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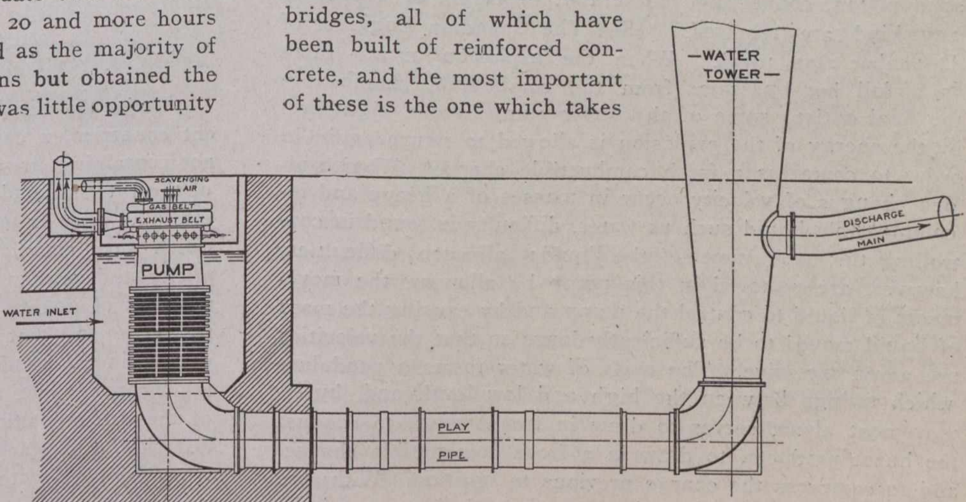
WATER SUPPLY FOR LONDON—LARGE HUMPHREY PUMPS.

A few years ago the water supply of Greater London was in the hands of various companies scattered throughout the suburbs; consequently, with so many suppliers, which varied in size and influence, and of course monopolized the business in their own particular districts, it is not surprising that the service for such an enormous collection of humanity, as is contained in the London area, left much to be desired. In many instances the companies did not increase the capacity of their plant in proportion to the growth of population, and during the prevalence of drought it was not unusual for the supply to be subject to great irregularity. In one particular area, in the north-east of the metropolis, serious inconvenience and danger to health were caused during dry summers by the supply being so inadequate that the water was occasionally cut off at the mains for 20 and more hours per day for many days in succession, and as the majority of the houses were not provided with cisterns but obtained the supply from the service pipe direct, there was little opportunity for the inhabitants to store any useful quantity. It was not uncommon to find that while conditions prevailed in some districts which closely resembled a water famine, only a short distance away—perhaps in the next street—plenty of water was available owing to the supply having been controlled by another authority who were placed in more fortunate circumstances.

In order to overcome these unsatisfactory conditions the various companies were merged into the Metropolitan Water Board at a cost of about £47,000,000 ($235,000,000), and it may be said that since then vast improvements have taken place in the service, and that, at least in comparison with the former conditions, the supply is now as nearly perfect in its regularity as it could be. However, to avoid a recurrence of the old difficulties the Board immediately started on the reorganization of the various plants and on the construction of several large reservoirs to form additions to those that then existed.

The largest of these reservoirs, which is situated at Chingford in the north-east of London, was begun in April, 1909, and is now practically completed. It is anticipated that it will be opened by the King towards the end of the year. The capacity of the reservoir is 3,000,000,000 gallons, as against 2,468,000,000 gallons, which was the total capacity of 12 reservoirs formerly belonging to the East London Water Company who supplied the district. The area of the new reservoir is 416 acres. It has 4½ miles of puddle core embankment, it is 1¾ miles long, about one-third of a mile wide at its narrowest part, and ¾ mile at its broadest. It has been constructed in the valley of the River Lee, a tributary to the Thames, and to make room for it the Lee has been diverted from its course for a length of three miles by a channel 55 ft. wide and 5 ft. deep, with side walls of concrete faced with Kentish rag stone and surmounted by a coping of concrete blocks. A smaller channel 3½ miles long has been provided to divert the contaminated water from the hill side and to discharge it into the old river channel clear of the site of the reservoir. The work has necessitated the construction of several bridges, all of which have been built of reinforced concrete, and the most important of these is the one which takes the public road over the river diversion. This structure is built on the skew and has three spans of 27½ ft. with 5 ft. rise and a width of 40 ft. between parapet walls. The embankment of the reservoir has been formed of material excavated from within its area, and it contains 2,000,000 cu. yds. of earthwork and 253,000 cu. yds. of puddle. The top of the embankment is 15 ft. wide, and is 5 ft. above top water. The outer slope is 2½ to 1, and the inner slope is 3 to 1 for a portion which is lined with concrete, beyond which the slope is 4 to 1. The core is 5 ft. wide at the top—three ft. below bank level—and is battered on both sides for a depth of 23 ft. 6 in., at which point it is 9 ft. wide. This thickness continues for 2½ ft. below the ground surface, and then it batters in with slopes of 1 to 1 on both sides to a thickness of 6 ft. until the London clay is reached. It then



Elevation of 45,000,000 gallon Humphrey Pump for the City of London, England.

slopes in again with ½ to 1 slopes for a depth of 3 ft., forming a key into the clay.

The most interesting feature of the whole work is the installation of some very large Humphrey explosion pumps to deliver the water from the River Lee above the diversion into the reservoir. There will be five of these pumps, and in order to take advantage of sudden floods they will have a total capacity of 180,000,000 gallons of water per day, a quantity that is equal to two-thirds of the daily water supply of London. Four of the pumps will each be capable of delivering 40,000,000 gallons of water per day, while the fifth will have a capacity of 20,000,000 gallons. In normal circumstances the small pump only will be used. The fuel for the pumps will be producer gas, and they will, of course, work on the internal combustion principle with the explosion in direct contact with the water to be lifted. In the larger pumps the combustion chambers and valve boxes are both 7 ft. in diameter with a 6 ft. play-pipe. The vertical towers at the other end of the pipe are in the shape of an inverted cone and are 15 ft. in diameter at the top which is 58 ft. from the bottom of the tower. On each explosion 10 tons of water will be forced into the tower, from which it will flow into the reservoir by gravity. With anthracite at 22s. a ton delivered the guaranteed cost is 0.0196 penny per 1,000 gallons delivered into the reservoir, and the guaranteed consumption is 1.1 lb. of coal per actual water h.p. hour. It is expected that in practice the actual cost will be still lower, or 0.016 penny per 1,000 gallons.

This type of pump is of comparatively recent introduction, and in designing it, the inventor, Mr. H. A. Humphrey, has stated that his object was to produce a pump of great simplicity and strength in which the explosive force is exerted directly upon the water, and in which no fly-wheel, solid piston, connecting rod, crank, bearings, or glands of any kind are required. (See The Canadian Engineer of December 21st, 1911). When the explosion occurs there is a full bore passage from the combustion chamber to the final outlet; some of the water pumped to a high level by the energy of the explosion is allowed to return again in order to compress a fresh combustible charge. When sudden changes of velocity occur in masses of a heavy and incompressible liquid such as water, difficulty is found in controlling the movement of the liquid; all such difficulties, however, are removed in this pump by allowing the movements of liquid to control the pump and by causing the mass of liquid moved to be sufficiently large so that the velocities are never excessive. The mass of water forms a pendulum which swings between the high and low level, and, by its movement alone, serves to draw in fresh water, to exhaust the burnt products, to draw in a fresh combustible charge, and to compress the charge previous to ignition. With the movements of the liquid quite unrestrained by any of the usual mechanical appliances the result is a pump which works with freedom from shock and noise and requires very few working parts. The arrangement consists essentially of a horizontal pipe connected by two bends at its ends with a vertical closed combustion chamber and the open water tower. The parts thus connected are nearly full of water forming a heavy mass or column of liquid which is made to oscillate under the action of the explosion. This oscillation is free and occurs in such a manner that the movement of the water causes the intake of a fresh combustible mixture, the compression of the mixture, the explosion and expansion which give the power stroke, and the exhaust. There are thus four primary movements of the water during each cycle, two being from the combustion chamber towards the tower and two in the opposite direction. The success of the arrangement is due to the use of the momentum acquired by the moving mass of water, for it is this momentum which enables the outward swing of the water under the action of the explosion to continue after the expansive force of the gases has finished and thus to draw in scavenging air and to cause the intake of fresh water from the low level, or supply, during the first outward stroke. On the first inward stroke which takes place under the head to which the water has been lifted, the column of water is allowed to acquire velocity and momentum while merely exhausting the burnt gases, and then the momentum is utilized to compress a cushion scavenging air imprisoned in the top of the combustion chamber above the exhaust valves. Energy is thus stored in the compressed cushion, and the cushion expands giving the second outward stroke and also the momentum which is relied on to carry the water column far enough to draw in behind it a fresh mixture of gas and air. The second return stroke takes place, and the explosive mixture is compressed; once more, owing to momentum, the compression pressure far exceeds that which would be due to the static head of the liquid, and permits a high thermal efficiency. The admission valves for combustible mixture and the exhaust valves for burnt products are placed in the combustion chamber, and the valves for admitting fresh water are placed circumferentially round a vertical valve box situated between the combustion chamber and the bend which connects the horizontal pipe.

Some of the castings for these pumps at Chingford weigh upwards of 20 tons each. The contract price for the pumps and producer plant is £19,388, and they are being built by Messrs. Siemens Brothers' Dynamo Works, Limited. It is expected that the installation, which is the largest of its type undertaken up to the present, will be completed in December and that a test under actual working conditions will then be carried out. The contract has been accepted subject to a fine of £1,000 for every 0.1 lb. of fuel consumed in excess of the guarantee.

COMPETITION FOR MINERS' LAMPS.

Under the auspices of the Acetylene Unions of the different countries, a competition for acetylene lamps for mines not containing fire-damp is opened from now under the care of the International Committee of Carbide of Calcium at Geneva. The prize or prizes will be awarded to the lamp or lamps which most completely fulfil the following conditions: Simplicity and regularity; cheapness; strength and lightness; easiness of upkeep; convenience in cleaning and refilling; resistance to upset; ease of handling and capability of being carried in the hand or being hung on the walls; solid material, light, durable, and unaffected by dampness or the results of the decomposition of the carbide; strong burner of long duration, and placed or arranged so as to avoid extinction from dripping water or by mine violences; production of gas as constant as possible, rational generation from the point of view of purity of the gas as well as the yield of the carbide; utilization of the present sizes of carbide intensity of 5/10 candle power as far as possible; duration of charge as long as possible. The competition will be divided into two categories: (1) Portable lamps for carrying by hand, duration of charge 8 to 12 hours; (2) portable lamps for carrying on the forehead, of extreme lightness, and a duration of at least 4 to 5 hours. At the discretion of the jury either one or two prizes may be awarded; of a total of 5,000 francs, which may be granted if two prizes are awarded, as to 3,000 francs for the best portable lamps for the hand, and as to 2,000 francs for the best portable lamps for the forehead. The models, with description, price of re-sale, &c., must be forwarded before March 20, 1913, to the International Committee of Carbide of Calcium, 5 Rue des Granges, Geneva. The jury will be composed of competent delegates from the different countries nominated by the respective Acetylene Unions.

