavement of this thickness.

Two samples taken from the pavement laid under these conditions analyzed as follows:—

		Sample 1. Per cent.	Sample 2. Per cent.
Bitumen		8.62	7.04
Passing mesh	200	4.1	5.0
" "	100	1.4	2.0
" "	80	1.5	1.0
" "	50	14.0	14.4
" "	40	29.4	27.0
" "	30	14.6	10.6
" "	20	12.3	11.2
" "	10	10.0	9.8
" "	4	12.7	19.0

It might also be interesting to note that this pavement was being laid on one of the heavy traffic streets of the city, and also on a street containing car tracks.

Just before the paving season closed this condition of affairs was brought to the attention of the city officials in charge, and after some considerable discussion, in which there was an attempted defense of the methods used, it was decided to allow an experiment to be made in laying a strip of pavement under better conditions.

The first thing that was done was to put the work under the supervision of an experienced man thoroughly familiar with the proper laying of sheet asphalt pavements. He secured a few experienced men from a nearby city and carefully watched the rest of the men, and instilled into them a little pride in the work which they were doing. On account of being very near to the end of the paving season, and the fact that it would have delayed the work considerably to get in more suitable materials for the binder and wearing surface, he took the materials which were on hand and proceeded to get the best results with them. The first thing that was done was to obtain an inch screen and screen out all the big stones contained in the gravel which was used for binder. This cost amounted to about 30 cents per cubic yard. More dust was added to the mix to stiffen it up, and the per cent. of bitumen increased to properly coat and bind the mineral aggregate. Careful attention was given to the details at the plant and on the street, temperatures were controlled as much as possible, and a fairly uniform mix obtained. A sample taken from the pavement laid under these new but improved condition analyzed as follows:—

		Per cent.
Bitumen		10.0
Passing mesh	200	6.4
" "	100	1.0
" "	80	2.3
" "	50	16.8
" "	40	14.0
" "	30	26.3
" "	20	8.7
" "	10	10.2
" "	4	14.3

The foundation was laid to a satisfactory grade, so that the pavement consisted of 1½ inches of binder and 2 inches of wearing surface. The mix was taken from the plant to the street in covered wagons, where it was handled by experienced rakers, and the rollerman was made to continue rolling both lengthwise and diagonally until the surface had the required compression and was free from marks and imperfections. Under these very adverse conditions a saving of a little over 25 cents per square yard was made in the wearing surface and a little over 24½ cents per square yard in the binder, or a total of practically 50 cents per square yard saved on the bituminous part of the pavement alone. Besides this, there was a considerable saving made on the foundation and on the grading, the details of which were not kept.

The following table gives a comparison of the amount of material and costs of construction between the work which was laid under the poor conditions existing at the municipal plant and under the adverse but improved conditions of expert supervision:—

Binder Mix.

	Weight of mix per sq. yd.	Cost per sq. yd., complete.
Old conditions	400 lbs.	$0.52
Expert supervision	188 lbs.	.2718

Top Mix.

	Sand per sq. yd.	Dust per sq. yd.	A. C. per sq. yd.	Mix per sq. yd.
Old conditions	250 lbs.	26.3 lbs.	39 lbs.	315.5 lbs.
Expert supervision	169 lbs.	21.3 lbs.	18.7 lbs.	209 lbs.

Old conditions, cost per sq. yd., complete...... $ .75
Expert supervision, cost per sq. yd., complete.. .4987

While the above example of inefficiency in running a municipal plant is, of course, unusual, and, in fact, ludicrous to those familiar with the industry, it is an accurate account of the exact condition existing in this particular city. If this poorly managed department had continued to operate their plant with their inefficient organization, tax-payers would be amply justified in condemning municipal plant ownership.

While the above example is one instance where a municipal plant will eventually become an absolute failure, there are many other municipal plants throughout the country that are not proving to be a good investment to the city, and are not being run to their maximum efficiency. There are many ways that savings could be accomplished, and if these plants were put under efficient management or someone well versed in the paving business, they would be very valuable assets for the city. For instance, a municipal plant in one of the Western cities saved over $1 per car on every carload of sand that came into their plant by merely rearranging their material and storage space, and by putting in about 50 feet extension on the side track. There are many details connected with paving plants by which much money can be uselessly expended. Cramped quarters and insufficient storage room for crude materials are an expensvie handicap, and cities desiring to install municipal plants should be careful to give proper consideration to the location.

The most common form of municipal plant failure is the one well recognized by those connected with the industry, i.e., where the city appropriates and expends sufficient money for plant and equipment to take care of all its paving, and then, on account of the laws or on account of the policy of the administration, can only run it a small part of each year for repair work. It is a waste of money for a city to invest in a plant having a capacity of from 1,000 to 2,000 yards of completed pavement per day and have only, say, 10,000 yards of repair work to be done during the entire season, and yet there are many cities owning their municipal asphalt plants where this condition prevails. In the writer's opinion no city should contemplate putting in a large municipal plant unless it expects to use that plant for at least 50,000 square yards per year. The maintenance and cost of operation for large plants are too great, and the result is usually a failure. There are numerous small mixers on the market to-day which are satisfactory for cities who wish to do their own repair work, amounting to only a few thousand yards per year. The initial and operating costs are small, and when not in use they require practically no expense. The maintenance and depreciation are also very low.

There are many other causes for municipal paving plant failures which require long explanations, but it is at least encouraging to note that the cities owning municipal paving plants are waking up to the fact that sometimes failures can be turned into success, and are putting their municipal plants under proper conditions to do the work for which they were intended.

CLASSIFICATION OF ONTARIO ROADS.

The roads of Ontario may, for a consideration of construction, be broadly divided into three classes, states Mr. W. A. McLean, in the annual report on highway improvement, one grade merging into another, however, at the arbitrary dividing line. It is estimated that in the organized counties of old Ontario there are 50,000 miles of road, and a classification would be approximately as follows:—

1. Trunk roads connecting the large towns and cities	5% or	2,500 miles
2. County or leading market roads	12% or	6,000 miles
3. (a) Main township roads	50% or	25,000 miles
(b) Secondary township roads	33% or	16,500 miles
Total	100% or	50,000 miles

In the foregoing classification, the roads described as trunk roads are, with the exception of a few connecting links, among the most important of the county roads, and are heavily travelled for local market purposes, but they carry as well an increasing amount of through inter-urban traffic. The heavy and complex nature of this traffic requires, as a rule, construction of the most durable type varying from a concrete, brick, or other durable pavement to first-class macadam. The classes one and two, including trunk roads and leading market roads, thus include two divisions of what what would be the main county roads of the province. These comprise 17 per cent. or 8,500 miles in all, which if properly selected and constructed should carry 80 per cent. of the traffic of the province.

The main township roads comprise principally the concession roads on which numerous farms front and which converge into and create the traffic of trunk or county roads. The more important of these should be metalled with gravel or broken stone, if available. Secondary township roads include the little travelled connecting roads which should be graded and given such further treatment as circumstances may permit. The first need for the roads classified as township roads is thorough grading, draining and bridging, and systematic maintenance with the log drag.

Gradients adopted, amount of camber or crown, width and depth of metal, foundation if any, drainage, binding material, and other details, should, as suggested, be largely dictated by the degree of traffic. A good road attracts and creates traffic so that the construction of any one road is very likely to raise it from one class to a higher grade, a matter which should not be lost sight of in planning improvement. Methods of construction should be as simple and direct as proper results will permit. There should, for true economy, be a well adjusted average between maximum service and minimum cost.

NEW YORK CITY A VAST BRICK MARKET.

It is difficult to realize the enormous quantities of brick used annually in greater New York. During 1912 the consumption was more than 1,000,000,000. The principal source of this vast quantity is the Hudson River region, which extends along both sides of the river from New York to Cohoes and embraces ten counties, nine in New York and one in New Jersey. Other sources of supply are the Raritan River region of New Jersey and the Connecticut region.

The year 1912 was one of unusual interest in the Hudson region. It opened with an increasing demand and the price of common brick was $7 per thousand compared with $4.25 in 1911. For several years the use of cement or concrete in construction appeared to be displacing brick to some extent, but owing to the strong "back to brick" movement the year 1912 saw in the New York market a change favoring brick as the best building material for many purposes. Influences that have contributed to this change are the failure of some concrete buildings, the advertising campaign carried on by the brickmakers and the improved quality of the Hudson River brick. The average price was the highest since 1906.

The marketed product of 1912 was larger than that of 1911 and would probably have been still greater but for the scarcity of labor, especially at Haverstraw, and the strike among the brickmakers in the Newburg district. The strike was of short duration, but the scarcity of labor drawn away by large construction enterprises, such as the Catskill aqueduct, railroad extensions and subway operations, was a serious drawback to the Hudson River brickmakers in 1912. This condition was so serious that the operators resorted to night work and rainy-day work in loading barges and imported laborers from the South.

An important development during the year was a large increase in the use of Raritan River brick in New York city, which has for some years been drawing on the Raritan River region. In 1912 the demand for this brick was very much greater than ever before.

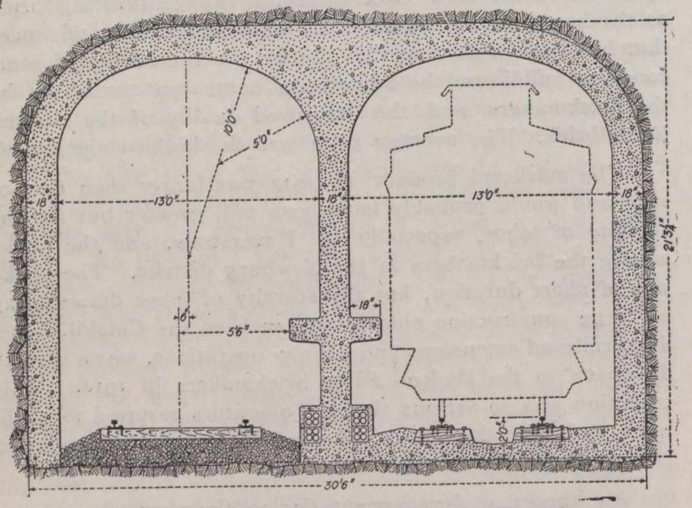
On the whole, the year may be regarded as one of prosperity. The demand was good, prices were high, the mild weather toward the end of the year permitted shipments to its close, and while the marketed product was not the largest recorded, it was considerably larger than that of 1911.

The statistics gathered by Jefferson Middleton, of the United States Geological Survey, show that the number of brick marketed in the Hudson River region in 1912 was 1,019,259,000, valued at $5,850,770, or $5.74 per thousand, compared with 926,072,000 brick in 1911, valued at $4,717,633, or $5.09 per thousand. This was an increase in 1912 of 93,187,000 brick and of $1,133,137 in value. The number of operating firms reporting in 1912 was 126.

During ten months ending May 1st Canada exported 3,250,272 tons of bituminous coal to the United States and imported in return 19,353,252 tons of anthracite and 22,356,868 tons of bituminous, according to the latest monthly summary of the United States Bureau of Foreign and Domestic Commerce.

THE CROSS-SECTION OF THE MOUNT ROYAL TUNNEL.

Various phases of preliminary and construction work in connection with the Mount Royal tunnel, to provide an entrance into the city of Montreal for the Canadian Northern Railway, have been described in previous issues of *The Canadian Engineer.* The first article, which dealt with the difficult problem encountered by the Canadian Northern Railway in arranging terminal facilities in Montreal, as the eastern distributing point for its trans-continental system, due to the location of the older and most congested part of the city lying between Mount Royal and the St. Lawrence River, appeared in the issue of January 16th, 1913. The tunnel was chosen to dispense with the necessity of making an extended detour of the city, including the possibility of two separate stations for west-bound and east-bound traffic. The location of the tunnel as then proposed was described, together with the system of tracking which it was designed to accommodate. A description of the plant to be used in this construction was also given.



Cross-Section of Mount Royal Tunnel.

In *The Canadian Engineer* for February 6th a description was given of the progress of the work upon each of the four headings which were being driven simultaneously, and general information concerning the character of earth and rocks encountered, and the methods of excavation, was included. The article illustrated the site of the tunnel, and various views of the machinery and equipment were given. An article appearing in February 27th issue dealt with the general survey work connected with the tunnel, and the methods used in precise measurements, while from time to time items of interest concerning the progress of the undertaking have appeared. The reader is requested to refer to the issues mentioned for full details pertaining to the gigantic piece of work.