LIGNITE AND ITS USES.*

By R. O. Wynne-Roberts.

The author, in another capacity, recently had the opportunity of collecting information regarding lignite and of presenting the same in a report to the government.

To-night it may be possible to supplement the report by discussing "Lignite and Its Uses" in a more general sense. It may, however, be necessary to incidentally refer to one or two items in the report because it is unavoidable.

Countless ages ago there were swamps and shallow lakes in which marsh-loving plants grow, deep waters in which algae flourished and aquatic mosses spread over the surface in tangled mats which, under the prehistoric condition, were such that these plants grow with a succulent freedom and rapidity unknown in later days. These plants died and fell into the water and by some preserving action of the water were gradually embalmed and fossilized. In course of time the deposit accumulated, fermentation took place and the vegetable matter was gradually altered in composition and character. This in time, and under increased temperature and pressure, became peat and afterwards converted into lignite and perhaps eventually became coal.

Coal is admitted to be the fossil remains of vegetation that flourished in the carboniferous period of the world's history, while lignite is that of the cretaceous and tertiary periods which are far more recent.

The nature of the compounds which go to build up coal of different kinds is still more or less a mystery, despite the fact that scientists have been investigating this subject for over 100 years. In nature there is a wonderful cycle of processes in continuous action by which the atmosphere is purified of the products of life and decay, through assimilation by vegetation, and under the influence of the sun's ray, the growing plant builds up its tissues from the carbon, hydrogen and oxygen, renders latent and storing the solar energy, and in the countless ages they were gradually converted into fuel.

According to Prof. Vivian Lewis, all the plants which were fossilized consisted of sedges and reeds, tree ferns, club mosses and trees akin to pine. The spores of club mosses of to-day give off a substance of so resinous in its nature as to resist the action of water and perhaps this has contributed to the preservation of plants in water. With some forms of vegetation the essential oils undergo oxidation and form resin and, these being more resistant to change, accumulate in masses of decaying vegetable matter so that large quantities of them are found in peat and lignite beds of Germany in a fossilized but little changed state, but whether they are to be found in this province, no information is yet to hand.

Peat, then, is merely decomposed vegetable matter, consisting chiefly of decayed moss and water plants, and is the lowest grade of fuel recognized in the classification of coals. It varies from yellowish or brown fibrous substance in which leaves and tissues of the plants are quite perfectly preserved through different stages of maceration to a dark brown colored material, in which little of the original structure can be recognized. Peat, after drying, is used for making coke, in gas producers, as domestic fuel, and in some countries it is briquetted. In the province of Schleswig-Holstein, a central power plant has been erected to supply electricity to 60 communities lying within a circle of 16 miles, and all power necessary is furnished by gas producers run entirely on peat.

* Paper read before Regina Engineering Society, December 5th, 1912.

Dr. Berguis, of Hanover, recently made some experiments in the artificial formation of coal. He made an apparatus consisting of a bomb bored out of a block of steel and having a coned lid, etc. He placed peat containing 85 per cent. of water in this bomb, and heated the same by an electric furnace to 660 degrees Fahrenheit and succeeded in obtaining coal similar to natural bituminous coal.

This experiment is confirmatory of the statement already made and it will be interesting to give the figures:

Material	Temperature in degree Fahrenheit	Time Taken Hours	Composition of the resultant Coal			
			Carbon	Oxygen	Hydrogen	Nitrogen
*Peat...	....	..	52.4	41.4	5.50	0.70
Peat....	480	8	74.3	19.4	5.20	1.07
Peat....	570	8	77.0	16.9	5.00	1.07
Peat....	645	8	81.2	13.3	4.65	0.89
Peat....	645	24	84.0	10.4	4.62	0.95
Peat....	660	11	85.2	10.4	4.50	....

* Composition of dry peat before treatment.

Lignite, again, is also formed by a mass of compressed and partly altered vegetable matter. Sometimes stems are found in it presenting the appearance of undecomposed wood. Lignite contains a larger proportion of oxygen than does coal. It is sometimes called fossil wood, wood coal and brown coal. Some lignite, however, so closely resembles good bituminous coal as to be indistinguishable. There are many varieties of lignite, ranging from soft and plastic substance that can be spaded like peat, to hard layers which have to be blasted. Some contain more than 40 per cent. of water. Its color ranges from brown to pitch black.

According to the 1911 report of the Canadian Commission of Conservation, there are 7,500 square miles and 20,000 tons of lignite in Saskatchewan, of which about two-thirds are located in the southeast portion.

The map exhibited will show the district where lignite deposits are found. That on the west is known as the Belly River formation and that on the south as Laramie formation. There appears to be in the neighborhood of Estevan, several lignite deposits down to a depth of about 600 feet; whether such layers extend into other parts of the province it is difficult to say, but it is probable they do.

Before discussing the uses of lignite, it will be desirable to refer to its quality. The quality of any fuel is dependent on the proportion of combustibles it contains. These consist of fixed carbon, and volatile matter. Sulphur is a combustible, but owing to its being present in lignite in such small quantities, it can be ignored. The impurities consist of shale clay and other inconsumable materials which give rise to ash, and this differs greatly with various kinds of fuel. Some fuels are now used containing over half their weight of impurities. Another item which has an important bearing on the use of lignite is the quantity of water which it contains.

Fixed Carbon.—Vegetable tissues are composed of carbon, hydrogen and oxygen. As these tissues, in the formation of coal, are not exposed to atmospheric conditions but are altered out of contact with air, the three chemical elements named rearranged themselves. For instance, carbon combining with oxygen forms carbon dioxide; carbon and hydrogen formed inflammable gas and hydrogen with oxygen formed water. The conditions which facilitate the formation and escape of these gases also favor the formation of coal having a high percentage of fixed carbon. Such conditions are pressure, heat, folding and erosion of the local bearing strata. So, in the Rockies, where great disturbances have occurred by tilting of the rocks, folding of the bed plane, and generally causing a tremendous pressure to take place, the coals found there have a higher percentage of fixed carbon than in those found on the east of the mountains, where no such disturbances have taken place, and this is one reason why lignites are relatively low in fixed carbon.

Volatile Matter.—Anthracite from Bankhead contains about 11 per cent. of volatile matter, and 85 per cent. of fixed carbon, while Souris lignite from Sutherland mine, for instance, contains 35 per cent. and 39 per cent. respectively. It will therefore be seen that in the anthracite the high percentage of fixed carbon gives off a hot, sustaining fire under steam boilers, whilst in the case of lignite the gases constitute one-half of the combustibles.

It is instructive to compare lignites from various countries and to contrast the same with American coal.

	Moisture	Computed to dry Bases			Heat value of coal as fixed
		Vol. Mat.	F. Car.	Ash	
1. Saskatchewan lignite	29.7	49.0	42.9	8.0	7520
2. Alberta lignite	8.3	37.5	51.5	11.0	10740
3. North Dakota lignite.	35.78	45.00	45.05	10.0	7279
4. California	17.36	46.5	35.0	18.8	8530
5. Texas	33.71	44.0	45.0	11.10	7348
6. Italy	12.5	38.0	45.5	15.16	9350
7. Hungary	24.0	48.6	24.3	21.2	5750
8. Germany	52.7	44.5	43.8	12.3	4500
For comparison with best American coal from West Virginia	1.36	15.0	78.0	7.7	14420

It will be observed that the moisture content varies greatly. In one case it was as much as 52.7 per cent., and yet the gas produced from it was good.

1. Montreal test on Western Dominion Colliery lignite.
2. Montreal, Galt Colliery lignite.
3. U.S. Bureau of Mines, Wilton Colliery lignite.
4. U.S. Bureau of Mines, Tesla lignite.
5. U.S. Bureau of Mines, Hoyt lignite.
6. From Kerpely catalogue.
7. From Kerpely catalogue.
8. From Kerpely catalogue.

The production of lignite, according to information received, is as follows:

		Tons.
1911	Saskatchewan	204,000
1910	North Dakota	400,000
1910	Alberta	784,000
1910	Texas	881,000
1911	Germany	80,000,000

The use of lignite in this province has not yet become extensive. One of the principal consumers in the Robin Hood Mill Company, where a new type of furnace will shortly be installed to consume it. Estevan Power Steam Plant is run on lignite. The Rouleau Electric Plant is operated by means of producer gas from lignite.

Lignite is occasionally consumed at the power plants in Regina and Moose Jaw. Special tests were recently made at Weyburn and Estevan in connection with the use of lignite under boilers. Alberta lignite is used at Edmonton, Calgary, and Lethbridge for raising steam; these three employing chain grates and mechanical stokers.

The Canadian Mines Branch in 1908 carried out a series of tests in raising steam and with gas producers, with a large number of Canadian coals and lignites. These tests were made at McGill University, Montreal, and are dealt with in reports published recently.

Collecting the results obtained at those places where relative figures are reported, they can be tabulated as follows:—

Steam Plant.—Estevan—One pound of lignite as fired, equivalent evaporation was 3.76 pounds of steam from and at 212 degrees Fahrenheit. Weyburn—One pound of lignite as fired, equivalent evaporation was 4.13 pounds of steam from and at 212 degrees Fahrenheit. Montreal—One pound of lignite as fired, equivalent evaporation was 3.91 pounds of steam from and at 212 degrees Fahrenheit. Average, ⅓ of 11.80, 3.93 pounds.

Thermal efficiency based on combustible consumed:

Estevan	50.85%
Weyburn	56.01%
Montreal	52.5 %

Average, ⅓ of 159.36, 53.12%.

Reference will later on be made to results obtained elsewhere, but it will be seen that in very instance the evaporation and efficiency were low. In each case the furnace and grade were practically the same as for superior coal. It is evident that much better results ought to be and are, no doubt, obtainable by adopting furnaces and grates better adapted for the consumption of lignites.

The United States Bureau of Mines conducted tests at Williston, North Dakota, steam plant, where a semi-producer furnace was built; superheated steam was used with Argand blower, and air was preheated in coils at the back of the boiler. The equivalent evaporation from and at 212 degree Fahrenheit was 3.17 pounds of steam and the overall thermal efficiency was 53.79 per cent. The moisture content of the lignite averaged 42.61 per cent.

Other steam tests were made at St. Louis, but the results were not so good.

Enough has been stated regarding the results of test obtained in raising steam with raw lignite.

It is well now to refer to results obtained with gas producers.

Two tests were made at the McGill University, Montreal, with the result that one brake horse-power per hour was obtained on a consumption of 2.58 and 2.70 pounds of lignite or an average of 2.64. These are the only tests made in Canada of which information has been received. Reference will be made to American tests later on.