It has recently developed that a twin tunnel cross-section has been adopted, of the design shown in the accompanying figure, which we reproduce from the Engineering Record. The adoption of this type is due to three especial reasons, viz., safety in case of accident or derailment, economy in excavation and construction, and economy and efficiency in ventilation. It will be noted that the new structure is similar to the tunnel work of other projects with which readers are familiar. The outside wall clearance is coincident with the clearance for the new structures in the New York Central Terminal work in New York, and exceeds the clearance of the Pennsylvania lines east of Pittsburg.

A high headroom, almost the same as that of the Detroit River tunnel, was adopted on account of the probability of a high-voltage overhead contact circuit. The flattened three-centered arch was adopted to allow for the sway of the pantograph and on account of the stratification of the rock where much of the lining will occur.

The walkway is made narrow, so that people will be forced to pass along it in single file, thus avoiding the danger of crushing and panic. The normal clearance at the walkway edge is 2 in. greater than that of the normal high passenger platform adopted in the terminal, which is somewhat greater than that allowed on the New York Central and Pennsylvania lines about New York. The walkway edge also coincides with clearance lines (outside of the platform) of the Pennsylvania lines east of Pittsburgh, including the through lines between New York and Pittsburgh.

Underneath the walkway is a continuous refuge niche, except at splicing chambers, where trackmen may sit on the duct bench at the bottom of the dividing wall and be absolutely protected from passing trains.

The work is being done by the Canadian Northern Montreal Tunnel and Terminal Company, Limited, of which Mr. S. P. Brown is chief engineer, and Mr. H. T. Fisher, tunnel engineer. This journal referred recently to 810 feet of heading having been driven in 31 days, beginning May 1st, as a tunnelling record for America. Ahead of it is a Switzerland record of 1,013 feet of 6½-ft. by 10-ft. heading accomplished in the same amount of time. The Mount Royal excavation is an 8-ft. by 12-ft. heading through Trenton limestone, which exceeds in hardness the soft triassic limestone encountered in the Loetschberg tunnel in Switzerland.

UNITED STATES PRODUCTION OF PIG IRON IN 1912.

According to a bulletin issued by the American Iron and Steel Institute, the production of pig iron in the United States in 1912 was as follows; the figures for 1911 and 1910 being given for comparison:

	1910 Tons.	1911 Tons.	1912 Tons.
Bessemer and low phosphorus	11,245,642	9,409,303	11,667,656
Basic	9,084,608	8,520,020	11,394,477
Charcoal	396,507	278,676	347,025
Ferro-manganese	71,376	74,482	125,379
Spiegeleisen	153,055	110,236	96,346
Foundry ferro-silicon, etc.	6,352,379	5,256,830	6,096,254
	27,303,567	23,649,547	29,727,137

With the development of long-distance electric-power transmission, the line voltage has increased steadily in spite of difficulties which increase at the same time. When the first 110,000-volt transmission line was put in operation, a few years ago, many considered that the maximum commercial voltage had been reached. But last year, the first 140,000-volt line was put in operation in the state of Michigan, covering a distance of 125 miles, which was soon increased to 235. The line is in regular service and is reported to be giving entire success.

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CONTENTS OF THIS ISSUE.

EXHIBITIONS OF BRITISH GOODS IN CANADA.

The established success of the "Made-in-Canada" exhibition trains of this year and last, and the growing popularity of the enterprise throughout the provinces, is responsible for a good deal of industrial activity in many western towns and cities. The tour of the 1913 train, which terminated in Montreal a few days ago, covered some 125 points on the lines of the Canadian Pacific, Canadian Northern, and Grand Trunk Pacific roads west of Winnipeg. To practically all these places, with the exception of the larger cities, the exhibition was a new feature, having been much more comprehensive in its make-up, and having touched other points than those visited last year.

The project has aroused a lively interest outside the Dominion, especially among manufacturers in Great Britain. British Chambers of Commerce are taking up the suggestion that the best way to place British goods before Canadian customers is by the provision in Canada of a British manufacturers' exhibition train. Various chambers and associations are working upon it, in conjunction with an endeavor to urge the establishment in Canada of permanent exhibitions of manufactures from the United Kingdom.

Although of the opinion that permanent exhibitions of machinery and engineering supplies are never a success, except in so far as a unit, satisfactorily installed and efficiently operated, may and should be regarded as an exhibit, its successful operation continued under working conditions, showing the desired result, we are inclined to believe that an exhibition of British manufactures, by train, would be a good thing for Canada and Canadian industry. For instance, cars representing such manufacturing centres of Great Britain as one might mention by the score, furnished with British machinery and equipment, pertaining to municipal and public works, would create, in municipalities, conceptions not born of catalogue illustrations or literature. At the same time, Canadian manufacturers would profit by the incentive to install equipment, which these exhibitions would arouse, in the direction of electric light and power, water-supply, sanitation, and general municipal development. Besides, the spur to industry which towns have experienced as a result of the Canadian trains would, in all probability, be forthcoming from the visit of a British train, providing the tours were properly executed and the idea not overworked.

AN INSTITUTION FOR MUNICIPAL ENGINEERS.

An organization to serve the needs of Canadian municipal engineers is advocated by letter in another column of this issue. We hope its appearance will arouse a discussion of the subject. Men following this branch of the profession are peculiarly situated with regard to each other and are segregated, in fact, from engineers in general, living more or less in a sphere of their own.

A municipal engineer enjoys the distinction, however, of acquiring by necessity a general all-round engineering experience—problems electrical, mechanical, geological, of transportation, waterworks, sewage disposal, costs, estimates, etc., are all within the category of the average municipal engineer's duties. Naturally, the benefits which he would derive from social and professional intercourse with others in this work are many, tending to result in greater efficiency of service, the elucidation of methods whereby other municipalities, in like or varied conditions, are served, and a general strengthening of the status of the municipal engineer.

Owing to the peculiar distribution of municipal engineers throughout the country—in special instances only can a few of them meet frequently—the working-up to the establishment of such an organization would be a long and arduous task, liable to prolonged lapses of inactivity. In short, although we believe that the municipal engineer would benefit greatly by such an association, it seems certain that his geographical position with respect to others in his field, together with his preoccupation with the particular needs of his own municipality, would afford him little opportunity for supporting an organizing committee in its work.

In the Canadian Society of Civil Engineers all branches of the profession in Canada should have ample representation. The society consists at present of four sections, namely, electrical, mechanical, mining, and general. A vast majority of municipal engineers throughout the country is enrolled in the membership of the society, and the well-established, coast-to-coast institution that it is, its sub-committees dealing with all engineering problems, including those pertaining to municipal work, its membership should include the entire body of three to five hundred municipal engineers estimated by Mr. Wynne-Roberts in his letter.

The establishment in the society of a section for municipal engineers would afford them the advantage of having behind it a strong, internationally recognized society, that has been serving for years all phases of the profession akin to municipal work. On the other hand, the society would be materially strengthened by having incorporated into it a section whose membership is carrying the work of the engineer into all parts of Canada, and is performing the service of connecting link between the profession and the community everywhere.

Mr. Wynne-Roberts' suggestion is good, provided the proposed association is formed as a section of the Canadian Society of Civil Engineers.

EDITORIAL COMMENT.

The Canadian Pacific Railway Company is contemplating a large extension of double track throughout Ontario, on lines both east and west of Toronto. Work is being started at once on a continuation to Guelph Junction of the double track line in use from Toronto to Islington. An extension to Detroit, 189 miles in length, is scheduled for next spring. The company also proposes double-tracking eastward to Smith Falls to link with the line from there to Montreal already in use.

* * * *

The proposed commission to investigate Ontario roads with a view to outlining a government policy for their improvement will not get an early start this season. No names have been disclosed, but Mr. W. A. Maclean, provincial engineer of highways, will likely be a member of the commission, if one may form an opinion from a recent report to the effect that Hon. J. O. Reaume, Minister of Public Works, has stated that no move would be made in this direction by the government until Mr. Maclean returns from Europe, where he is attending the International Roads Congress.

The twelfth annual meeting of the International Geological Congress, which will open shortly, should be attended by mining engineers in great numbers. The chief feature of the congress will be the numerous excursions to the principal mining districts of Canada, and to her many localities of geologic interest. The Geological Survey of Canada, the Canadian Mining Institute, and the Government are putting forth every effort to afford profitable papers and suitable accommodation at its meetings and on the numerous excursions. Cobalt, Porcupine, Sudbury, Nova Scotia, and the Yukon are among the localities which will be visited. It goes without saying that the convention will rank as the best ever held in Canada for mining men. The session in Toronto opens August 7th.

* * * *

The University of Toronto's venture in discarding separate heating and lighting units in favor of a central plant for all buildings appears to have achieved vindication at last. Better service and lower cost of operation are prominent features of the report for the 1912-13 season. With the temperature 4.70 degrees above the average, for the entire season, the cost per square foot of radiation was as low as 24.153 cents, as against 38.27 cents for the previous year and 41.32 cents for 1908-09, under old conditions of separate heating units. During last year light and heat was supplied to twenty-six buildings, including Wycliffe and Victoria Colleges, containing 170,221 square feet of radiation surface, at a cost of $41,183. The report states further that by centralizing its heating systems, the University has evaded the expenditure of a large sum in the necessary renewal of individual plants, and in the installation of new systems into buildings erected during the past three years. It has, at the same time, redeemed for other urgent needs, the space previously occupied by boilers and coal bunkers.

* * * *

The International Joint Commission has before it the consideration of a proposed lease in which the Michigan-Lake Superior Power Company and the United States are the contracting parties. The power company desires to divert, for power development purposes, a flow of water from the St. Mary's River, to the extent of 25,000 to 30,000 cubic feet per second, and proposes to construct compensating works opposite Sault Ste. Marie, Mich. Under the new conservation policy adopted by the United States, the Government proposes to lease the water for power with a view to ultimately owning the development works constructed by the company. In the lease at present under consideration the latter offers to pay a yearly rate of $2.50 per cubic foot per second up to a flow of 25,000 cubic feet, in excess of which $1 per cubic foot per second is the charge it offers to meet. The question being of boundary water, and therefore of international concern, the finding of the International Joint Commission will govern the situation, and its report will be awaited with interest.

CALCUTTA SECTION, THE INSTITUTION OF MECHANICAL ENGINEERS.

The fifth annual report of the Calcutta and district section of the Institution of Mechanical Engineers has just been received. The report shows an increasing membership and a healthy contribution of interesting papers read during the past year. The membership on March 31, 1913, consisted of eighty names.

LETTERS TO THE EDITOR.

[NOTE.—Opinions are solicited from readers concerning subjects opened for discussion in these letters.—ED.]

Previous Conventions in Canada of Am. Soc. C.E.

Sir,—I was much interested in reading your account of the proceedings of the recent convention of the American Society of Civil Engineers in your issue of June 26th. It recalled to my mind the first time the society met in Canada, as you rightly state, in 1881. I have very vivid recollections of that meeting—one of the most successful, socially and scientifically, ever held up to that time, and for many years thereafter.

I recall with considerable pleasure the entertainments provided the visitors and their guests—the reception at the residence of Col. C. S. Gzowski, in Toronto; the trips to Ottawa; shooting the rapids on logs at Chaudiere Falls; Rideau Hall; Parliament Buildings; Quebec; Falls of Montmorency, etc.—in charge of the Montreal local committee, headed by Mr. John Kennedy, chief engineer of harbor commissioners, chairman, with his associates, E. P. Hannaford, chief engineer of the Grand Trunk; P. Alex. Peterson, chief engineer, Intercolonial Railway: Louis Lesage, chief engineer of waterworks; Geo. Doane Ansley, city engineer, and not forgetting the noble veterans, Messrs. Thomas C. Keefer and Sandford Fleming. How many of these gentlemen are now living! The writer at that time, and for some years before and after, was chief clerk, assistant secretary and auditor of the society under Hon. John Bogart, who for many years was its most efficient and accomplished secretary.

The recent meeting in Ottawa was the third held in Canada. The convention of 1897 was held at Quebec.

THOMAS B. LEE.

Montreal, July 1st, 1913.

* * * *

A Plea for a Canadian Institution of Municipal Engineers.

Sir,—Out of about 70 societies, Canadian technical societies, 16 are associated with general engineering; 3 represent electric engineers, etc.; architects have 7 societies; land surveyors have 6; mining engineers, 3; gas engineers, 1; railway engineers, 3; chemists, 1, and the remainder are associated with builders, astronomers, stationary engineers, good roads, smoke abatement, peat, forestry, cement, and miscellaneous, numbering in all about 18. The mayors, aldermen, councillors, and town clerks have 10 societies, organized to represent their views and wants. It is also worthy to note that there is one Public Health Association in Canada, and this is said to consist largely of medical men.

Canada is a large country, with a population of about eight million people. The health of the communities, where human activities are so pronounced, is of vital importance, yet, the last named association is the only one which has been established in this country, primarily in the interest of public health. The municipal engineers, however, as an organized, coherent body of officials, do not exist at all. In Canada, therefore, at the present time, so far as I am able to ascertain, there is no organization which has specially the right to represent and voice the views of the important profession of municipal engineers.

Why is this so? Is there a good sound reason for the absence of such a representative society? Is the immensity of Canadian territory a deterent to a prosperous institution?

After studying the situation, the writer was forced to the conclusion that it was because each municipal engineer had as much as he could do to carry on his own professional duties, and consequently, had but little time or occasion to think of such an organization. Furthermore, they dwell and work at distances, more or less great from each other, with the result that the engineer in British Columbia, for instance, rarely meets his confreres in the Prairie Provinces, much less have many opportunities of conferring with those in the East. If this applies to engineers working in the West, but whose native home is in the East, then it is still less probable that those living and working in the East get frequent opportunities for visiting works in the West. There is no inducement, at present, for them to make the trips. This, however, is not a strong reason for the absence of a Canadian Institution of Municipal Engineers, but is a powerful argument in favor of its immediate formation. The vastness of this country renders it even more desirable that engineers should combine and by means of an organized effort, eradicate the present tendency to insularity caused by their isolation from engineers in other cities and provinces.

Many of these engineers have occasion at one time or another, however infrequent, to visit other towns and cities, and to inspect various works of interest to themselves, and by making the most of their individual opportunities, they are able to secure valuable information which tends to show them that different engineers have different ways of achieving similar results. But if an insitution was formed and meetings were held at different centres, the benefits would be collective and not individual.

In the field of general engineering, there is probably an ample number of societies, and for almost every phase of engineering in Canada—except municipal engineering —there is a representative organization.

According to the Dominion census of 1911, there were 107 cities and towns in Canada having a population of 4,000 and over. This was an increase of 45 per cent. over 1901. The increase in population has been much greater during the last five years than in any other similar period, and it is safe to reckon that the number of towns and cities of 4,000 inhabitants and over will by 1921 be about 200.

Most of these towns employ an engineer, some of them also have departmental engineers, and the writer ventures to estimate that there are at present from 300 to 500 engineers engaged on municipal works in Canada, who, owing to the non-existence of a distinctively representative society, common to practically every other class of men, are left to their own resources and initiative.

A Canadian association representative of these men might include city engineers, municipal, electric, water, drainage, road, street, railway, gas, and other engineers. Perhaps consulting engineers engaged on municipal undertakings would be allowed to join. The only qualification, which would probably be needed (especially at the commencement) would be that the applicants either hold principal civic appointments or are engaged on municipal works. The members could, of course, be divided into classes according to their individual qualifications and occupations, if it was thought desirable.

Such an institution would meet in different cities, at least once a year (the oftener the better) where papers would be read by the engineers, describing the works undertaken by the city. These works would be inspected and explained, questions would be invited and answered, and a general discussion would take place.

It is ofter the case, in other societies, that a free discussion affords more useful and comparative information than is to be found in the paper itself. Such discussions are good, the weak and strong points of any scheme are brought out prominently, for in the multitude of counsel there is often much wisdom. Discussion also broadens the mind, enlarges the horizon of thought and developes the reasoning faculty; it is also educational to both the speaker and audience alike, it creates a healthy and generous rivalry, and establishes a standard of excellence which by mutual accord becomes higher each year and which will inevitably reflect credit on the profession generally, and give greater satisfaction to the public for whom we work. Such discussion would be of immense advantage to the engineers and to the authorities; the latter would not only secure an excellent advertisement, by virtue of the official visit of the society, but what is of even greater value, the town authority would hear criticisms and obtain information useful for future operations.

Later on, the institution could, if it was deemed desirable, organize examinations in the theory and practice of municipal engineering and in municipal law.

Such an institution would tend to weld together the band of municipal engineers to their own direct benefit, and the town authorities, by sending their engineers to the meetings, would in every way reap great advantages, because the educational and social aspects of such meetings would be conducive to mutual interest, efficiency, confidence, progress and *esprit-de-corps* among the officials.

Considering that enormous sums of money are annually spent by municipal engineers, of various classes, and that so much depends on the efficiency of their works in the direction of public health, public utilities, and public amenities, it might seem strange that active steps to combine had not long since been taken. An official who is perforce to follow solely his own ideas—ploughing his lonely furrow—without seeing what has been done by others in the same sphere of operations, is apt to fall behind and develop the spirit and sentiment of the proverbial cobbler who never went beyond the confines of his own little village.

Whilst in the early stages, it might perhaps, be found possible to form only provincial institutions, the formation of a powerful Dominion institution should be advocated, for in union there is strength and in co-operation there is prosperity. The aim and object of the promotion should be to force it to become a power in the land and that the opinions, transactions and developments of the institution should carry weight and tend to create an appreciative public opinion of the inobstrusive work carried on by engineers in the Dominion. Such an institution, if rightly directed and loyally supported in its initial stages, would soon reach the position when its power and influence would be felt outside the circle of engineers.

At present if any Canadian engineer desires to meet in conference, men of similar vocation, he has to cross the international boundary where, of course, he will see much to his advantage, and though he will certainly receive a warm welcome and a great hospitality, he cannot help but feel a sense of lonliness in the crowd. If, however, a representative society were to make an official visit to the same town the members would not only receive even greater welcome and more bountiful hospitality, but they would also feel far from being lost in the multitude but rather as if they were members of a great family.

From a national point of view, moreover, we should be patriotic enough to be in a position to announce that we have similar societies in Canada, for certainly we have much to be proud of in the number of municipal works, which we can visit.

The suggested Canadian Institution of Municipal Engineers, if formed, could occasionally pay an official visit to a city across the line, just as the gas engineers visited Toronto last year, and the American Society of Civil Engineers visited Ottawa recently. This is a graceful manner of recognizing the internationality of the engineering profession.

The writer does not know what are the views of the municipal engineers on this subject. He has spoken to a few and they appear to be favorable to the suggestion of forming the institution, but it will be advisable to have a free discussion before anything is done in the matter. Perhaps the editor will throw open the columns of this journal for such purpose.

R. O. WYNNE-ROBERTS.

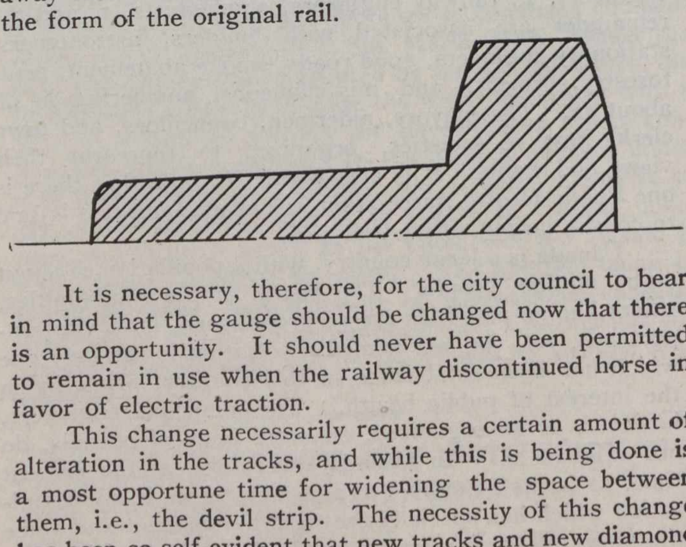
Regina, June 27th, 1913.

* * * *

The City of Toronto and the Acquisition of the Toronto Railway.

Sir,—There are several matters which it will apparently be well for the city council of Toronto to take into consideration in estimating the expenditure that will be necessary within the coming year or two, in order to bring the street railway and its equipment into such a condition that will provide a better service than is at present afforded to the citizens.

Gauge.—It must be remembered that the present gauge of the tracks is a special one, and one to which it will never pay any radial railway to construct its tracks. The gauge of four feet, ten and seven-eighths inches, was adopted in the first instance to permit vehicles of ordinary gauge to run inside the elevated portion of the rail. Even at the outset this was a mistake, because it was always a difficult matter for a wheel running upon the lower portion of the rail to be lifted out over the elevated portion, and many a wheel tire was torn off in endeavoring to get away from the track. The accompanying figure shows the form of the original rail.



It is necessary, therefore, for the city council to bear in mind that the gauge should be changed now that there is an opportunity. It should never have been permitted to remain in use when the railway discontinued horse in favor of electric traction.

This change necessarily requires a certain amount of alteration in the tracks, and while this is being done is a most opportune time for widening the space between them, i.e., the devil strip. The necessity of this change has been so self-evident that new tracks and new diamond crossings have already been laid to a greater width than previously, in readiness for this contingency.

Wide Devil-Strip Necessary to Accommodate Cars of Radial Railway.—The actual width between new tracks at present is not known to the writer, but from observation it appears to be too small. He found, when constructing an interurban railway, the cars of which were to be run through the streets of the City of Rochester, N.Y., that the devil-strip there, of four feet in width, was too narrow to admit of cars of suitable width for longer journeys than are usually taken on the street railway. As far as possible, therefore, the cars for radial railways which must be constructed sufficiently wide for comfortable seating, will be run over streets that have only a single track laid upon them, unless there is a suitably wide devil-strip on double-tracked streets.

After much consideration the City of Chicago decided, last year, that in streets with double tracking, the distance of the tracks from centre to centre should be ten feet two inches, leaving a clear space of twenty inches between two cars, each eight feet six inches in width, so that all classes of cars could be safely moved upon them.

In order to have a suitable width in the seating of the Rochester Street Railway cars, when there was a central aisle there was a double seat on one side and a single seat on the other—a very poor arrangement, but one occasioned by a devil-strip only four feet in width.

Naturally these changes will require considerable expenditure on capital account, there being, of course, items of labor and new materials required in the alteration of the track gauge.

Central Aisles in Cars.—The trucks of existing cars will likewise require alteration and many cars should now be scrapped, the annoying "wet curtain" cars first of all, and others of modern standard construction provided to replace them. The very undesirable system of longitudinal seats should be done away with in any cars, such as those of the convertible type, that are sufficiently wide to admit of a central gangway.

Low Floor Cars.—A number of Pittsburgh low floor cars should at once be put into commission, to obviate the unnecessary climb which now exists in Toronto cars, and which is so trying to many ladies, to children, and to infirm persons of both sexes.

P. A. Y. E. Cars.—There is no reason why all cars should not be prepared for the pay-as-you-enter system, so as to be ready as soon as the system is adopted on all routes.

The above items are only a few which suggest themselves as points of engineering importance. There are many more which will naturally occur to those familiar with the operation of a city service. Existing methods show abundance of room for improvement.

It would not be surprising if, after acquiring the properties now under consideration, at a cost of $29,000,000, a further outlay of $11,000,000 were required for the lines which are already in commission, and for the necessary alterations to existing track and equipment. It would seem prudent, therefore, for the city council to provide for a total outlay of $40,000,000 accordingly, when making the requisite financial arrangements.

EDMUND WRAGGE.

Toronto, June 24th, 1913.

* * * *

Sir,—According to the Calgary newspapers, I note that the city of Calgary is considering piping water from a point forty-five miles distant.

Calgary is growing greatly and I presume that they would not install less than a 50-inch main. This would make the cost great. It is surprising, particularly in view of the financial conditions in Western Canada, that this proposition would be considered seriously, in view of the fact that a twenty-million-gallon filtration plant, sufficient to supply the city of Calgary for several years to come, could be installed complete at a cost not exceeding $400,000.