Assuming that 18 pounds of steam are required per indicated horse-power hour to run a first-class steam turbine, then at least 4½ pounds of lignite are required, and with gas producers at least 2⅔ pounds.

The American gas producer tests will now be referred to.

So that this paper will not be overloaded with statistics, it may be stated that at St. Louis (Mo.) a large number of American coals and lignites were tested under steam boilers and in gas producers, and it required 8.46 pounds of lignite similar to that locally produced to generate one electrical horse-power at the switchboard when consumed under a steam boiler as compared with an average of 2.93 pounds of various lignites when used in gas producers.

In Texas the average consumption of raw lignite during last year at a 5,000 h.p. gas producer installation was 4 pounds per kilowatt hour, after allowing for all contingent losses, etc.

In these cases, with the exception of Williston, where the air was preheated, no attempts were made to utilize the waste heats.

You will readily understand that after the coal has been converted into gas and consumed under the boiler or in the gas-engine, there is much sensible heat left. If means were adopted to utilize the same by way of economizers, waterheaters, etc., the fuel consumption would doubtless be reduced.

It will be interesting now to discuss what is being done in Europe.

As has already been stated, peat is the forerunner of lignite, and if it can be used for any purpose with efficiency, then it is reasonable to expect equal, if not better, results with lignite.

Mond gas plant has been installed at Orentana (Italy) to consume 100 tons of peat per day. Part of this gas is used in three 500-b.h.p. double-acting gas engines driving alternators in parallel. The current is distributed over the surrounding district and to the town of Pontedva, 14 miles away. Another plant gasifies German peat containing 40 to 60 per cent. of water and producing 85,000 cubic feet of gas having a heat value of 150 B.t.u. per cubic foot out of every ton of theoretically dry peat.

Mond gas plant is economical if the ammonia can be recovered, but so far as the information extends at present, the cost of commercial sulphuric acid delivered in Regina is too great for this.

Reference may be made to the Volcker furnace, which is shown on cartoon. A test was made at Leipziger Cotton Mills, Leipzig, Linderau, Germany, in 1903. There were three boilers, each having a water heating surface of 302.5 square meters and in 1908 another test was made at the Renate Mines, Germany. The general results are given below:—

	Leipzig.	Renate.
Water heating surface of boiler	907.5 sq. m.	267. sq. m.
Superheater heating surface ..	107.5 sq. m.	87.8 sq. m.
Grate area	25.92 sq. m.	10. sq. m.
Heat value of lignite combustible	2503 cal.	2019 cal.
Duration of test	7¾ hrs.	8 hrs.
Coal consumed	34,620 kg.	19,900 kg
Coal consumed per sq. m. grate area and per hour	....	247 kg.
Water evaporated	101,012 kg.	41,324 kg.
Water evaporated per sq. m. heating surface per hr. ..	....	19.19
Actual evaporation	2.86	2.08
Water from o deg. C. to steam 100 deg. C.	2.91	2.34
Steam pressure	10.8 atms.	12.8 atms.
Temperature of feed water....	....	36.4 deg. C.
Temperature of superheated steam	245 deg. C.	356.2 deg C.
Percentage of C.O. in flue gas	15%	12.7%
Heat absorbed in calories per kg. of combustible	1,826.3 cal.	1,489 cal.
Net thermal efficiency	72.9%	73.7%

As no information is given as to the proximate or ultimate analysis of the lignite, it is not possible to express any opinions to the similarity of the lignites used to that found in this province. Even allowing for some difference in quality, the results obtained are high.

In connection with gas producers, it is possible to obtain a certain quantity of steam as well as gas by means of water jackets on producers, economizers on gas engine exhausts, etc. With regard to water-jacketed producers, this has been adopted to a small extent in the States and in England, but apparently this arrangement has been more developed in Germany. One of the cartoons on the wall depicts a Kerpely producer encased in a Marischka boiler, in other words, the producer is provided with an enlarged water jacket, while the fire brick lining which is usually found inside produc rs is entirely absent in this case.

A large install tion of these combined producers and boilers have been ected in connection with the Vienna municipal gas work at Leopoldau.

Coke breeze is used as fuel; this has a calorific value of about 10,000 B.t.u. per pound and contains 11.75 per cent. water and 15.8 per cent. ash.

These producers are 2 metres or 6 feet 8 inches in diameter, and have 55 square metres or 600 square feet heating surface. One kilogram of coke evaporated 1.13 kg. of water, and 11.4 kg. of steam were obtained per sq. metre of heating surface per hour at a pressure of 76 lbs. per sq. in.

The temperature of the feed water was 45.9 deg. C. or 114.6 deg. Fahrenheit, and that of the gas at the outlet of the producer was 220 degrees C. or 428 degrees Fahrenheit. As the temperature of the hot gas in other producers is ordinarily about 1,100 degrees Fahrenheit, it will be seen that a large absorption of sensible heat had taken place. The net value of the gas was 1,218 cal. per cubic metre, or 134 B.t.u. per cubic foot.

The gas had the following average composition:

Carbon dioxide	CO............	2.78%
Carbon monoxide	CO............	29.84%
Hydrogen	H............	9.12%
Marsh gas	CH............	0.8 %

The loss of carbon in ash was 1.43 per cent.

The heat contained in the steam was 689 caloric; 3.8 cubic metres of gas were produced per kg. of coke, the specific heat of which was 0.31, and the heat value obtained was 3.8 c.m. × 220 deg C. × 0.31 — 259 calories.

To gasify the coke 0.18 kg. of steam was required per one kg. of coke.

The efficiency of the combined producer and boiler may be calculated as follows:—

Heat value of coke	5,636 calories
Heat value of steam used	110 "
	5,746 calories
Heat obtained from steam	689 calories
Heat obtained from gas	4,628 "
Heat obtained from temperature of gas......	259 "
	5,576 calories

The total net efficiency of combined producer and boiler was

$$\frac{5,576 \times 100}{5,746}$$ equals 97 per cent.

The heat balance may be struck off as follows:—

11.99% in producing steam.
80.54% in the gas produced.
4.51% sensible heat of hot gas.

When the gas was cleaned and cooled ready for use in gas engines, the efficiency was reduced to 92,53 per cent. as compared with about 85 per cent. in other producers. As one kilogram of coke produced 1.13 kg. of steam of which 0.18 kg. was required in the generation of gas, the balance —0.95 kg.—was available for other uses. For example, as in this case, if 15,000 kg. of coke were consumed in 24 hours, the 600 kg. of steam per hour is available, which is equal to at least 60 h.p.

As this test was made with gas coke, it is a question that requires answering, whether equal results could be obtained with the consumption of raw lignite.

Another test made with the same make of producer, but without the encasing boiler, is stated to have resulted in a net thermal efficiency of 86.87 per cent., when consuming Syrian lignite of Austria.

Saskatchewan lignite is stated to correspond approximately in quality to the lignite of Bohemia and Upper Hungary. One German firm of engineers claim that the efficiency of their producers average about 80 per cent. and state that the efficiency of gas-fired boilers averages from 80 to 85 per cent., so that the combined efficiency of separate producer and boiler will therefore be 68 to 72 per cent. And, further, if Bonecourt surface combustion is applicable, then the combined efficiency would be in the neighborhood of 90 per cent. Whether Bonecourt's system can be applied depends on the quantity of dust and carbonaceous matter that may be discharged with the gas from the producer.

There is another method of using lignite for raising steam, and this is by using dust fuel. Lignite, in this case, would have to be dried and pulverized and the makers claim this can be done effectively and cheaply. The appliance which disintegrates the coal also acts as a fan and blows the fuel along into a burner fixed in the centre of a specially designed vertical boiler, and there ignited.

Four tests were made in Johannesburg, South Africa, with coal of the following composition:—

Moisture	2.15%
Volatile matter	22.80%
Fixed carbon	57.55%
Ash	17.50%

The average results of these tests were:—

Duration of tests in minutes	95
Steam pressure, in lbs. absorbed	189
Steam temperature, in deg. Fahr.	576
Feed water temperature, in deg. Fahr.	70
Percentage of CO_2, in flue gas	16.8
Factor of evaporation	1.265
Coal fixed per hour, in lbs.	3,451
Water evaporated per hour actual, in lbs.	25,190
Water evaporated from and at 212 deg. F., in lbs.	31,860
Water evaporated per lb. coal actual, in lbs.	7.30
Water evaporated from and at 212 deg. F., in lbs.	9.24
Net efficiency, per cent.	80.4

It will be unnecessary to discuss further the question of generating power by means of steam boilers or gas producers and sufficient proofs have been submitted to show that it is possible and in view of the cost of imported fuel and local conditions it is also cheap.

Before proceeding to another phase of the problem of using lignite, it may be desirable to submit a few points which might be profitably debated.

1. Lignite is a highly oxygenated fuel, containing a large proportion of volatile matter and moisture.

2. The efficient consumption of lignite for raising steam is dependent on the furnaces and boilers being specially adapted for its use.

3. If lignite is used in the solid form, there should be a large grate area, deep, fuel bed, efficient air preheater, and an ample sized combustion chamber.

4. Lignite is adapted for generating power by means of gas producers and engines. The producers, etc., must be designed for this particular fuel, as the grate area must be larger, fuel bed deeper, less steam is required and less tar is produced.

5. Ample provision should be made for reducing the formation of clinker and for its removal by mechanical means, because, barring by manual labor is both inefficient and expensive.

6. More economical development of power from lignite appears to be possible when the surplus heats are absorbed by suitable economizers, etc.

7. The most promising method of developing power from lignite on a large scale is by gas producers and engines with the installation of waste heat utilizers, together with steam boilers and engines.

8. Every unit of increase thermal efficiency obtained with any type of power plant means a tangible saving in dollars and cents for the steam user.

There is another method of using lignite and that is by converting it into gas by ordinary distillation process. This has been fully set out in the report and consequently only a general reference to this subject can be made to-night.

It is a question for the public to decide whether they want artificial gas of the same quality as is made in other Canadian cities, which can be used for lighting, cooking, heating and power, and which will cost more to supply owing to the great distance from which the gas-coal must be brought, or an artificial gas possessing small illuminating power but of good enough quality for heating, cooking and power, made from local fuel and costing less to supply. Natural gas is, of course, superior to both.

Lignite gas, which name is applied advisedly to differentiate it from ordinary coal-gas, can be made in an ordinary gas works plant, but the heat required for distillation will probably be less and therefore the cost of production will be less. Moreover, as lignite distils more quickly than ordinary gas coal, more gas can probably be made in a given time, and therefore smaller plant will be necessary. If the public should desire the lignite gas to be richer in lighting power, then it can be enriched at small cost.

Gas work may not be so familiar to some of you as steam and producer plants and therefore a short elementary description will be given of the process.

The gas works plant consists of retort benches, exhauster, condensers, scrubbers, washers, purifiers, station meter and gas holder with tanks for tar and ammoniacal liquor, all of which are connected together by pipes.

The retort benches are virtually ovens in which are placed a number of fire-clay retorts built over a furnace. These retorts are either circular, D shaped, or oval, in cross section. They are often "singles," that is, they are closed at one end and fitted with a cast iron mouthpiece at the other; in other places two retort benches are placed back to back and the retorts are "throughs," that is, they are open from mouthpiece to mouthpiece. There are flues from the furnace beneath surrounding these retorts to heat them. These furnaces, in small work, are direct fired with coke, but in larger work regenerative and producer furnaces are built with passages to preheat the air so that when the gases from the furnace meet and mix with the hot air, and burn in the combustion chamber, intense heat is generated. This is circulated around the retorts and finally passes up the chimney stack.

Retorts are usually laid horizontally but sloping retorts are in use, as well as chamber retorts. The latest development is the vertical retort, which consists of fire-clay rings surrounded by flues. These verticals are heated by producer furnaces, and as the coal is carbonized into coke, it gradually falls in the chamber. Outside the lower part of the vertical retort there are flues to preheat the air, and this at the same time cools the coke, so that when it is discharged it requires very little quenching.

Returning again to the horizontal retort, coal is charged into it, and the lid on the mouthpiece closed and made airtight. The externally applied heat causes the coal to be carbonized or distilled, gases and vapors are driven out and as there is but one outlet they perforce must travel up the ascension pipe from the mouthpiece into the hydraulic main when the heavier hydrocarbons and some vapor are condensed and deposited.

As the gas would, in the absence of pumps, have to force its way through water in the hydraulic main and through the condensers, washers, scrubbers, purifiers, meter and into the gas holders. There wo ld naturally be some back pressure thrown on the retort a d this would reduce the quantity and quality of the gas pr luced from each ton. So, an exhauster is installed, the fu tion of which is to pump the gas out of the retort and th eby to keep the pressure on the retorts at a minimum, and also to drive the gas through the various clearing appliances and into the gas holder.

The gas, then, after it passes through the hydraulic main, flows along the "foul main" into the condenser, in both of which more tar and ammoniacal liquor are condensed. It then has to pass through washers and scrubbers where the remainder of the tar and ammonia are extracted, as well as some of the impurities, such as carbon dioxide and hydrogen sulphide.

The next step is to purify the gas, and this is done by means of lime or oxide where the remainder of the carbon dioxide and sulphuretted hydrogen are removed.

The gas, after passing through the various processes of purification, is stored in a gas holder and delivered to the cities as it is required.

There is another process by which gas can be manufractured, and that is by means of coke ovens where a large quantity of coal is distilled at one time.

The gas obtained from lignite by any of these methods will be equal to about two-thirds of the heat value of first-class coal gas, but much less so far as illuminating power is concerned. But in these days gas is not consumed in old-fashioned flat flame burners. It is burned in mantles which are heated to incandescence, thus causing the rare-earths to give off the brilliant light which we all know. Lignite gas used in this manner will yield a fair amount of light, and if desired, can be so enriched as to give any candle-power. The principal aim of gas engineer is to supply good and cheap heating gas. In many places in Europe coal-gas is now supplied of practically the same heating value as that to be obtained from lignite, because it is cheaper to make.

In the United States two-thirds of the gas supplied is made by another process, namely, the carburetted water gas. The plant for making this gas consists of generators which are similar in many respects to producers. Regenerators, which are chambers filled with checker or baffle brickwork, are in duplicate. The generators are heated to incandescence by means of air blast; the gas passes up out the regenera- tors, where they are burned, and the brickwork raised to a very high temperature. Steam is then admitted into the generator and in passing through the hot fire in the pro- ducer and then through the regenerators, it is converted into its component parts, namely, hydrogen and oxygen. The latter combine with the carbon to form carbon monoxide and the hydrogen is made free. Thus two gases are ob- tained, hydrogen and monoxide, which have higher values than producer gas, but not much lower than lignite gas. With gas producers, however, the process is continuous, whilst with water gas plant, owing to the fire being cooled by the injection of steam, it is intermittent.

The water gas burns with a blue flame and will yield no light, but oil is carburetted by volatilizing and fixing it and this raises its lighting power to that of the best coal gas.

Although examples of the production of water gas by consuming lignite is not yet to hand, there does not appear to be any reason why it should not be as feasible as when using coal. Until further information is collected, it will not be wise to dogmatize on this subject.

Reference might here be made to Bonecourt surface combustion. Gas is made to pass through a porous plate of, say, fire-clay, and is ignite on the outer side. The flame is of the ordinary white kind you see when burning coal gas. Then air is admitted with the gas and the flame alters in appearance and finally disappears, but gas continues to be consumed, maintaining the surface white-hot, whilst the inner surface remains cool. This form of heating can be applied to grilling, evaporating, etc.; the latest domestic application is to toast a few million pieces of bread per day in large cafés. This system can be applied for industrial purposes, for instance, it can be used to welt lead, to heat crucibles, muffled furnaces. The heat obtainable can be made so intense that it is difficult to find a material that will withstand it.

Steam boilers can be heated by this method, and when gas is made available it may be used to heat hot air, steam or hot water boilers for house warming.

What appears to be a simple adaptation of surface combustion is an arrangement for fitting ordinary drawing-room or other fireplace with a gas fire. The gas in this case passes through a bed of loose sand or granulated substance and the gas burns on the surface as already described.

This method of consuming gas results in high efficiency and economy.

Much is heard to-day of cooking by electricity and, as an incidental feature of this paper, it may be interesting to make a simple comparison.

Electricity sold at, say, 3 cents per kilowatt, having a heat value of 3,400 B.t.u., which equals 113,300 units for each dollar, and allowing an efficiency of 75 per cent., then the available heat is about 850.00. Coal at $7 per ton, having a heat value of, say, 10,000 B.t.u. per pound, will give 2,860,000 heat units for one dollar, but as the efficiency in this case is as low as two per cent., then the available heat is 57,200 per dollar.

Artificial lignite gas, sold at, say, $1 per 1,000 cubic feet, having a calorific value of 450 B.t.u. per cubic foot, will theoretically yield 450,000 heat units per dollar. The efficiency in this case is about 25 per cent., so, only 110,000 units are obtained per dollar. If Bonecourts' system is applied, then the efficiency will be, say 50 per cent., in which case the heat value available will be 220,000.

The comparison will consequently be:—

Electricity at 3 cts. per kw......	85,000	heat units per dollar
Coal at $7 per ton...........	57,200	" " "
Lignite gas at $1 per 1,000 cubic feet	110,000	" " "

The water, which is condensed from gas and the additional quantity used for washing gas, contains ammonia This ammoniacal liquor is distilled and the ammonia drawn off and passed over acid.

The product, sulphate of ammonia, is an excellent fertilizer, and can also be used for rendering wood less inflammable. Ammonia is also used in connection with refrigerating plant, and by another process is used for the manufacture of explosives.

Having disposed of the question of developing power by steam producer-gas, lignite-gas and water-gas, we may now turn our attention to briquetting of lignite.

This is not so easy of solution. In raw lignite, one-third of its weight consists of water, and when it is air-dried, about one-half of the water is evaporated, but the lignite breaks up or crumbles and in that condition it is not so easily handled. Stokers object to it because it means more labor in firing and needs more careful watching. This can be obviated by using mechanical arrangements. Steam users object because at present full steaming capacity of the boilers are not secured, and there is more loss due to the small particles falling between the fire bars. This may be improved upon by installing lignite consuming furnaces. Householders object because it is too flashy when burned, and requires more attention, and this can be improved by using briquettes.

In this province we have no available asphalt supply; there are no gas works to provide coal-tar-pitch; but it is quite possible to utilize local material which will answer as agglomerations or binders for making briquettes.

If a lignite gas works is installed, some distillates from the tar, such as pitch, paraffin, wax, etc., may be useful.

A sample of local lignite was sent to a briquette machine maker and this he made into briquettes which are on view to-night. Owing to the smallness of the quantity of the sample, the maker referred to found he was unable to carry out the experiment as efficiently as he would wish. Consequently, the briquettes before you are not good specimens. Samples A and B have been briquetted by a certain special steaming process without the use of any binder, but these briquettes do not appear to be satisfactory. Samples C to F are made with five per cent. pitch, sample F being the best. It is hoped that further experiments will be made. Other experimenters are endeavoring to find a cheap and simple process by which raw lignite can be satisfactorily briquetted.

What promises to be a solution of this problem is the carbonization of lignite at low temperatures. Although North American lignite has not been subjected to this treatment, non-coking Illinois coals have, and a few of the results obtained may be stated.

When the coal was distilled for an hour at a temperature of 500 degrees to 900 degrees Fahr., the percentage of fixed carbon was increased more than 25 per cent., and there was a corresponding decrease in volatile matter, and furthermore, the fuel became smokeless. Another feature of low distillation of Illinois coal is the production of gas of exceedingly high heating value, almost equal to that of natural gas. Illinois coal is not of high quality, nor has it the propensity of making coke, and in these respects it is similar to lignite. Prof. Lewis, in another experiment, found it was cheaper to manufacture gas at low temperature of 720 deg. Fahrenheit and the value of the gas was higher, whilst more coke and ammonia products were obtained. The temperature of ordinary gas-coal distillation is about 2,200 deg. Fahrenheit and the composition of the tar produced is quite different from that at low temperature. The latter yield paraffin oils valuable for lubrication and power purposes.

In Germany thousands of tons of tar are annually produced by the distillation of lignite at low temperature. Gas oil extracted from the tar is used for making oil gas, and it is stated to be equal in value to the residuum of crude petroleum, known in the States as Pennsylvania gas oil, such oil could probably be used to enrich lignite gas. The German manufacturers also obtain paraffin wax from lignite tar, also the following:—

Solar oil is obtained by distillation of tar, and this oil is used for driving motors.

Putrol is a yellowish cleaning oil, used for cleaning greasy metal, for extracting and producing wagon grease.

Gas oil is a reddish brown oil used for producing oil gas.

Paraffin oil is used principally for driving Diesel motors.

Creosate oil for impregnating timber.

Peat, as far back as 1786, was converted into gas and coke and the tar more or less resembles lignite tar. Fifty years ago gas was made from peat in New England, New York and Jersey States, but the cost and quality of peat rendered the process unprofitable in these and other places.

There is, however, no known process by which lignite coke can be made into a coherent mass like gas-coke, metallurgical coke. As there are plenty of coals in the Eastern States which will produce good coke, very little attention has been paid to solving the lignite-coke problem.

In response to enquiries, the author has interested a number of people in different parts of Europe and America in this matter, and it is to be hoped that a process can be found whereby the raw lignite and lignite-coke can be made into serviceable fuel.

It will have been observed that low-temperature distillation of lignite promises to be the solution, and it may be advantageous at the point to outlive what the author considers the possible scheme.