The operating cost of such a filter plant would not be as great as the interest on the difference in cost between the filter plant and the pipe line. Furthermore, there is the large item of patrolling this line and keeping it in shape, and the possibility of the source of supply not being sufficient or becoming contaminated and subject to a period of turbidity in future years. The city officials of Calgary will do well to consider this matter thoroughly before going ahead with it, and should certainly secure the best possible engineering advice.

WATERWORKS ENGINEER.

Winnipeg, June 26th, 1913.

ROAD INSPECTORS IN NEW ZEALAND.

Judging from the schedule of duties, with a copy of which a correspondent, resident in New Zealand, has recently favored us, and which appears below, the position of road clerk, or overseer, in some municipalities of this antipodal sister colony, is not without a full course of obligations.

(1) The clerk and overseer to give all his working time, i.e., eight hours per day on six days of the week, to the service of the board, excepting statutory holidays, or holidays given by the board or its chairman for the time being; such working time to be spent in such manner as the board shall instruct in connection with the carrying out of office work and the inspection of roads, etc., and other necessary work.

(2) To do all the clerical work in connection with the business of the board, i.e., to carry out all necessary correspondence, keep all accounts, and prepare all necessary specifications and estimates.

(3) To do all surveying and measuring in connection with, and superintend all works and contracts carried on or let by the board, also to inspect frequently and report upon, monthly at least, all roads, etc., under the control of the board, and to carry out to the satisfaction of the board all the usual duties of a clerk and overseer to a road board.

(4) When on his rounds of inspection of roads and supervising the work of the board's employees, or contractors, the clerk to carry with him suitable tools for effecting small repairs to roads, fords, etc., such work to be carried out by him as the time at his disposal will permit.

(5) The clerk to provide his own horse or horses, vehicles, harness, necessary for carrying out the above duties.

(6) The clerk shall not undertake any work or duty of whatsoever kind other than that of the board, without its consent

(7) The clerk shall, beside his other duties, perform the duties of poundkeeper.

(8) The clerk to be paid by the board a salary of £200 (two hundred pounds) per annum, with free use of house, outbuildings, stables, garden and balance of five acres of land.

(9) The clerk to enter into a fidelity bond in the sum of £300. The premium of such bond to be paid by the board.

(10) One month's notice to terminate the appointment to be given by either side.

THE SCIENTIFIC UTILIZATION OF NATURAL RESOURCES.*

By Dr. W. W. Andrews.

In these days of modern development conservation has come to be a great work. As a people, we have marched across this continent, skimming its resources in most wasteful ways. This has been called "the White Peril" of the world, for we are found under every sky, wastefully exploiting nature's gifts to the race. A method of agriculture which over large areas has robbed the soil of its fertility, and a method of lumbering which has taken no care of the younger trees, with frequent forest fires destroying millions of dollars worth of timber, have hardly troubled our consciences.

During the last few years, however, a more enlightened sense of values has been making itself felt. In some businesses the dump heaps of former years have become the great sources of profit. We have further begun to realize how enormous are the resources lying unused and wasted around us, and the best powers of science are being devoted to the task of finding the best means of putting these to human use.

So rapidly are we laying under contribution the forces of nature, increasing human efficiency by millions of horse-power and lifting burdens from human muscles, that we may hope very soberly for the time when the manufactured wealth of the world will be so great that drudgery will be almost totally eliminated from human life, and the wealth produced through these borrowed powers be so abundant that poverty will be practically unknown. All that remains after physical science has done its work is that social science shall lead us to a condition of society in which wealth will be more evenly distributed than it is at present. The promise of this is already above the horizon.

The physical resources of a country are limited and unrenewable. Such are coals, our gold, iron and all other mineral deposits. The more rapidly we exploit these the sooner they are used up, never to be at the service of the world again. The ancient bituminous and anthracite coals, and the modern lignites can never be restored. Why should we be in so feverish a haste to use up these assets of the world which belong to future ages as well as to ourselves?

The second class of resources are those which are perennial and exhaustless, because they are perpetually renewed, such as growths of our fields and our forests, the flow of our waters, and the force of our winds. All these depend upon the force of the sun, and from year to year they are reproduced. Emerson said: "Hitch your wagon to a star," and that nation which builds its prosperity on a wise utilization and conservation of these resources may keep its population and its prosperity as long as the sun shines.

Utilization of the Wind.—The first of these of which I shall speak is the force of the wind. The difficulty in using this force is found in the fact that it is a widely diffused force, and is fitful in its operation. If we can economically capture it and store its energy so that it will be at our call whenever we wish to use it, it may be made of immense service.

The winds of Saskatchewan are nearly equal to a nine-mile breeze blowing day and night from June to June. The total force of this is equal to a thousand Niagaras. Can it be utilized? It is interesting to note in these days of the supremacy of steam power that of the forty thousand vessels which comprise England's merchant marine, thirty thousand are yet wind-propelled. It was the wind power which carried the Anglo-Saxon Celt around the world, and it is seen that he is depending in a large measure upon it still. I call your attention to the following recent developments. It has been found that a comparatively slight change in the shape of the fans in a wind motor will give almost double the power. It has further been shown that the wheel of a hydroplane working in the air is more efficient than a wheel working in the water. If, therefore, these two discoveries are made good use of, we may expect to find very much more efficient wind motors than we have known heretofore.

The development of the storage battery is being rapidly promoted, and the increasing efficiency of dynamos points to a time when the energy of the wind will be economically stored. We have all heard of the Edison storage battery, which may be charged and discharged at any rate without injury to the battery. In the common lead battery Prof. Hannover, of Copenhagen, has discovered a method of making what he calls "pore" lead, which increases the capacity of a battery about four times. On the basis of such advances as these we may look for the time when the electric automobile will be the common automobile throughout the country, and wind stations, with their installation of windmills, will be as marked features of the prairies as the grain elevator is at present.

Clay Resources.—The next great asset of this country of which I shall speak are our practically omnipresent clays. These clays have been produced from the original granites of the earth, through the action of water, rain, and moving ice, and by streams they have been deposited in their present beds. They are thus produced indirectly by sun power throughout millions of years of the earth's past history, and are being produced and laid down today. They therefore belong to the exhaustless resources of the world, even though their quality was not as great as it is. The clays of these prairie provinces will yet prove to be, after the fertility of the soil, the most useful asset of the people. Their variety is so great, the new methods of manipulating them is so efficient, that there are but few of them which cannot be put to commercial use. Structural material, such as wood and iron and stone, will always be dear in these prairie provinces. In the clays we must find our substitutes. Leaving out of account the Portland cement, which requires lime, in addition to the clay, we need only speak of the use of the clay for building purposes, in the form of bricks, tile, pillars, decorative panels and pottery, and for road-making purposes.

I could show you some specimens of bricks and pieces of pottery, which have been made out of clays which were deemed to be almost hopeless. When this much can be realized with these, we may speak hopefully of all other clays. In China the clay-workers of one generation dig the clay for the next. Modern methods enable us to produce an equal amelioration of the clay in ten days, instead of thirty years. Each clay-bed, however, needs to be subjected to careful experimental tests, and this should give results definite enough for wise investment.

We all know what a trial our clay is when wet, to those who try to haul loads along our roads. It has been

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* Read at the 8th Annual Convention of the Union of Saskatchewan Municipalities, June 26th, 1913.

found that if we subject the clay, which has been compacted somewhat by road traffic, that if it be piled up in beehive shape kiln, and well burned, we get a material devoid of all stickiness and in its smaller particles very hard, and quite porous to water. This substance will grind under traffic into a dust. But this may be counteracted by a judicious mixture of raw clay.

The experimental road which was laid down for the government was built in this manner. A narrow trench was dug along the centre of the road. In this a tile drain was laid, and then covered in with burnt clay, hammered down. Then a layer of straw was laid over the clay of the road, and over that eight inches of burnt clay containing 25 per cent. of raw clay was laid over the surface as the road metal. The whole was then well rolled with a heavy roller. This portion of road is standing up well under traffic, dries quickly, does not load the wheels, and is showing the same properties which most of you are familiar with in many parts of the country where sand and clay have been mixed by nature in such proportion that bad roads are seldom found. All such a road needs is that it shall be dragged after every rain with a split-log drag. It looks as if it could be depended upon to give a clean, satisfactory road at all seasons of the year. It is very easy also to treat such a road when it is wet, by hauling over it either the split-log drag or the lap-drag backwards.

Another suggestion which I have made has not yet been put to experimental test. I have thought that the marble-like hardness which our gumbo acquires, when it dries under traffic, could be made use of to give us a firm foundation for asphalt roads, in place of the costly concrete. Certain it is that if water be kept out of it, it will stand the heaviest kind of traffic, even without the protection of an asphalt sheet. To conserve the hardness ot the gumbo base, I suggest the laying of a central underdrain with cut-offs to the side ditches, so placed that whichever way the wind blows they may cause a movement of dry air through the heart of the road. I am in hopes that some form of this road will make the asphalt road cheap enough to become a country road proposition, at least on those roads which are subjected to the heaviest traffic.

The burnt clay, when properly prepared, is found to have the properties of good sharp sand. It may, therefore, replace sand in ordinary mortar. Word has come that the British Government specify this for some of the work done in India. A homesteader, therefore, may out of the clay dug from his cellar find a substitute for sand. This ought to prove of great value to homesteaders who are miles away from a good sand-pit.

A little special treatment will also produce a very fine material which can take the place of costly broken stone in asphalt and concrete work.

Fuel Production.—The last subject before you is that of the possible utilization of the great stores of fuel which we have in the straws which are burned in so immense quantities each year on the prairie.

Various authorities state that the amount of combustible gas in straw amounts to twelve thousand cubic feet per ton. The writer's measurement, without being made very exact, supports this estimate. Personal analysis of the straw shows the following:—

Volatile hydrocarbons, 64 to 72 per cent.
Moisture, 6 to 10 per cent.
Fixed carbon, 21 to 24 per cent.
Ash, 6.5 to 8.2 per cent.

If 25 to 30 per cent. of the volatile matter be driven off, that is, the moisture and the hydrocarbons, we have a slightly charred mass, which is very brittle, is very similar in composition to good dried lignite, and has a calorific value of eight thousand seven hundred B.t.u. This I have named "Lignite Char." If 70 per cent. of the weight be driven off, in the form of volatile matter, then a char similar to anthracite in many of its qualities, and of very similar chemical composition, is left as a residue. This I call "Anthracite Char." Both of these residues can be readily made into briquettes, named respectively "straw lignite briquettes" and "straw anthracite briquettes." It is possible to manufacture any grade between these two extremes.

The purpose of this study was to find whether it is possible to make a portable machine which would go from farm to farm, after the manner of a threshing machine, and using the materials on the farm, manufacture a farmer's fuel. It is found that the slight charring of straw solves the problem of reducing the straw to a powder fine enough for briquetting, and also that pulped potatoes forms an excellent material for binder. Beet sugar waste also is a very satisfactory binder. One ton of straw will produce 1,400 pounds of briquettes. If we allow 400 pounds to be used up in producing the charring of a ton, then one ton of straw will yield a thousand pounds of fuel. If we count the yield of straw as one ton per acre, then one-half section of wheat or other grain will yield 160 tons of fuel, equal to the best lignite. Three acres of potatoes will supply sufficient binder for this quantity. It will thus be seen that the farm may not only produce all the fuel necessary for household and power purposes, but the small towns or villages may be supplied with fuel from the neighboring farms. As the fuel may be cheaply produced, it opens up the possibility of cheap fuel, and therefore of small manufactures through the province. Wherever the homesteader goes, there can be found his fuel without haulage and freight charges.

How enormous the possibilities are will be shown from the following: Suppose we think of a square forty miles each way, with Regina as the centre. If 24,000 acres be left out for the city and vacant places, and supposing that one-half the remaining area is given to grain crops, 250,000 tons of this fuel may be produced every year for all time, nearly all of this coming a distance of less than twenty miles from the city.

The importance of this kind of work must be evident to all. If it is done, it must be thoroughly done, and with fully adequate equipment. I need scarcely appeal to the members of this influential body to heartily support the government to carry on this kind of work, whether it be directly under government auspices, or by the university. In the work that I have done, the discovery that our clay would make a substitute for sand at a cost of 50 cents per cubic yard, as against $1.80 to $2 for natural sand, when it comes to be used as largely as it may, will repay many times over every year all that these initial researches have cost. All future development must depend first of all on the application of scientific research and scientific principles to the problems which arise in connection with the development of the enormous resources of a province such as this. No investment of money can pay as well.