The lignite should be partially distilled at low temperature, the gas to be either distributed for use in the district or in firing the furnace. The tar distilled to extract the paraffin and oils. The coke to be briquetted with some binder obtained from local products and waterproofed with paraffin, and made into a fuel which will equal any imported coal, and probably at a much less cost.

It will doubtless be recognized that whilst the information given to-night is limited, and necessarily supplementary to the report, which the author has prepared, it will require more time, funds and facilities to develop the enquiries and carry on experiments.

Lignite is out local fuel and it will manifestly be to the advantage of the community if fuller use can be made of it. If a central power plant is erected, its value will be circumscribed by the range to which it can be economically transmitted, and the increase in the consumption of lignite will be, say, 50 per cent.; but every farmer, householder and industry requires fuel, and the cheaper it can be supplied, so much the better. If, however, its quality can be improved for transportation and general use, then the demand will doubtless increase greatly, because it has the advantage over imported fuel, inasmuch as less freight has to be paid.

THE NEW CANADIAN PACIFIC LINERS.

Two new vessels for the Pacific service of the C.P.R. are now being completed at the Fairfield Works in England; the second, which was launched last week, is the eighth constructed by the Fairfield Company for the same owners. It will surprise no one who knows of the courage of the Canadian Pacific Railway, to learn that the new vessels will be by far the largest trading between the American continent and Japan and China, and, further, that they represent in their design the highest achievement in naval architecture, alike from the standpoints of safety, comfort, and economy. As regards the first, the water-tight bulkheads are more closely spaced than has hitherto been usual, so that four compartments can be opened to the sea without affecting the flotation of the ship. As to comfort, the 200 first-class, 100 second, and 800 third-class passengers to be carried are ensured every convenience which experience can suggest. As we hope later to illustrate the vessels, we need only here remark that one—namely, the Empress of Russia—is decorated in the Louis XV. and Louis XVI. styles, whilst the second, the Empress of Asia, is treated according to the Georgian period. The first-class cabins are all in a deck-house, 340 ft. long, on the bridge deck. Whilst the rooms are nominally for two persons, the arrangement is such that when one person is occupying a room, all evidence of the other berth is hidden, leaving only a single brass bedstead with the other stateroom furniture. In nearly every case each pair of cabins can be converted into a suite. The vessels are of 15,000 tons gross, the length being 590 ft., the beam 68 ft., and the depth 46 ft. A considerable amount of freight, particularly of the perishable type, can be carried. There is an innovation in connection with the form aft, as the vessels have been given a cruiser stern, which increases the water-line for a given over-all length and facilitates the propulsion, while adding to the available deck area aft. There is the further advantage that many of the lifeboats can be carried over the poop, and here it may be noted that boats are provided for the maximum number of passengers arranged for. The vessel is propelled by turbines, with the construction of which the Fairfield Company have had very large experience. A high degree of propulsive efficiency is thus sure to result.

THE RISE OF TEMPERATURE ASSOCIATED WITH THE MELTING OF ICEBERGS.

By Prof. H. T. Barnes, D.Sc., F.R.S., McGill University.

In a letter to Nature, published in the issue of December 1, 1910, I showed by means of microthermograms taken on a trip to Hudson's Straits that an iceberg melting in salt water produces a rise of temperature. The experiments were performed on the Canadian Government steamship "Stanley," and indicated that when approaching ice a rise of temperature occurred followed by a rapid fall of temperature a quarter of a mile abeam of the 'berg.

During the past summer I had an opportunity of examining in detail the temperature effects of icebergs. The Canadian Government placed its steamship "Montcalm" at my disposal for the tests, and three weeks were spent through the Straits of Belle Isle. Careful records were made of the temperature effects of icebergs and land. These tests have shown conclusively that it is the rise of temperature which is the direct action of the melting iceberg, and that when a fall of temperature is observed near ice it is due to the action of a colder current in which the iceberg is floating, and is not due to the cooling influence of the ice. Cooler currents may exist throughout the Arctic Current, whether accompanied by ice or not, but the presence of the ice causes a zone of warmer water to accumulate for a considerable distance about it.

The icebergs I studied in the Straits of Belle Isle and off the eastern end of the Straits in the Labrador Current showed no appreciable cooling, even within a few yards of them. The rise of temperature approaching an isolated 'berg was somewhat over two degrees Centigrade. In Fig. 1 I show the isothermal lines about a typical 'berg off the eastern end of the Straits of Belle Isle. This diagram was obtained by arranging a number of courses for the ship from all sides up to a radius of six miles.

As a good illustration of how icebergs and groups of icebergs affect the water temperature I show a microthermogram in Fig. 2, taken from the records made passing westward through the Straits of Belle Isle. In every case the approach to ice caused a rise of temperature.

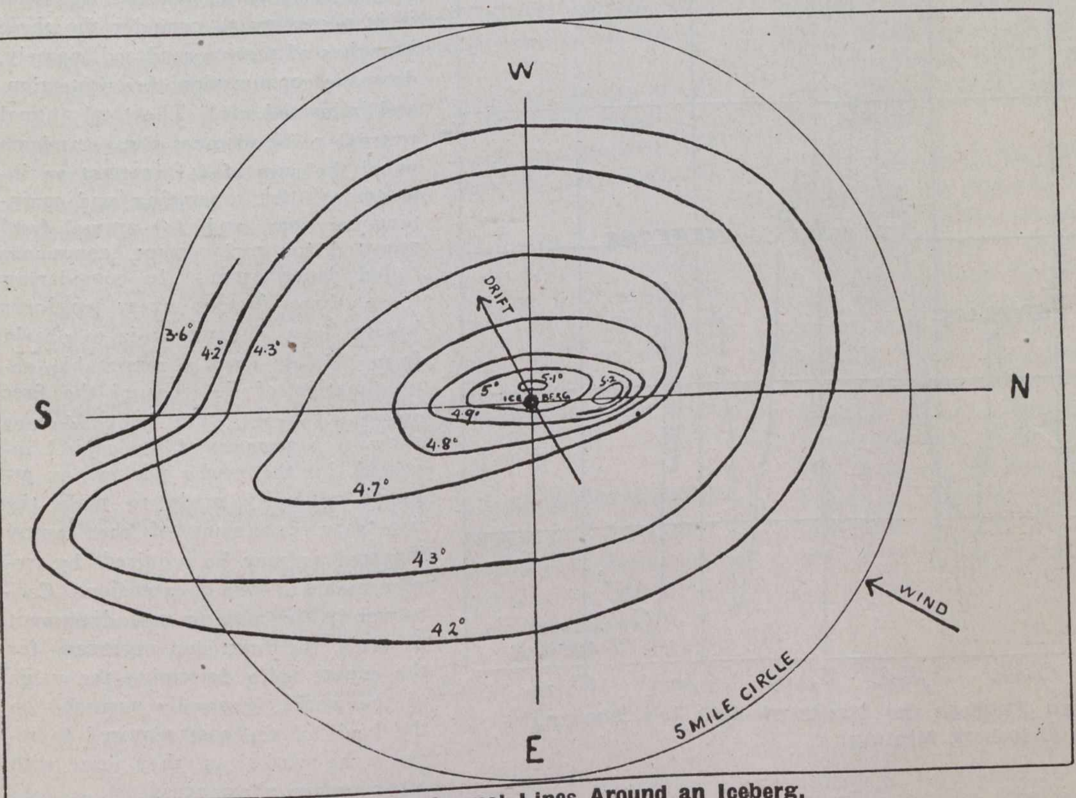


Fig. 1.—Isothermal Lines Around an Iceberg.

The explanation of this effect which I gave at my Friday evening discourse at the Royal Institution last May was founded on Pettersson's theory of ice melting in salt water. By this theory, which can easily be verified by a simple experiment, ice melting in salt water produces three currents: (1) A current of salt water cooled by the ice which sinks downward by gravity; (2) A current of warm salt water flowing towards the ice; and (3) A current of light fresh water from the ice rising and spreading out over the surface of the salt water.

I at first thought that it was this surface current of fresh water that influenced the microthermometer. The fringe of this lighter water would be warmer than the sea water on account of the action of the sun and scattered radiation, which is very strong at sea. The lighter water would retain the heat because it could not mix readily with the sea water. Near the iceberg I considered that a fall of temperature would result from the cooling influence of the surface current of fresher water.

My recent tests have shown, however, that an iceberg melts so slowly that no effect of the dilution can be detected, even right beside the berg. I took a number of samples of sea water at different distances from icebergs as well as samples taken far from ice. These samples I carefully bottled and brought home to the laboratory, where they were most accurately tested by the electric conductivity method in the Physico-Chemical Department by Dr. McIntosh and Mr. Otto Maass. No possible error could result in this way, and the tests, being carried out at a constant temperature under the most favorable circumstances, there is no reason to doubt their correctness. The comparison shows no dilution due to the icebergs, which goes to show how quickly the melted water from the 'berg is mixed with the sea water. Larger variations were found at different parts of the sea than were obtained in the proximity of ice.

It is evident that an iceberg in melting causes only two of the Pettersson currents, i.e., a cold current which sinks downward carrying with it all the melted ice water, and a horizontal surface current of sea water flowing in towards the ice to cause its melting. By this means we should expect the sea in the immediate proximity of icebergs to be warmer than further away, because the sea surface current is moving in towards the 'berg and does not share in the normal vertical circulation which tends to keep the sea surface temperature cooler.

The iceberg, in causing its own current of warmer water, provides for its own disintegration. Abundant evidence is at hand to show the melting process going on under the water line.