More durable and elastic than ordinary macadam is said to be a new pavement laid in Paris with a bottom layer of concrete, an intermediate one of concrete mortar reinforced with iron rods and a surfacing of crushed stone and mortar.

REINFORCED CONCRETE PONTOONS FOR A MODERN FLOATING BOATHOUSE.

By D. C. Findlay, B.Sc., A. M. Can. Soc. C.E.

The universal presence of the "teredo" in the salt water of the ocean renders very short the life of wood used for supporting floating boathouses, etc. Likewise, steel pontoons require special surface coating and frequent inspection to ensure against their being corroded by the salt water.

In the design of the modern boathouse described below, concrete was used for the novel purpose of building the pontoons, as it is unaffected by either, if properly constructed. Fig. 1 shows the outside form assembled and the reinforcing in position. The walls and floor are only 2½ inches thick and consequently the design and installation of the reinforcing required great accuracy and care. Half-inch square bars were carefully bent to the shape of the shell, carried along the bottom and up the sides. These bars were spaced about 18 inches centres, and the ends of longitudinal ½-inch bars were carefully looped to accurately fit the ½-inch vertical bars. One of these bars was driven down with a sledge until it was 1 inch from the bottom on each side. A second bar was placed on the top on either side and across the ends. This

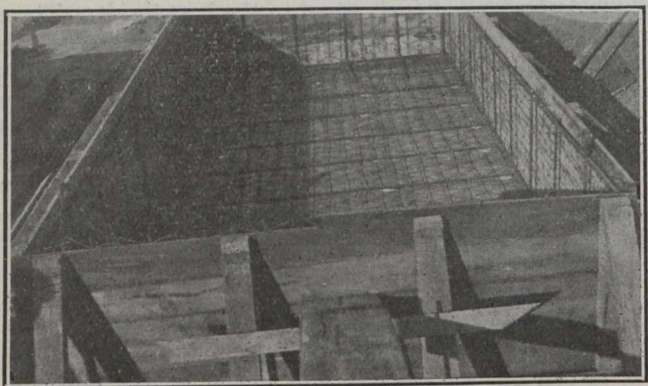

Fig. 1.—Pontoon Form Showing Reinforcing.

formed a very rigid skeleton steel frame of interlocked bars which could not be displaced, and which afforded ample support for fastening the intermediate bars in position. On this framework was carefully spread triangle wire mesh, style No. 26. The lengths were cut and formed so as to extend along the bottom longitudinally and up the two ends, and the sides were treated likewise. The wire mesh was carefully wired to ½-inch bars at every intersection. At about 20 inches from each end a special reinforcing bar had an eye welded to it, projecting above the top of the finished side wall. This enabled chain blocks to be applied for launching, and furnished means of attaching ropes for towing to the site of the boathouse.

This building is 100 feet long by 27 feet wide with a clear height of 17 feet 6 inches to the bottom of the roof truss. Calculations to ascertain its weight determined the most economical size of pontoon to be 16 feet long by 7 feet 6 inches wide and 30 feet deep.

Fig. 2 shows one of the finished pontoons in the water after launching. A centre partition was built into the side walls and floor and consisted of "ferro-dovetail" sheets with their ends projecting 1½ inches into the walls and plastered with concrete on both sides. This stiffened the walls and made two separate water-tight compartments.

For attaching the sills of the boathouse ¾-inch bolts, threaded at the ends, were set into the concrete about 3 inches off the centre of the pontoon, to which the 6-inch by 8-inch sills of the boathouse were bolted. This offset was calculated sufficient to withstand the extra weight of the roof slab and to cause the pontoon to float properly in the water.

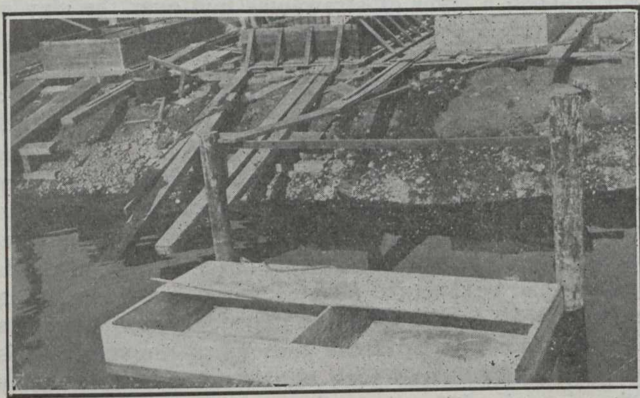

Fig. 2.—Finished Pontoon.

It may be noticed that the roof slab extends on one side only. Further, the end walls were cast with a 2-inch fall from the centre. This portion of the pontoon is outside the building line and the roof sheds the rain. The roof is made of "ferro-dovetail" sheets ⅝-inch in depth of groove, resting on the centre partition wall, and fastened to the ends and side by ⅜-inch carriage bolts placed in the green concrete. Both top and bottom of the sheets were then plastered with a 1:2 mixture. The finished roof slab was only 1¼ inches thick, but possessed remarkable strength and absolute watertightness.

In order to get all the buoyancy possible, every pound of unnecessary weight had to be eliminated. As constructed, the pontoons weighed about 8,000 lbs. and, on launching, floated to within ¼ inch of calculated water line. Each pontoon supports a live load of about 7,800 pounds.

The boathouse under description has 11 pontoons under it, five on each side and one on the forward end, while the other end of the building, containing the large swinging doors, as shown in Fig. 3, was tied together by a 1½-inch iron bar attached by galvanized bolts to the top of the pontoon, and passing between guide bolts set in the bottom, so as to distribute the load in a vertical plane. The horizontal part of the tie rod was 6 feet below water, allowing a yacht to pass over it in entering the boathouse.

The building is rigidly built, and the roof supported by trusses, both roof and walls being covered with a special V crimp, galvanized iron, with a panelled lattice running around the entire building. Manholes in the floor allow for inspection of the inside of the pontoons, which are used for storing light material used about the yacht. At one end it is held in position by a reinforced concrete pile 24 inches square, and by a floating boom attached to the shore at the other. A floating fender attached by spreaders to the sill was installed to prevent the yacht ramming the pontoons in making a landing alongside the boathouse.

In constructing the pontoons, 3 casting floors of ship-lap were built on the beach and carefully levelled up. These served as forms for the bottom of the pontoon and two sets of collapsible wood forms were then made up, which were used 15 times in all. The outside forms were first set up and the reinforcing carefully placed and supported from the bottom by small concrete blocks which were cast into the floor. The floor was then poured, using a wet mixture of 1 part cement and 2 parts sand. This covered the steel completely, and was very thoroughly tamped to fill all the voids.

A mixture of 1 part cement, 2 parts sand and one part screened gravel of ½ inch maximum size was then poured on the top and brought to a depth of 2½ inches. The collapsible inside form was then quickly set in place, and braced into alignment, and the concreting of the walls continued without a break. Very great care was used in the mixing, and especially in tamping the thin walls, to insure the steel being thoroughly enclosed and all air ex-

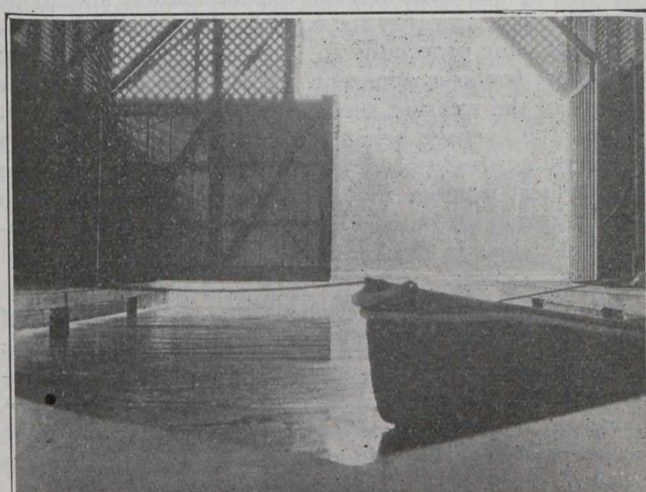

Fig. 3.—Showing Pontoons in Place.

pelled. Very gratifying results were obtained, as of the 15 pontoons built, not one of them showed any indications of dampness of any sort when launched. They have been in the water now for nearly nine months.

Forms were stripped in about 36 hours and allowed to season until thoroughly set, when a frame was placed over each end. Chain blocks were used to lift the pontoon clear of the floor, when launching timbers 10 by 14 inches were placed under on rollers. At high tide the pontoon was about 6 feet above the water. An incline runway was built, extending into the water, and a temporary roof built over the open side of the pontoon to prevent shipping water on launching. Two men with bars easily pushed it off the floor and it took the water very easily. A motor boat then took it in tow for about a mile to the site of the boathouse.

Accurate account was kept of the cost, which amounted to $78 including launching, for each pontoon.

Considering their indestructibility, they are far superior to anything else in use, and prove conclusively that concrete itself, if well placed, is a sufficient waterproofing agent, as no waterproofing was used in the concrete.

The pontoons and boathouse were designed and built under the direction of Mr. D. C. Findlay, A. M. Can. Soc. C.E., chief engineer of the Vancouver Portland Cement Company, Limited, of Victoria, B.C., for Mr. R. P. Butchart, managing director of the company.

MACADAMIZED ROADS CONSTRUCTED WITH TARRY, BITUMINOUS OR ASPHALTIC BINDERS.

At the third International Road Congress the third question, "Construction of Macadamized Roads Bound With Tarry, Bituminous or Asphaltic Materials," was discussed by representatives from twelve different countries. Interests on this side of the Atlantic were looked after by Professor A. H. Blanchard, of Columbia University, and consulting engineer of New York; Major W. W. Crosby, chief engineer to the Maryland Geological Survey, and consulting engineer of Baltimore, and Prevost Hubbard, Department of Roads and Pavements, the Institute of Industrial Research, Washington. The following is taken from Professor Blanchard's paper, which dealt with bituminous surfaces and bituminous pavements constructed by the mixing methods, and refers to progress made during the past three years:

In order to avoid continual explanations and the use of long expressions, the following definitions are given:

Bituminous surfaces consist of superficial coats of bituminous materials with or without the addition of stone or slag chips, gravel, sand or materials of a similar character.

Bituminous concrete pavements are those having a wearing surface (crust) composed of stone, gravel, sand, shell or slag or combination thereof, incorporated together by mixing methods.

Bituminous concrete pavements which have been used in the United States during the past three years and of which broken stone forms an integral part may be grouped in three classes dependent upon the character of the mineral aggregate.

Type A consists of so-called one size crusher run broken stone mixed with bituminous material. This description of broken stone refers to the product obtained at a crushing plant which passes over a screen having holes of one size and through a section of screen having the next larger size holes or which passes through a screen of one size of holes and is retained upon a screen having smaller holes.

Type B consists of one size crusher run broken stone as defined above and sand or other fine mineral matter mixed with bituminous material.

Type C consists of a predetermined graded aggregate usually composed of broken stone and sand with or without other mineral matter mixed with bituminous material.

Foundations and Drainage.—The following statements contained in the 1912 Report of the Special Committee on "Bituminous Materials for Road Construction" of the American Society of Civil Engineers embody the underlying principles of the best current practice relative to foundations, subdrainage and surface drainage.

Sub-Grades and Foundations.—Your Committee believes that the use of any form of a bituminous wearing surface does not preclude the necessity for the construction of a well-drained, thoroughly compacted and adequate sub-grade. In fact, such improvement of the road surface frequently attracts heavier traffic, and thus increases the stresses in the sub-grade.

Crown.—The investigations and observations of the Committee to date have convinced it that the crown generally used in construction of macadam roads is excessive when bituminous materials are used, and that a crown of even ½ in. to the foot should be avoided when a lesser crown can be secured without detriment to the surface drainage.

The above report will hereinafter be designated as the "Am. Soc. C.E. 1912 Report."

Sizes and Shapes of Broken Stone for Bituminous Bound Surface Crust.—Bituminous surfaces have proved more efficacious when constructed on macadam roads composed of well compacted and thoroughly bonded broken stone ranging from ¾ in. to 2 ins. in the wearing surface than when the stone is of smaller dimensions. This size of stone is usually obtained by passing over a screen having 1¼-in. holes and through a screen having 2¼-in. holes.

Bituminous concrete pavements. Type A.: The best results have been secured by using a mineral aggregate composed of broken stone varying in size from stone passing a 1¼-in. laboratory screen to a small amount passing a ¼-in. screen. This product is usually obtained from the ordinary type of crushing plant from stone passing over a ½ or ⅝-in. screen and through a section of a screen having holes 1¼-in. in diameter. A typical analysis of such a product follows:

Per cent. passing ¼-in. screen	5.4
Per cent. passing ½-in. screen	34.7
Per cent. passing ¾-in. screen	40.6
Per cent. passing 1 -in. screen	17.3
Per cent. passing 1¼-in. screen	2.0

The following excerpt from the "Am. Soc. C.E. 1912 Report" bears especially upon the construction of Type A.:

Your Committee recommends that trap rock in sizes greater than that passing a 2-in. screen should be used with caution in the construction of the upper course, unless the voids of the same are properly reduced, because of the liability of the individual stones to rock under traffic.

Type B.: The mineral aggregate has been composed of a combination of one size crusher run broken stone and one or more grades of sand or stone screenings. The mechanical analysis of a typical combination covered by the description, two parts trap rock passing a 1¼-in. ring with a maximum of 5 per cent. dust and one part sand, follows:

Per cent. passing 200-mesh screen	3.3
Per cent. passing 80-mesh screen	6.9
Per cent. passing 10-mesh screen	29.7
Per cent. passing ¼-in. screen	25.1
Per cent. passing ½-in. screen	24.3
Per cent. passing ¾-in. screen	10.7

Type C.: One class of mineral aggregate which has been used to a considerable extent during 1911 and 1912 is known as the "Topeka" grading and is usually composed of broken stone and sand with or without a filler of fine material. The grading for this mixture is covered by the following limitations in the mechanical analysis:

Per cent. passing 200-mesh screen	from 5 to 11
Per cent. passing 40-mesh screen	from 18 to 30
Per cent. passing 10-mesh screen	from 25 to 55
Per cent. passing 4-mesh screen	from 8 to 22
Per cent. passing 2-mesh screen	less than 10

Many bituminous pavements of Type C with proprietary names are laid in the United States. Among these may be mentioned "Bitulithic" and "Warrenite."

Use of Partially Worn Materials in Bituminous Bound Surface Crust.—The universal practice has been to condemn the use of materials, which have been previously employed, for the mineral aggregate in the construction of bituminous concrete pavements.

Thickness and Composition of the Strength Crust and of the Super or Wearing Crust Under Different Conditions.—Bituminous surfaces: A thin coat of the proper kind of bituminous material has given better satisfaction than the formation of a comparatively thick carpet, especially when the surface is subjected to excessive horse-drawn vehicle traffic.

Bituminous Concrete Pavements: Type A is usually laid upon a foundation course of broken stone having a thickness varying from 4 to 8 ins. Type B is laid on a broken stone foundation course as indicated for Type A or a cement concrete foundation, 5 to 6 ins. in thickness. Type C is laid on a broken stone or a cement concrete foundation as mentioned for Type B. It is being recognized as a fundamental principle that where Type C is used under conditions which render it economical and suitable, only the cement concrete foundation should be employed. The necessity for constructing strong foundation courses due especially to the rapid development of motor truck traffic is apparent. For Types A and B the thickness of the wearing surface has varied from 1½ ins. to 3 ins., the average being 2 ins. For Type C, when a fine mineral aggregate is employed, 1½ to 2 ins. has been used, the best practice favoring 2 ins. Pavements with mineral aggregates having larger broken stone are generally laid 2 ins. in thickness, although 3 ins. has been used in some cases.

Life of Surface Crust Under Different Conditions of Traffic, Weather, Subsoil, etc.—Bituminous surfaces: The life depends primarily upon the character of the material and the amount and kind of traffic. Bituminous surfaces on macadam roads have a life of from one to three years and on bituminous concrete pavements from one to five years.

Bituminous Concrete Pavements: As with all types of bituminous pavements, the life of the wearing surface depends, to a large extent, upon the character of maintenance. Granted proper construction, including adequate foundations and drainage, and continual maintenance, which includes the use of seal coats applied periodically, the life of bituminous concrete pavements, based upon such information as is at hand, may be estimated at from 20 to 35 years. This estimate is based upon the supposition that the various types of bituminous concrete pavements are used under conditions for which each is suitable. More definite information is at hand covering the life of pavements which have not been maintained. The following estimates cover average life without maintenance: Type A, 4 to 10 years; Types B and C, 7 to 15 years.

Relative Importance of Patching, Repairs and Periodical Renewals of Surface Crust. Extent of Wear Permissible Before Renewal of Surface Coating.—All types of bituminous surfaces and pavements are liable to develop weak spots. Patching in these cases is found to be economical and practical as it is comparatively simple to replace a portion of a bituminous concrete pavement or a macadam road. Likewise periodical renewals of bituminous surfaces are efficacious. This method of repairing will be economical until such time as the pavement begins to generally wear out or disintegrate.

Measurement of Wear and Appliances Used for This Purpose.—Work of this character on bituminous concrete pavements has been limited to that of a few investigators, all of whom have used the method of periodically taking accurate elevations in order to determine the amount of wear.

Various Methods of Bituminous Treatment. (a) Mixing Methods.—(1) in Factories; (2) on the Spot.— Type A.: In 1910 practically all of the bituminous pavements of this type were constructed by hand mixing methods. In very few cases was the broken stone heated. During 1911 and 1912 there has been a general abandonment of hand mixing methods and a substitution therefor of various machines especially designed for the heating of the mineral aggregate and the mixing of it with bituminous materials. The introduction of these machines has made possible the use of the most suitable types of bituminous materials. Generally this type of mineral aggregate is mixed in portable mixing plants at the roadside.

Types B and C.: The mineral aggregate of these types of pavement has during 1911 and 1912 been universally mixed in a special machine designed to heat the mineral aggregate and mix with it the bituminous material. The location of the machine depends upon local conditions. In some cases the mixing plant is located at a railroad siding at which both the broken stone and the bituminous material are available and in other cases, near the road to be constructed. In some instances large mixing plants have been installed in municipal yards. Type C is also manufactured in the form of asphalt blocks at factories. The following reference to heated aggregates in the "Am. Soc. C.E. 1912 Report" is pertinent:

Your committee recommends that in the use of a heated aggregate for the construction of a bituminous pavement, non-uniformity or excess in the heating of stone, such as usually occurs with the use of flat plates or similar crude appliances for this purpose, should be avoided.

All of the above types have been constructed with and without a seal coat of bituminous material. The best practice, however, favors the use of a seal coat.

(c) **Carpeting Methods:** In the case of macadam roads, the mode of procedure is to thoroughly clean the surface by sweeping with hand bass brooms or horse sweepers or a combination of these methods. The bituminous material, which is generally heated, is applied to the surface with the aid of pouring cans, hose attached to gravity tanks, hand-drawn gravity distributors, horse-drawn or power-driven gravity distributors and pressure distributors. After a varying interval, some kind of mineral coating is generally applied to cover the bituminous material. The construction of bituminous surfaces on bituminous concrete pavements during the construction of the latter is usually accomplished by the use of brooms, squeegees or hand-drawn gravity distributors. For a periodic application of bituminous materials all the above methods are used.

Relative Advantages and Use of Tar, Tarry Compounds, Asphalt, Bitumen, and Other Materials. Tests and Chemical Analysis of Tarry, Bituminous and Asphaltic Compounds.—Bituminous surfaces: Since 1910 there has been slowly crystallizing an objection to the use of bituminous materials on macadam roads which require from one to three weeks to "set up" to such an extent that tracking will not occur. Refined coal tars and water gas tars, combinations of asphalts and tars, and certain asphalts have given satisfaction in this respect as they have "set up" satisfactorily within 6 to 48 hours. Usually about ½ gal. per square yard has been used which has been applied either in one or two applications. In the construction of bituminous surfaces at the time of the building of macadam roads, it has been found possible to employ the same grades of asphalt as are employed in the construction of bituminous pavements by penetration methods provided large stone is used in the surface and the latter is dry and thoroughly broomed.

Bituminous Concrete Pavements: In the construction of both the mix and the seal coat of Types A, B and C, asphalts, possessing the proper physical and chemical properties, have given excellent results. Coal gas and water gas tars have been used in the construction of Type A and to a very limited extent in the construction of Types B and C. In the construction of Type A, coal tar has been used in the mix and an asphalt for a seal coat with satisfactory results. The use of high carbon tar of a certain consistency does not appear to give satisfaction as a seal coat when the traffic includes many horse-drawn vehicles. Compounds of asphalt and tar have been used in the construction of Type A and to a limited extent in the construction of Types B and C.

The amount of bituminous material used is expressed as either so many gallons per square yard of wearing surface or as a given per cent. by weight of the mix. In the various types mentioned, the amount of bituminous material used varies from 5 to 10 per cent. by weight.

Climatic Effects Causing Slipperiness of the Roadway—Remedies.—In some cases bituminous concrete pavements with seal coats of tar and certain grades of asphalt have been slippery, especially in cold weather. Many types of bituminous pavements are rendered non-slippery by the application of an additional covering of stone chips or pea gravel.

Effect on Public Health, Fish Life, or Vegetation.— The effect of using bituminous surfaces and bituminous pavements has been beneficial from the above standpoints except that the odors characteristic of certain asphaltic oils are obnoxious.

Specification of the Methods of Construction.—Detailed specifications have been drawn up covering the construction of bituminous surfaces and the various types of bituminous concrete pavements referred to above. These specifications generally cover the quality and size of the various components of the mineral aggregate, the physical and chemical properties of the bituminous material and detailed descriptions of the methods to be used in mixing and in the laying of the wearing surface. Typical detail descriptions of methods are covered by the following references:

Bituminous surfaces: Trans. Am. Soc. C.E., 1911, Vol. LXXIII., pages 44-73, and 1912, Vol. LXV., pages 548-571. Bituminous concrete pavements. Types A, B and C: Trans. Am. Soc. C.E., 1911, Vol. LXXIII., pages 99-135, and 1912, Vol. LXXV., pages 572-648. Type A: Borough of Queens, N.Y., Special Report, 1912. Type B: 1911-1912 Specifications, Washington, D.C.; 1912 Specifications, Lincoln Park, Chicago, "Good Roads," April 6, 1912. Type C: 1911 Specifications, Borough of Richmond, N.Y.; 1912 Specifications, Borough of Queens, N.Y.; 1912 Specifications, New York State Highway Commission, 1912 Specifications, City of Philadelphia.

Cost Data.—Bituminous surfaces: The average cost of constructing a bituminous surface, using 0.5 gal. per square yard with either an asphaltic or a tar product or a combination of the two, is 7 cents per square yard.

Bituminous Concrete Pavements: Besides variations dependent upon local conditions, the cost varies with the kind and quantity of the bituminous material used, the character of the aggregate and the type of construction employed. Type A: Using an aggregate of one size crusher run stone mixed 1.5 gals. of bituminous material per square yard of 2-in. wearing surface and a flush coat of 0.75 gals. per square yard, the cost varies from 25 to 35 cents in excess of water-bound macadam. Types B and C: The cost of pavements with mineral aggregates of broken stone and sand, with or without other fine material, varies from $1 to $2.25 per square yard including the foundation course and light grading.

Cleansing and Watering.—Bituminous surfaces and bituminous concrete pavements constructed on highways outside built up districts when subjected to considerable motor car traffic are found to remain clean and practically free from dust. When subjected to excessive horse-drawn vehicle traffic in suburban or urban districts, the practice of periodical flushing at night has proved efficacious. Sprinkling with water bituminous surfaces and bituminous concrete pavements is universally condemned as tending to shorten the life of pavements and as being characteristic of uneconomical administration of street cleaning.

THE RAILWAY TIE SITUATION IN EASTERN CANADA.

By E. S. Clements,

The timber supply in Canada is by no means extraordinarily large. From the best information regarding the forests of Canada as a whole, the standing timber totals about one hundred and twenty billion cubic feet, or about fifteen thousand cubic feet per inhabitant, based on the present population. Merely as a matter of comparison, there are in the United States about five hundred billion cubic feet of standing timber, or about six thousand cubic feet per inhabitant.