In my observations of icebergs I was greatly struck with the large amount of air dissolved in the ice. The white color of the 'berg is due to innumerable air bubbles in the ice, and not to snow on the surface. An iceberg is very deceptive in this way. While it looks quite soft, the ice is so hard

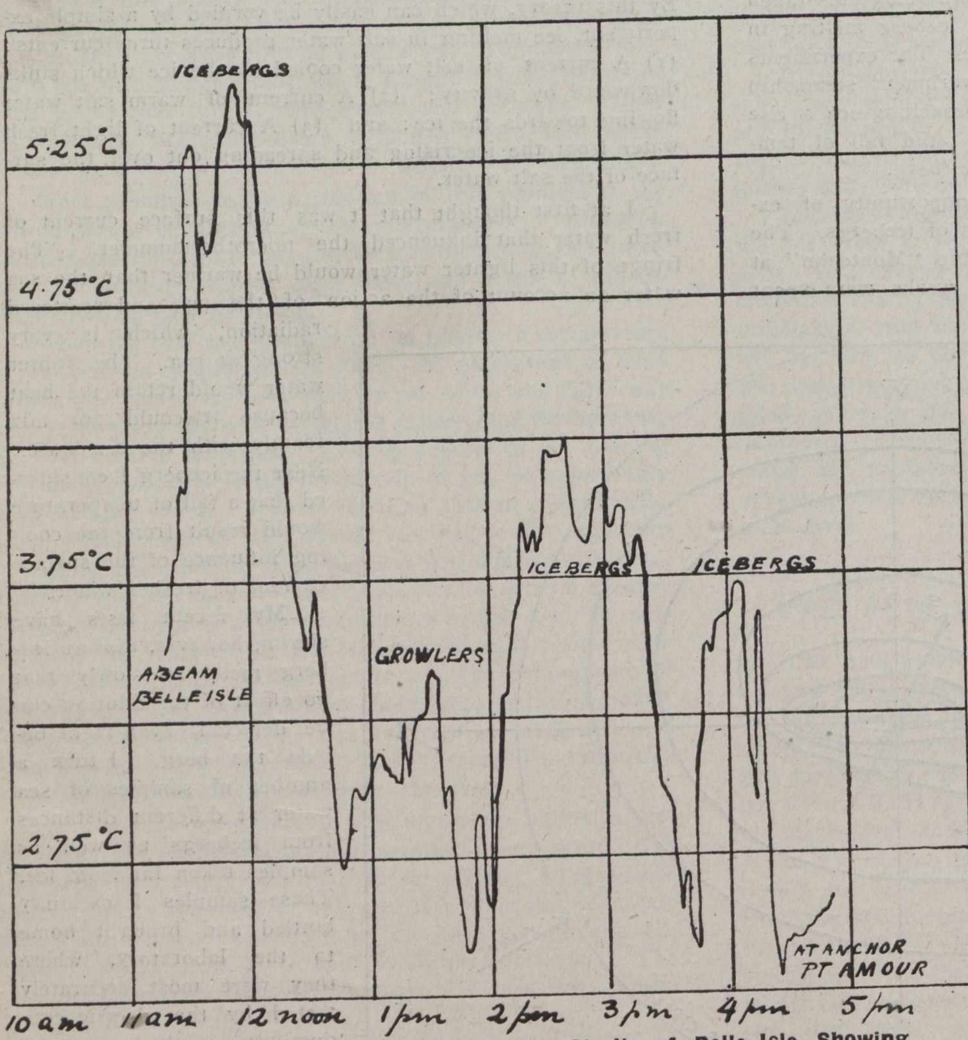


Fig. 2.—Microthermogram Taken Through the Straits of Belle Isle, Showing Effect of Iceberg Meeting.

as to make it difficult to chop it with an axe. Ice water which I prepared for drinking on board ship with iceberg ice appeared to effervesce like soda water, merely due to the liberation of the air from the melting ice. It is possible that the sudden disappearance of 'bergs with a loud report is due to their explosion from accumulated air in the interior. I passed close to one berg which was casting off small pieces, apparently by the pressure of the pent-up air.

While icebergs send the temperature of the sea up, land and coast line send it down. This was observed all along the coast in the Straits of Belle Isle. This effect is due to the action of land in turning up the colder under-water by the action of tides and currents. A great deal of work remains to be done in studying the effect of land and shoals on the temperature of the sea, but observations show the effect not only here, but on the Irish and English coasts.

From the point of view of the safety of our St. Lawrence route, the effect of land is most important. The iceberg causes us little worry because we have only a very short ice track, but to find means whereby the proximity of land can be determined is of the greatest importance.

WATER RATES.

The question of water rates comes under two heads, the engineering and the financial. The latter has probably been as productive of discussion as any single feature of waterworks operation. A few of the broader aspects of this subject particularly in the case of communities of 30,000 population or less were dealt with by Mr. Philip Burgess, consulting engineer of Columbus, Ohio, in a paper presented before the recent annual meeting of the Central States Waterworks Association. A summary of his remarks is given below.

In making an adjustment of the proper rates to be charged for water it is necessary to consider the three branches of service rendered, namely, domestic consumption, fire protection. and industrial use. The total annual revenue received must always at least equal the sum of (1) interest on investment, (2) operating and maintenance costs, and (3) annual fund required for replacement, commonly called depreciation. In considering these three factors every engineer knows how difficult it is to obtain from officials even a reasonable approximation of the cost of the first and third items. The books do not show a statement of the capital invested in the works nor is any attempt generally made to make the necessary corrections of the capital invested as may be required by replacements or even of extensions. Consequently, in making an adjustment of rates, the first step necessary for the expert is to determine the value of the works, generally assumed on the basis of the cost required to replace the works as they exist with other proper allowances.

In regard to the operating and maintenance costs, the former are comparatively easy to determine with accuracy. Maintenance, however, frequently is neglected or is charged to depreciation or replacement.

Waterworks and municipal officials may do a great deal of good towards the securing of equitable rates by seeing

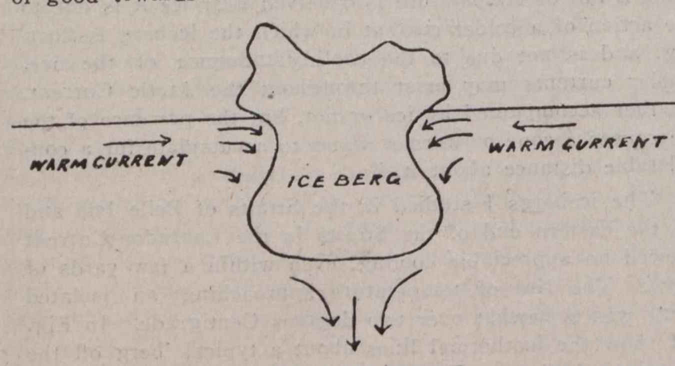


Fig. 3.—Currents due to Melting Ice in Salt Water.

that the books are properly kept. The financial condition of the works may well be made public so that the consumers may know whether or not the water rates are reasonable and fair.

In determining these rates it is understood that the total revenue is to be made up of that for domestic and industrial uses and for fire hydrants. The total amount received annually may be determined from the factors mentioned above, but the proper charge for individual service must always be determined by a very thorough study of local conditions by an expert.

In considering the matter of charges for fire hydrants and for other services directly of benefit to the community at large, it is now coming to be understood that the value of all such general services should be properly determined and charged for in all plants whether municipally or privately owned. In the case of a municipal plant, the charges for fire or hydrant and other public services should be met by a general tax levy in an amount equal to the value of the services rendered and the fund so received placed to the credit of the water department. The present more or less general policy of basing the charge for public service on so much per hydrant frequently results in poor service as well as poor compensation for the general public services rendered, and may place an unwarranted expense on the domestic consumers.

In the adjustment of rates for domestic service municipal officials may save much trouble for themselves and, perhaps, for the consumers by advocating and working for the installation of meters, which afford the only equitable basis for selling water.

The water served to a community must be of good quality. If it is thought desirable to correct a fallacious estimate of the cost of furnishing filtered water, as it is frequently stated that filtration of a public water supply necessitates rates at least 25 per cent. greater than would be required without filtration. The average cost of installation and operation of works, with and without purification, for a city of 30,000 population is shown.

Representative Waterworks Data for City of 30,000 Population.

	Without Purification.	With Purification.
Total cost of investment	$600,000	$675,000
Interest at 5 per cent.	30,000	33,750
Replacement at 2 per cent.	12,000	13,500
Probable cost of operation and maintenance	35,000	41,000
Total annual revenue required	$77,000	$88,000

These figures show that the total annual revenue must be approximately 15 per cent. greater with filtered water than without. It should be noted, however, that the operating costs are less than one-half the total annual cost and it is well known that a plant may supply water at less cost per million gallons up to its full capacity than is possible at less than full capacity. Consequently, a waterworks should aim to get all the business possible, and it is believed that a filter plant will always bring in more revenue than it will cost. In fact, experience shows that the filter plant frequently is the only salvation for the waterworks, because you cannot make people buy poor water at any price.

As evidence of this fact the following figures refer to the waterworks situation at Niles, Ohio, a city which last year constructed a filter plant, under the direction of the writer: Ownership, municipal; population served, 8,000; estimated value of works, $125,000; investment per capita, $15.63; miles of mains, 21; number of hydrants, 125; source of supply, Mahoning River, unfiltered; quality of water, very poor; lift of pumps, 200 ft.; number of consumers, 900; consumers per mile of main, 43; total annual income, $8,758; total annual expenses, $14,942, including interest, depreciation, operation and maintenace.

In the above statement it is of interest to note that the waterworks were not self-sustaining although the rates charged for service compare fairly well with those charged in the neighboring communities. Attention is called to the low number of consumers per mile of main, namely 43, or about one-half of what might reasonably be expected were the supply of good quality. It is believed that the installation of the filter plant, although increasing the annual cost, will result in placing the works on a sound financial standing, due to increased business.

As compared with the above, the following data relate to the waterworks at Warren, Ohio, where there is in use one of the oldest mechanical filter plants in the United States: Ownership, private; population served, 10,000; estimated value of works, $268,000; investment per capita, $26.80; miles of mains, 31; number of hydrants, 161; source of supply, Mahoning River, filtered; quality of water, excellent; lift of pumps, 150 ft.; number of consumers, 2,300; consumers per mile of main, 74; total annual income, $38,783; total annual expenses, $34,466, including interest, depreciation, operation and maintenance; rates charged for service, 6-room house, $6, 1 bath and 1 basin, $2.75, 1 closet, $2.50, total annual, $11.25; sprinkling 50 ft. and street, $5.00.

In comparing the situations at the two plants, it is of interest to note that the Warren water supply has been maintained of excellent quality for many years, and that consequently the water is in general use, resulting in an excellent financial standing for the plant. It should be added, however, that the annual income at Warren contains a hydrant rental of $6,675 and that no hydrant rental is credited to the plant at Niles. As previously stated, however, there is a growing appreciation of the fact that all water departments, whether private or municipal, should be credited with and funds placed to their account for all public services rendered. Even on this basis, the conditions at Niles clearly warranted and required the installation of the purification plant even from a purely business standpoint, and not considering the health of the consumers.

EXPERIMENTS WITH KEROSENE FUEL.

An investigation of kerosene fuel is being conducted by the Engineering Experimental Station at the Pennsylvania State College under the direction of Prof. J. A. Moyer, of the mechanical engineering department. With the increase in the price of gasoline has come the demand for some cheaper fuel that will give as good results. Kerosene would meet the demands if a satisfactory carburetor can be designed, and it is with a view of determining the merits and defects of various types of carburetors that the investigation is being carried on. The price of gasoline has nearly doubled in this country in the past year, while in England the price has risen to 50 cents a gallon for "motor spirit." Many of the writers in the trade journals in England advocate the use of a mixture of gasoline and kerosene, but point out that without an efficient carburetor no such mixture may be used. Professor Moyer, who has made numerous experiments on smoke washing and electrostatic treatment of smoke, has already installed at the college a motor built to utilize the energy from either of the two fuels mentioned which is suitable for use on farms and country estates. Experiments will also be made on various mixtures, and a carburetor valve will be designed to shift the fuel supply automatically from a small gasoline tank, used only for starting, to the main kerosene tank. These experiments should be of interest to manufacturers and users of gasoline motors throughout the country.