So that there is only one-fourth as much available merchantable timber in Canada as in the United States, even though there is about 2½ times as much available timber per inhabitant in Canada as in the United States. It must also be considered that to a large extent the timber standing in Canada is quite small, and the amount of merchantable timber per square mile is not very great, particularly in northern forests. This explains the fact that while there are extensive forest areas in Canada, much larger than the present standing forest areas in the United States, relatively there is not the supply of timber in Canada that there is in the United States.

In the eastern portion of Canada the wooded areas along the lakes and the St. Lawrence River have been practically cut off. Lumbering operations in the territory near the lakes and the St. Lawrence River stopped some years ago. The lumber cut off was mostly white pine, but the forests have been pretty thoroughly cut up where they could be reached from the stream.

The principal lumber supplies now for Eastern Canada are the Georgian Bay district, the north shore of Lake Superior and the Ottawa River district. Mills in these sections are cutting Norway pine, spruce, hemlock, tamarack and jack pine. These are the principal woods so far as lumbering operations are concerned. They are what are called workable woods at the present time. There is, however, a large amount of hard wood, particularly in the territory which has been logged over. There is a good deal of hard wood available in the territory between Georgian Bay and the mouth of the Ottawa River, and between the Ottawa River and the lake. This timber has not been cut to any extent. The principal hard woods in this territory are birch, beech and maple. There is practically no oak.

There were 13,683,700 cross-ties purchased in Canada in 1911. The timber at present being used is cedar, spruce, tamarack, hemlock, jack pine.

There is, as stated before, hard wood available, but it is of such a character that it will rot very quickly in the track unless previously treated. The timber at present used is, of course, of a softer and weaker character, and in order to get stronger timber some of the railways have imported long-leaf hard yellow pine ties from southern United States. The native woods which are used, excepting cedar, have a life averaging, say, seven years. Some of the woods, like jack pine, have less life than this. Under the present requirements of speed and load, these woods cut very quickly, and it is difficult to hold the track to gauge. This, of course, can be remedied by the use of tie plates, but the woods, excepting cedar, are very short lived and it does not pay to use the tie plates. The ties themselves rot nearly as quickly as they wear out.

A good, sound cedar tie is a most satisfactory railway tie for lighter loads. It gives a long life under light traffic conditions, and is most economical. For heavy traffic conditions and high speed, however, the cedar tie does not make a safe track, even with tie plates. As an example, the Michigan Central Railroad, on its main line, has found it absolutely necessary, as a matter of providing safe track for its high speed heavy trains, to abandon the use of cedar ties. Furthermore, for the railways located in Eastern Canada, generally speaking the cedar tie is becoming somewhat scarce and the quality available has deteriorated very materially. Consequently the Canadian railways have, in the effort to make safe tracks, imported hard pine ties from the United States, even going so far as to import yellow pine ties from Louisiana, hauling these ties 1,500 miles. It is, therefore, of great importance to note that there are hard woods available in Canada at present which, when properly treated with creosote oil, will give most satisfactory results as well as being economical.

Beech, when sound, is stronger than white oak It is very much stronger in compression across the grain than is white oak. Creosoted beech ties which have been used on the Big Four Railway in the United States for over eight years under comparatively heavy traffic show very little rail wear. The most important information as to the use of creosote in beech ties comes from France. Creosoted beech ties in that country give from twenty to thirty years' service. Creosoted beech ties have also been used on the Prussian States Railway in Germany.

The birch tie also lends itself to preservation. Its sap wood can be penetrated thoroughly. There were put in on the New York Central Railway about 1,100 birch ties treated experimentally at Shirley, Indiana, about seven years ago. These ties are at present sound, and their appearance is such that the New York Central Railway has started a campaign to get all the birch ties possible in the Adirondack territory.

Maple ties, that is the hard maple, compares favorably with beech. The sap wood can be thoroughly penetrated with creosote. Of the other woods the jack pine is the most permanent so far as creosoting is concerned. This wood being softer, it is imperative that large tie plates be used. If it is not done the ties will be rail cut long before they begin to decay.

The old English railway tracking practice was to inject from eight to ten pounds of creosote oil per cubic foot of wood. Results from this were such that Baltic fir ties (a soft pine tie) lasted from fifteen to twenty-five years. It could not be considered good practice, on account of the loss through evaporation, to use less than eight pounds of creosote oil per cubic foot of wood. In the United States the American Creosoting Company, in creosoting some eight or nine million ties per annum, leave in these ties about eight pounds per cubic foot of wood. The actual figures used in this work are:

2½ gallons of creosote oil for a 6" x 8" x 8' tie.
3⅛ gallons of creosote oil for a 7" x 9" x 8½' tie.

Although in the treating of these ties the old English minimum of eight pounds per cubic foot is closely adhered to, these ties are treated by the Lowry process. This process is to inject in the tie an amount of oil in excess of the specified amount to be left in the tie (2½ gallons of creosote oil for a 6" x 8" x 8' tie), this amount running up to 3⅛ gallons for oak and as high as 5 to 6 gallons for pine, and sometimes even higher. The excess amount of oil is withdrawn by high vacuum, only the specified amount of oil being left in the tie. This means that the thoroughness of the penetration of the wood is as good as when twelve to fifteen pounds of oil are used by the common creosoting process, whereas actually only about eight pounds per cubic foot is left in the wood.

The most important element in creosoting wood is a thorough and deep penetration of the creosote oil. Although the old English practice for railway ties was to use from eight to ten pounds per cubic foot, in order to get better penetration present railway practice requires more than this. Ties treated by the ordinary creosoting process means the use of extra oil. By the Lowry process fully as good results are obtained, if not better, with less oil.

The most important element in creosoting timber is to have the timber properly prepared before the injection process is started. It was formerly the practice in the United States to steam timber and artificially season it. It has been proven, however, that steaming is bad practice. It is important to season the timber in air before the creosoting is started. Thoroughly air seasoned timber not only can be more thoroughly penetrated with creosote, but is stronger than green timber. To have thorough air seasoning, it is, of course, necessary to provide the ties sufficiently in advance of the time at which they are to be treated. For beech, birch, maple, jack pine, etc., the seasoning period ranges from five to eight months.

The world's highest-head water-power plant is now nearing completion at Martigny, Canton Wallis, Switzerland. The fall utilized is 5,400 feet, and the pipes conveying the water from the head of the fall to the power-house, a distance of three miles, are specially remarkable. The pressure gradually increases with the fall till the lowest part is reached, where the pipe, having to withstand 2,500 pounds per square inch, had to be made of special ingot-pressed steel. The turbines, which are of the Pelton type, have a total rating of 15,000 h.p. and it is of interest to note that, with the 5,400-foot head, only about 30 cubic feet of water per second will be necessary to develop the full 15,000 h.p. output of the station.

The Toronto Exhibition Grounds, the scene every year of the great Canadian National Exhibition, contains buildings to the value of $2,500,000. Its paved streets and street and interior lighting equipment has no rival on this continent. Over 40,000 lamps are in use during exhibition period.

COAST TO COAST.

Winnipeg, Man.—Complete reorganization of the high-pressure plant, including electrification of the whole equipment, is contemplated by the board of control. At present the whole plant is operated by gas engines supplied with gas from a producer plant in the building. The big container is falling into disrepair and the necessity of making repairs has brought to a head the proposition to change the plant so that electricity, of which the city has so much at small cost, will be the mainstay in operating the immense high-pressure pumps, while gas will be used only as a "standby." Acting on a specific recommendation from City Engineer Ruttan, the board is calling for tenders for two new pumps, which will add 20 per cent. to the pumping capacity of the present plant. It is the intention, when the new pumps are installed, to proceed with repairs to the big gas retainer, which is not in very good shape. The new pumps will supply any temporary deficiency in pumping power while the gas container is being repaired, as they will be connected with the electric power. When this is completed, it is proposed to proceed gradually to change the present equipment of the pumps so that they may be operated directly by electric power, but can be shifted to gas power on a moment's notice. It is estimated that the electrification of the plant would cost in the neighborhood of $50,000, but this amount would soon be saved by cutting off the constant cost of keeping up fires for the gas producer plant. Tenders are being called for two styles of pumps, one style to have a capacity of 360,000 Imperial gallons per minute at a pressure of 150 pounds to the square inch, while the other is to have a capacity of 180,000 gallons per minute at a pressure of 300 pounds. The efficiency of each will be about the same. Another proposal is that the gas producer plant should be cut out altogether when the plant is electrified and that the "standby" gas engines should be operated with gas from the street railway company's gas plant. A 12-inch main is laid to the high-pressure plant, and the big container would hold enough of this gas to operate the engines for any time that the high-pressure is likely to be required.

Sault Ste. Marie, Ont.—Another international question re-opening the rather vexed issue of division of international water powers is involved in an application received by the Dominion Government at Ottawa from the Michigan Superior Power Company. It came through the United States Secretary of War, with the suggestion that the two governments refer it to the joint International Waterways Commission. What is sought by the company is the privilege of damming St. Mary's River at Sault Ste. Marie in order to increase the flow of water to the works of the Michigan, Lake Superior Company at the American Soo. Compensation works to prevent the levels of Lake Superior being injuriously affected are proposed. The application is accompanied by plans and profiles of the proposed work and the compensative undertakings in connection with it. The matter doubtless will go to the Waterways Commission for full investigation, but it is evident that there will be objections not only from American standpoint, but also from navigation interests on the Canadian side. It is divined that the dam will have the effect of diverting much water which now flows through the Canadian channels, and also furnishes power to the Lake Superior Company. In many respects it is similar to the Chicago drainage canal scheme, which, it will be recalled, was vigorously combatted by the Canadian Government and ultimately rejected. A. C. Boyce, M.P., who is in Ottawa, when told of the proposal, stated that the American interests already have a larger slice of the water, the arches of the international bridge being three-quarters on that side. "If this scheme goes through," he said, "it simply means starving the Canadian industries and navigation interests."

Ottawa, Ont.—The annual report of the surveyor-general for the last fiscal year shows that 4,550 miles were surveyed by day labor and 12,483 by contract, a total of 17,033 miles. The average cost per mile under the former system was $83.72 and under the latter $26.78. The cost aggregated $615,247. One hundred and sixty-six whole townships and eight fractional townships were completely subdivided while a partial subdivision was made of three hundred and thirty others, and a resurvey either partial or complete was made of two hundred and twenty-five others. The surveys were carried on exclusively in the western provinces. The report discusses a proposal for reciprocity among surveyors and tells of a conference on the subject. It says in part, by way of approval of the scheme: "Even if a part only of the examinations for qualifying as surveyors should be accepted throughout the empire, so that a candidate who had passed that part of the examination in any portion of the empire would be excused having to undergo it again, in order to qualify as a surveyor in another portion of the empire, a step forward would be made."

Ottawa, Ont.—The Department of Public Works has decided to leave the work of surveying Esquimalt harbor, with a view to the location of the new $3,000,000 drydock, which it is proposed to establish there, to District Engineer McLachlin, who is located at Victoria. The order and instructions, it is understood, will be forwarded to him shortly, so that there will be no delay in pushing forward the work. The engineering staff of the Public Works Department is working at the present time on the plans for the piers and harbor work at Victoria. The department is overloaded with similar work, and the preparation of the plans has been somewhat delayed. Chief Engineer Lafleur states, however, that the plans will be ready within the next month, when tenders will be called for at once.