IMHOFF TANKS.*

By Henry N. Ogden.†

The Imhoff tank is said to throw down 95 per cent. of the "capable-of-settling" suspended solids, and the advocates of the tank explain that the term "capable-of-settling" refers to that proportion of suspended matters in the sewage which will settle out in a measuring glass when allowed to stand quiescent for two hours. If Mr. Fuller's estimate of the amount of colloidal matter in sewage not capable of settling is 30 per cent., then the remainder, 70 per cent., is that which remains as precipitable after the use of chemicals; and if the Imhoff tank will throw down 95 per cent. of this it means that, of the total suspended solids, it will remove 66.5 per cent. This should be compared with the 50 to 55 per cent. which is obtained from strictly domestic sewage, and it is probably correct to say that the increased efficiency of the Imhoff tank due to the separation of the rising gas increases the deposit of solids from 10 to 15 per cent.

The second principle of the Imhoff tank is its remarkable performance in taking care of the sludge. Three reasons are assigned for this. In the first place, below the settling tank proper there is provided a large compartment in which the sludge is allowed to remain three to six months, during which time decomposition proceeds and effectively destroys the organic matter so that when finally the sludge is removed it is odorless and much reduced in quantity.

Perhaps no single element has worked more against a greater use of the septic tank than the fact that during the septic process offensive gases are given off. It is to the elimination of these odors that the energies of the inventor of the Imhoff tank were directed, and for this purpose he provides a separate tank for disintegration of solids, but he carries on that disintegration without producing odors. His second point, therefore, was that there must be through the sludge compartment no moving or renewed fresh sewage. The construction of the tank seems to solve this problem.

In the septic tanks the liquid sewage and the deposited sludge undergo decomposition together, while in the Imhoff tank all supernatant liquid passes through the tank so rapidly that no septic action is obtained, although in the sludge underneath a very high degree of septicization may be going on. It is said, therefore, that the organic matter in solution, either true or colloidal, is that part of any decomposition that is responsible for offensive gases, and that the deposited solids not subjected to renewed application of fresh sewage do not in their decomposition become offensive. This may explain why the Travis tank smells and the Imhoff tank does not.

The third point which seems to be fundamental in the design is that the deposited solids shall be overlaid with 25 or 30 ft. of liquid. Shallow tanks do not seem to be as effective as deep ones and the reason assigned for this is that the gases of decomposition which are produced in the lower strata must, on account of the high pressure, accumulate in greater volume and in their escape produce a greater separation of the sludge particles than in shallow tanks. It is to this action of the gases in the lower layers of the sludge deposits that Dr. Imhoff ascribes the marked porous condition of the sludge which gives it its rapid drying properties after being taken from the tank. The decomposition which goes on at the bottom of the Imhoff tank also gasifies and liquefies a large proportion of the solids originally deposited.

Based on experiments of Dr. Spilner and Mr. Blunk, chemist and engineer respectively for the Emscher Association, the fresh sludge deposited in the lower compartment contains, on an average, 95 per cent. of water. After remaining several weeks or months in the septic chamber it will contain only 75 per cent. of water, and about one-third of the original organic matter will have been either gasified or liquefied. Through these two agencies an original volume of 100 cu. yd. of fresh sludge will be reduced, according to their experiments and figures, to a volume of 16 cu. yd., a shrinkage in volume of about 84 per cent. They assert that through septic action only an original 5 cu. yd. of dry sludge matter will be reduced to 3.92 cu. yd., a reduction of 22 per cent. The largest part, therefore, of the reduced volume is gained by the loss in water, this being pressed out on account of the great depth of tank, or indirectly by the greater pressure of entrained gas.

Instead of being compact, non-porous and in texture much like asphalt or rubber, the Imhoff sludge is so porous that the contained water disappears readily, drying out so that it can be spaded in about five days and is thereby still further reduced in volume so that its volume is about 40 per cent. less than when emptied from the tank.

Since sewage disposal plants are generally built on the lowest ground where foundation soil is the poorest and where the ground saturation is most complete, it is inevitable that the cost of tanks 30 ft. down will be high. Wisner estimates the Imhoff tank to cost twice that of shallow tanks for the same volume of sewage, although the actual volume of the Imhoff tank is perhaps only one-fourth that of ordinary tanks in volume, but the storage compartment for sludge underneath is so great that the total volume of the tank is nearly that of an ordinary settling tank. Apparently the practice of Dr. Imhoff is to make the upper compartment large enough to hold about two hours' flow and to make the lower one twice this size. This makes the Imhoff tank large enough to hold about six hours' sewage flow, which is about the capacity of the more recently built septic tank.

The cost of the Imhoff tanks is higher even with smaller capacity because of higher unit prices in both excavation and masonry linings. The question, therefore, resolves itself into this: Is the greater sedimentation, the freedom from odor at the plant and the vastly reduced labor of disposing of the sludge sufficient justification for an increased cost of construction of the tank and for the patent fee which the inventor very properly claims? It has been said that there is no opportunity for equalizing the variable flow in so small a tank and that for best results a large sedimentation tank ought to precede the Imhoff tank action. But with every criticism considered, and with full appreciation of the difficulties of the deep tank construction, the boon of an odorless sewage disposal plant is so great and the elimination of the sludge problem so gratefully appreciated, that its rapid installation in this country cannot but follow its European successes.

* Abstract of paper delivered before American Society of Municipal Improvements, November 12-15.

† Professor of Sanitary Engineering, Cornell University.

STREET RAILWAY FOR PRINCE ALBERT.

An estimate of the probable cost of a street railway at Prince Albert, Saskatchewan, consisting of eight miles of track and eight or ten cars to start, has been submitted to the civic authorities by Mr. J. S. Townsend, of the Messrs. Stone and Webster Engineering Company of Boston, placing the figure at $275,000.

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ESTABLISHED 1893.

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CONTENTS OF THIS ISSUE.

SEWAGE DISPOSAL IN ALBERTA.

In our issue of August 4th, 1910, we published a copy of a resolution passed by the Provincial Board of Health of Alberta calling upon municipalities to delay any contemplated sewage disposal undertakings until the Government had completed a plant, demonstrating what is purported to be a new system of sewage disposal, invented and patented by the engineer to the Board of Health under the name of "The Live Earth Bed System." In a further issue of September 1st, 1910, we published a description of the system, together with drawings, and also in an editorial called attention to the fact that the system was not new, but was apparently an adaptation of "Dibden's Slate Bed System," in vogue at several places in Great Britain for the treatment and digestion of the solids in sewage.

"The Live Earth Bed System" has been adopted by the Alberta Government in connection with the drainage of Ponoka Asylum. The system has created no little interest in the Province, especially as it has had the strong backing of the Provincial Board of Health. We have been informed on several occasions that engineers have had difficulty in getting plans passed by this authority unless such plans are in line with this system.

It is a somewhat unique position for any central authority having control over stream pollution to dictate or attempt to dictate as to the particular method of sewage disposal to be adopted by municipalities. We have always understood that expert authority is inclined to agree that there is no one system of sewage treatment which will meet all local conditions, and that it is only after a study of the particular conditions appertaining to a district that it is possible to define the system which will give the required efficiency. This is not, however, the policy of the Provincial Board of Health of Alberta, as is evident by the following letter, signed by R. B. Owens, the advising engineer to the Board. The town of Macleod, Alberta, having determined to treat its sewage before discharging into the river which eventually forms the water supply to Lethbridge, etc., further down stream, addressed a letter to the Provincial Board of Health, asking if the government had yet come to any conclusion with reference to "The Live Earth System."

This is the reply which the Provincial Board sent on:—

[Copy.]
Dated March 15th, 1912.

G. H. Altham, Esq., City Engineer, Macleod, Alta.:

Sir,—I am in receipt of your letter of the 11th inst.

The Provincial Board of Health are very well pleased with the showing made by the Live Earth Bed system installed at the Ponoka Asylum. The latest report, dated March 7th, from the general building foreman on the Ponoka Asylum works is as follows:—

"The amount of solids now distributed over the face of the slates is about fifty per cent. less than it was the first of December. This alone shows an increase in efficiency of more than 100 per cent. now in comparison with the same time two months ago.

"The temperature in the building has been very even, never ranging over ten degrees of a variation during the winter. Our lowest inside temperature was 36 and our highest 46, while the outside has ranged from 47 below zero to 46 above zero. There is always two degrees difference between the inlet and outlet of the tank."

This system can be constructed for much less than any other; it can be operated for less than any other; every other system will freeze solid in winter in the filter portion; it is the only system odorless in its operation; it fulfils the requirements of the Provincial Board of Health, and the certificate that it can be constructed, operated and carried out without injury or danger to the public health will be granted to those installing it. The sterilization process used in connection with it ensures the total destruction of pathogenic organisms. There is practically no sludge, which is practically the whole of the solids in sewage, to be pumped out and removed, a filthy and costly job, as is the case in others such as, say, the proposed Lethbridge plant. What more could you wish?

The proposed Lethbridge plant, on an old, out-of-date system, is to cost $63,522, and is supposed to give an effluent free from pathogenic organisms, but it will certainly leave practically the whole of the solids to be dealt with by pumping out and drying in the atmosphere, thus creating a serious menace to health, whereas my system could be installed in Lethbridge for less than $40,000, and would give an effluent free from pathogenic organisms and would leave practically no sludge to be dealt with.

I unhesitatingly recommend the Live Earth Bed System for Macleod.

Messrs. Dutcher, Maxwell & Co., Civil Engineers, who are now installing a sewage disposal plant, etc., in Camrose, are making a speciality of sewage disposal, and should you feel that you would like a firm of consulting engineers to help you out in this work, you communicate with them. Their address is Camrose.

I am, Sir,

Your obedient servant,

(Signed) R. B. Owens.

From the above letter it would appear that the Provincial Board of Health of Alberta has come to the definite conclusion that the "Live Earth Bed System" of sewage disposal is the only one on earth which deserves any consideration, and is, further, the only system which warrants a certificate from the Board that it can be constructed, operated and carried out without injury or danger to the public health. This Board of Health appears to have finally solved the much-discussed sewage disposal problem upon the strength of a single experiment made at Ponoka Asylum, and apparently upon the report of the general foreman, dated March 7th, 1912.

We know that up to March 15th, this year, no chemical or bacteriological examination of the effluent from the Ponoka Asylum had been made by the Provincial bacteriologist attached to the Board of Health.

We know that even up to May 23rd, this year, an examination of two samples of the treated and untreated sewage at Ponoka Asylum showed results for removal of solids as follows: Sample No. 1—Untreated sewage, 603 parts per million of suspended matter; treated sewage, 570 parts. Sample No. 2—Untreated sewage, 500 parts per million of suspended matter; treated sewage, 448 parts per million.

It will be noted, however, that the remarkable letter to Macleod above quoted is signed on behalf of the Board of Health by the patentee and inventor of this system.