Toronto, Ont.—The repair and renewal of small bridges and culverts during the timber or plank period of construction, has, in purely agricultural districts, been a serious drain on municipal resources, states W. A. McLean, in his annual report on highway improvements in Ontario, but the policy now being adopted of replacing these with concrete or other permanent material is one which, in the near future, promises to relieve taxpayers of this annual expenditure, and permit the outlay to be directed to more necessary road building. Some municipalities, with commendable desire to avoid public debt, are burdening themselves, and delaying progress, in order that all bridges and culverts may be built by annual levy. Where permanent material is used, construction carried on under proper supervision, and repairs provided for, there is every justification for borrowing money to build bridges of steel or concrete, extending payment over a term of twenty or thirty years. In this way those who benefit hereafter will contribute to the cost, and those who use them to-day are not unduly burdened. This does not apply (it must be emphasized) to flimsy steel trusses, weak concrete structures, wooden floors and substructures of steel legs, steel tubes and wooden backing; but only to those in which the greatest degree of permanence and strength is provided with a view to future traffic demands. The future users should not be burdened with charges for which they derive no service. Road building has, in the past, suffered much by this annual demand for culverts and bridges. A decayed bridge, or broken culvert, must of necessity be replaced or repaired, while the road, if at all safe or passable for a part of the year, can wait. It should not be forgotten that, while bridges are necessary, they are only short part of the highway; are only built because of the high way, and are an unfortunate necessity. Users of the road may pass over a bridge or culvert in ten seconds, while it may take ten minutes longer to drive over a mile of road. The writer has found many localities in which excellent bridges are being built, but in which the roads proper are in a neglected state. Good bridges should be accompanied by good roads, and every councillor may feel assured that the community which will sanction expenditure for permanent bridges, will with equal good will sanction the cost of good roads when shown a model of what well-directed expenditure will do in that regard.

St. Catharines, Ont.—Chief Engineer Weller, of the Welland Ship Canal, work on the lower section of which will begin in August, announces that the present old canal will be closed between Allanburg and Marlatt's Bridge, near Thorold, for building a new weir at the head of Lock No. 25 of the present canal, to supply the above-mentioned water. A dam will then be thrown across the old canal at Allanburg, and the old bed of the canal between the dam and Marlatt's Bridge will be utilized as a dumping ground in which to place the material removed from above water in widening the deep cut. The total length of the canal from lake to lake is 25 miles, and the difference in level between the two lakes 325½ feet, is to be overcome by seven lift-locks, each having a life of 46½ feet. The dimensions of the locks are to be 800 feet in length by 80 feet in width in the clear, and with 30 feet of water over the miter sills at extreme low stages in the lakes. The width of the canal at the bottom will be 200 feet, and for the present the canal reaches will be excavated to a depth of 25 feet only, but all stretches will be sunk to the 30-foot depth, so that the canal can be deepened at any future date by the simple process of dredging out the reaches.

Fort William, Ont.—The Dominion Government, realizing the importance of the harbors at the head of Canadian lake navigation, is doing all that can possibly be done to meet the demands of the marine trade, which during the past ten years has increased in volume over 100 per cent. Fifteen million dollars have been spent during the last ten years in harbor imrovements at this city and Port Arthur. This year alone an appropriation of two million dollars has been set aside by the Dominion Government for work in the harbor, and the contemplated improvements yet to be made will cover a period of at least five years more and will cost between fifteen and twenty million dollars. When the contemplated improvements to the harbor have been completed there will have been spent an amount approaching fifty million dollars.

Niagara Falls, Ont.—This city may soon be the scene of an engineering feat that, when completed, will go down in history as one of the greatest engineering triumphs of the times. The engineers of the Ontario Power Company are considering the construction of a tunnel under the bed of the Niagara River just above the Horseshoe Falls, the object being to provide a new water course for their powerful turbines. At the present time, the turbines are fed from two tunnels, each about eighteen feet in diameter, but the ever-increasing demand for power has taxed these channels to the utmost. These two pipes are located just under the ground surface, alongside of the street car tracks that go up to Chippewa, and experience has shown that it is not wise to duplicate this construction for future use. One is made of steel overlaid with concrete, and the other is of reinforced concrete. These are subject to atmospheric changes, and it is on this account that the peculiar location of the new tunnel has been chosen. The under waters of the Niagara River never freeze, and it has been noticed that the temperature variation is very slight. On this account it would be an ideal spot for a power pipe, as there is a remote possibility of severe changes in temperature causing trouble to the pipes. The beginning of the new pipe will be at the dam just out from Dufferin Islands, and it will be carried almost to the brink of the Falls, then it will swing over to this side, and from here the waters will drop to the turbine house at the foot of the Falls.

Montreal, Que.—A new invention to detect the origin of noises heard at sea was tried out on the Allan liner "Victorian" on the last voyage. The ringing of bells, shouts and other noises, when heard at sea with a fog prevailing or in the darkness, are often hard to locate. The new instrument is the invention of Messrs. W. & T. G. Hodgkinson, of London. The latter gentleman sailed on the "Victorian" in order to give device a thorough testing under deep sea and ocean liner conditions. It worked well on the voyage, and he was fully satisfied with what he learned. The machinery consists of a huge drum so arranged that sound waves may reach it freely from every side. These are automatically recorded, and from this the direction from which they come is calculated. Two ships fitted with the device are at present running on the Mersey with excellent results.

Quebec, Que.—A provincial highway between Levis and Montreal, going through Sherbrooke and the Eastern Townships, is the last move decided upon by the Gouin Government. The announcement was made recently to a delegation of about one hundred representatives of all the counties on the proposed road who had assembled in the Prime Minister's office for the special purpose of presenting their views to the Cabinet. The construction of the highway was certain, explained Sir Lomer Gouin, but the government did not promise that work would be started at once, as the constructive power of the road department was already taxed to its capacity by the construction of a provincial highway on the North Shore, between Quebec and the Canadian metropolis. The proposed highway on the South Shore would, Sir Lomer added, be 250 miles long, with a link from Sherbrooke to Richmond connecting with the International road between Montreal and the United States boundary, and another link between Sherbrooke and Granby, via Magog and Waterloo. In the course of his remarks the Premier said if the government came to the conclusion that it needed more than $10,000,000 for the betterment of public roads in this province, he would be willing to borrow more money or to ask the Federal Government to increase again the provincial subsidies, which it could easily do with the enormous revenue now coming in. The Hon. J. E. Caron declared that the road department had only two skilled engineers at this time on the construction of good roads in this province, while about fifty would be required. He promised, though, that his staff would be completed and working before the end of the season.

Victoria, B.C.—Investigation of the water power resources of British Columbia, which was begun three years ago by the Commission of Conservation at Ottawa, is being continued during the present summer, Arthur V. White, cf Toronto, consulting engineer on water powers for the Commission, having recently arrived in Victoria to supervise the work. Engineering parties are being placed in the field to canvass, first of all, portions of the mainland coast and the territory tributary to the Grand Trunk Pacific Railway. The party undertaking this work, according to Mr. White, will probably outfit at Hazelton. "One of the chief objects which the Commission has," stated Mr. White, "is to draw attention to the various natural resources by publishing inventories and descriptions of such resources in its various publications. The Commission has in course of preparation a report which will deal with the water powers of Western Canada. A great deal of space in this report will be devoted to the water powers of British Columbia, and, as the reports are widely distributed throughout the world, attention is directed to such a resource in a manner perhaps that would not otherwise be attained. The present work of the Commission in British Columbia, since its inception, has had the sympathy and practical support of the Provincial Government, and through the Department of Lands has received financial and other assistance, which has contributed much to facilitate the furthering of the data desired. The gathering of information in British Columbia is the most difficult work of this kind which the Commission has undertaken," said Mr. White. "No province of Canada has so many difficult problems to solve connected with the administration of its water resources, involving as it does irrigation, mining, logging, water powers and other interests. But, while this is true, the efforts made by the province through special legislation and regulations are unique, so far as Canada is concerned." Mr. White has with him on his expedition two engineers, C. J. Vick anl Napier Simpson, both of Toronto, and other men will be engaged from time to time as is necessary.

PERSONAL.

Mr. THOMAS B. LEE has recently been appointed chief clerk of Robert W. Hunt & Company, Limited, in their head office at Montreal.

Mr. J. S. McLACHLAN has been appointed, by the Department of Public Works at Ottawa, a member of the corps of expert engineers to take charge of the construction of the drydock at Esquimalt, B.C.

Mr. W. A. DUFF, until recently assistant chief engineer of the Transcontinental Railway, has been appointed chief engineer of bridges of the Intercolonial Railway. Mr. Duff is a graduate in engineering of the University of Toronto.

Mr. ROBERT J. THOMAS is the newly-elected president of the American Waterworks Association. Mr. Thomas has been superintendent of waterworks at Lowell, Mass., for the past twenty-three years, and was president of the New England Waterworks Association in 1909.

ARTHUR V. WHITE, Toronto, consulting engineer on water powers for the Commission of Conservation at Ottawa, will supervise the investigation of the water power resources of British Columbia, and left recently for Victoria for that purpose. Mr. White is also consulting engineer to the International Joint Commission.

Dr. J. W. S. McCULLOUGH, chief officer of health for the Province of Ontario, will leave this week for Great Britain to obtain an expert knowledge of the treatment and disposal of sewage according to the most scientific methods known. His study will take him through all the larger cities of England, France, Germany and other countries where the same problems as those affecting Ontario are to be found.

A. N. TALBOT, of the University of Illinois, has been elected president of the American Society for Testing Materials. Professor Talbot was born in Illinois, October 21st, 1857, and graduated from the University of Illinois, civil engineering department, in 1881. He was engaged in railroad work for some years, but in 1885 returned to the university, with which he has been connected ever since. The testing of materials has been Professor Talbot's particular field for some years, and it is largely through his efforts that the materials testing laboratory at Illinois University has grown to be one of the best equipped in the country.

SIXTH ANNUAL ASSEMBLY R.A.I.C.

The sixth general annual assembly of the Royal Architectural Institute of Canada will be held at Calgary, Alberta, on September 15th and 16th, 1913. A very interesting programme is being prepared which will include matters of interest to every architect in the Dominion. The programme will be sent early in August to all the members of the R.A.I.C., and will contain all the particulars concerning the convention.

COMING MEETINGS.

UNION OF CANADIAN MUNICIPALITIES.—Thirteenth Annual Convention will be held in Saskatoon, Saskatchewan, July 15th to 17th. Secretary and Treasurer, W. D. Lightall, 305 Quebec Bank Building, Montreal, P.Q.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—The Twelfth Annual Meeting to be held in Canada during July and August. Opening day of the Toronto Session, Thursday, August 7th. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa

THE ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Sixth General Annual Assembly will be held at Calgary, Alberta, September 15th and 16th. President, J. H. G. Russell, Winnipeg, Man.; Hon. Secretary, J. W. H. Watts, R.C.A., Ottawa, Ontario.

CANADIAN PUBLIC HEALTH ASSOCIATION.—Annual Meeting in Regina September 16, 17 and 18, General Secretary, Major Drum, Ottawa; Local Secretary, Dr. Murray, Regina.

AMERICAN ROAD CONGRESS—Annual Session will be held in Detroit, Michigan, from September 29th to October 4th. Secretary, J. E. Pennybacker, Colorado Building, Washington, D.C.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—Twentieth Annual Meeting to be held in Wilmington, Del., October 7th to 10th. Secretary, A. Prescott Folwell, 15 Union Square, New York.

UNITED STATES GOOD ROADS ASSOCIATION.—Convention will be held at St. Louis, Mo., November 10th to 15th. Secretary, J. A. Rountree, Lo21 Brown-Marx Building, Birmingham, Ala.

AMERICAN ROAD BUILDERS' ASSOCIATION.—Tenth Annual Convention to be held in First Regiment Armory Building, Philadelphia, Pa., December 9th to 12th. Secretary, E. L. Powers, 150 Nassau Street, New York, N.Y.

NATIONAL ASSOCIATION OF CEMENT USERS.—Tenth Annual Convention to be held in Chicago, Ill., February 16th to 20th, 1914. Secretary, E. E. Krauss, Harrison Building, Philadelphia, Pa.

THE INTERNATIONAL ENGINEERING CONGRESS.—Convention will be held in San Francisco in connection with the International Exposition, 1915.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—176 Mansfield Avenue, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, A. B. Lambe, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, A. R. Decary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

CALGARY BRANCH—Chairman, H. B. Mucklestone; Secretary-Treasurer, P. M. Sauder.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, F. Pardo Wilson, Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290. Meets 2nd Thursday in each month at Club Rooms, 534 Broughton Street.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSIOCATION.—President, Wm Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer, J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ALBERTA ASSOCIATION OF LAND SURVEYORS.—President, L. C. Charlesworth, Edmonton; Secretary and Registrar, R. W. Cautley, Edmonton.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, A. C. Garner, Regina; Secretary-Treasurer, H. G. Phillips, Regina.

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

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

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

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

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, The Thor Iron Works, Toronto, Ont.

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

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, C. E. Bawden, Birkbeck Bld., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

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

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

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

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

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