Two independent examinations and reports have been made with reference to the Ponoka Asylum plant, one by Mr. Child, the late City Engineer of Calgary, dated April 17th, 1912, and another by Mr. T. Aird Murray on behalf of the Bureau of Public Health, Saskatchewan Government. These reports, published in this issue, will be read with interest, and generally bear out the remarks and criticism which *The Canadian Engineer* thought fit to make in the 1910 issues referred to.

TORONTO AND HER SIX MILLION DOLLAR WATER BY-LAW.

A by-law for the provision of $6,000,000 for an additional water supply for Toronto is one of the items to be voted on by the citizens on the first of January. The Board of Commissioners, who reported a few months ago on Toronto's water supply, emphasized the necessity of an additional and alternative supply to the present system now operating on the Island.

The plans, as outlined by the Commission, for which funds are now being asked, contemplate the establishment of the duplicate system on the heights at Scarboro, about twelve miles east of the Island plant.

The Scarboro plant, if installed, will cost about five and one-half million dollars, and will give an additional capacity of sixty million gallons per day.

The city is voting at the same time, on money by-laws for other purposes, with a total of six million dollars. The present state of the money market is such that the prospects for floating twelve millions of bonds this coming year are rather dubious.

Before the citizens are asked to provide the money for this duplicate system, they must be assured that the very best location has been picked for the plant, and that adequate returns in the way of an abundant supply of pure water at the lowest possible cost will be secured.

Is the report of the Commission, recommending the location of the new plant at Scarboro, the solution of the problem? Are the public satisfied that the conclusions of the experts as outlined in their reports, are justified? In next week's issue we hope to deal with some features of the report which have been overlooked.

SPELLERIZED PIPE.

Spellerized pipe has been on the market for some time, but no explanation has heretofore been offered as to what the process consisted in. The method is now explained by the National Tube Co. as follows: Spellerizing consists in subjecting the heated bloom to the action of rolls having regularly shaped projections on their working surface, then subjecting the bloom while still hot to the action of smooth-faced rolls, and repeating the operation, thereby working the surface of the metal to a uniformly dense texture, adapted to resist corrosion, especially pitting.

This process is, of course, of most service on 4-in. pipe, or smaller, because of the thin walls. The larger sizes, because of their thickness, do not require so much extra work of this character.

REPORT OF MR. CHILD, CITY ENGINEER, AND DEPUTATION OF CITY COUNCIL AFTER VISIT TO SEWAGE WORKS AT PONOKA

COPY.

Dated Calgary, April 17th, 1912.

City Commissioners,
Calgary.

Gentlemen,—Re the live earth system recommended by R. B. Owens, B.A., sanitary engineer for the province of Alberta.

This system of dealing with sewage appears to be adapted entirely to the retention and decomposition of the solid matter in sewage and takes no cognizance of the purification of the sewage liquid.

The system consists of a series of tanks, generally three in number, as illustrated by a plan submitted by Mr. Owens. The first two tanks are simply rectangular receptacles filled with layers of concrete slabs. The third tank is a rectangular receptacle for holding the liquid sewage after it has passed through the first two tanks. In the last tank provision is made for disinfecting the liquid sewage by means of the addition of chlorine.

The theory upon which the first two tanks is based is apparently the well-known attraction of matter to matter, and it is held that the concrete slabs attract the solids from the sewage which settles on the surface of the slabs and then gradually undergoes putrefaction until it becomes like ordinary earth. The essential difference between these tanks and ordinary sedimentation tanks exists in the adoption of the concrete slabs producing a greater surface area on to which the solids may settle. I understand that the system has been put forward in England by Mr. Dibden, who uses layers of slate instead of concrete slabs, and that in 1902 the Massachusetts State Board of Health carried out several exhaustive experiments with tanks similarly constructed filled with layers of slate about a half inch apart. Quoting from the State Board of Health, I find as follows: "The effluent was never of good quality. During May and June anaerobic conditions were noted and later became strongly marked and the experiment was discontinued. The filter lost open space rapidly and showed signs of choking." Mr. Owens claims that the action is aerobic and not anaerobic.

It is generally reported in England that the system has gained no ground, as the beds invariably choke and are difficult to flush or clean. The system of sludge removal, as now being adopted, appears to be based upon an entirely different process from that which is adopted in the concrete or slate bed systems. It appears to be recognized in all the newer forms of tank that the chief aim should be the immediate removal of the putrefying sludge from contact with the flowing sewage. This is exemplified in such forms of tanks as the Emscher or Imhoff types, the Traver's tanks and the forms as adopted at Lethbridge. With the slab system the liquid sewage must pass over the surface of the decomposing sludge and in this way much of the finer matter in recollected and the products of decomposition such as the sulphides, etc., are carried away with the liquid. Thus there is produced a septic effluent which it is acknowledged is most difficult to purify or disinfect. In fact, there is little essential difference between this form of tank and the old septic tank. It is simply a septic tank filled with concrete slabs. Mr. Owens claims that the tanks are essentially contact beds, and this form of tank has been shown to be simply a septic tank when it stands full of sewage and the air driven out.

Apart from the question as to whether the tanks are based upon a good working principle or otherwise, they are not suited to conditions at Calgary. Gravel here of any size and quantity is available for filtering purposes, and would be out of the question to substitute for gravel expensive concrete slabs, of which an enormous quantity would be required.

While the system may be suitable for some small installation it certainly does not lend itself to any large plant where extensive contact beds would be required.

One of the main difficulties in connection with the system appears to be the difficulty of removal of the settled sludge between the concrete slabs. While this may be possible in a small tank, it appears almost impossible in any large tank consisting of a huge body of such slabs. The slabs, once being put into position, it would be most expensive to remove them and reset them, and it does not appear possible that any working principle of flushing can be adopted for a large area.

All the newer systems of sewage disposal with which I am acquainted appear to aim at the immediate and automatic removal of sludge by means of slow velocities and secondary sludge storage receptacles, into which the precipitated sludge at once gravitates.

Another and very vital objection is the amount of fall requisite. Mr. Owens' plans show 15 feet. The tanks as proposed at Lethbridge for the removal of solids require only 1 foot, the difference between inlet and outlet weirs.

From personal observations obtained whilst visiting the Ponoko asylum sewage disposal works, one is able to deduce the following: The works, according to Mr. Owens' own statement, is overtaxed four times its capabilities, that is to say, instead of 300 people accommodated these works would be overtaxed with anything over 75 persons. The cost of the system was $6,236.10. Proportioning this to a city of 75,000 the cost would be $6,236,000.

The noticeable features in connection with the Ponoka system are, that an objectionable odor is very apparent, caused by putrefactive process in connection with the sludge retained on the slabs, and that the effluent is far from clear. The discharge is into an open ditch extending some 300 yards, and depositing onto a ploughed field. The bottom and sides of this trench are lined with slime and the effluent itself has a distinct odor. This, no doubt, is accountable to the system being overtaxed, still, without filtration as a final treatment before discharging into our rivers, there are grave doubts as to the health authorities allowing this city to adopt a system of this nature without filters, which, after all, are the essential points of sewage disposal works.

Respectfully submitted,

[Signed] J. T. CHILD,
City Engineer.

REPORT UPON PONOKA ASYLUM PLANT BY T. AIRD MURRAY TO THE BUREAU OF PUBLIC HEALTH, SASKATCHEWAN

July 26th, 1912.

Dr. M. M. Seymour,
Commissioner of Health,
Regina, Sask.

Dear Sir,—You informed me on the 19th of April last that you had received enquiries as to whether you would accept, as satisfactory, proposals to install schemes of sewage disposal within your provincial jurisdiction of Saskatchewan similar in principle to a scheme recently installed under the auspices of the Provincial Board of Health of Alberta in connection with the government asylum at Ponoka. I informed you that I had no personal actual knowledge of this plant, but that I had seen plans and a description of it, but had not seen any data referring to its working efficiency.

You commissioned me to proceed to Alberta, visit the plant at Ponoka asylum and confer, if possible, with the authorities of the Provincial Board of Health with reference to this matter and report direct to you upon this plant.

I inspected the plant in question on the 22nd of April, and interviewed the provincial bacteriologist at Edmonton on the 23rd.

I took two samples of the sewage, one representing the raw sewage influent as it entered the works, and the other representing the sewage effluent as it left the works after treatment. These samples I divided, leaving a portion of each with the provincial bacteriologist, and the other two portions I had sent direct to my analyst in Toronto. I considered this a proper course to pursue, as I take it, that more accurate results would be obtained by immediate analysis at Edmonton than I could obtain after sending samples over so long a distance occupying the considerable period of time between sending off from Edmonton and arrival at Toronto. The provincial bacteriologist promised to examine the samples left with him and report to me the nature of the results obtained. He has done so, and a copy of his results are appended.

The System of Sewage Disposal as Installed at Ponoka Asylum.

I met at Ponoka the foreman in charge of the works, who kindly went over them with me and freely gave me all the information which he could. It appears that the system of disposal has only been in vogue for about 10 months; it treats of the sewage, which is purely domestic, from the asylum, representing about 300 people, with a normal discharge of about 24,000 gallons per 24 hours, or 80 gallons per head per day.

The location of the disposal works is a considerable distance from the Asylum buildings, and is upon falling ground forming an ideal site for treatment of sewage upon the modern biological methods, there being ample fall. The character of the site presents ideal conditions which are not often met with in the prairies, as the main difficulty is, generally, lack of fall.

The plant consists of duplicate primary contact beds, each with a capacity of 1,000 gallons, rectangular in shape, 19 feet 9½ inches x 11 feet 11½ x 3 feet deep, and one secondary settling tank of 1,000 gallons capacity. The sewage first enters the primary tanks and is held there for a period of about 4 hours, when a valve is operated and the sewage allowed to flow into a channel pit and then into the secondary or final settling tank. From the latter tank the effluent discharges into an open channel and terminates in a hollow forming a small slough, from which it appears to percolate and evaporate. The soil is sandy and very friable, and will probably continue to absorb sewage effluent for some considerable time.

Laid longitudinally in the entrance channel to the secondary tank is a perforated zinc pipe which is periodically filled with chloride of lime, the object of this is, that the flowing sewage may absorb chlorine from the lime and be disinfected.

The whole of the works are extremely simple and compact and are housed in a roofed building.

The cost of installation was reputed to be $6,236.10, and the intended capacity designed for 300 persons, representing a sewage discharge of 24,000 gallons per day. The plant has, however, been found to be too small and incapable of producing satisfactory results, and work was in progress for doubling the capacity of the system and building similar tanks alongside the present ones.

The chief feature in connection with this plant is the adoption of what is called in England "Dibden's Slate Bed System"; the only difference being that instead of slates, concrete slabs are used. The concrete slabs are laid in the tanks in layers. Each slab is 24 inches x 12 inches with square openings 8 inches x 6 inches in each slab. Concrete rests are placed between each layer to keep the slabs apart. In the primary tanks the slabs are 4 inches apart, and in the secondary tank 2½ inches apart.

I understand that the system has been patented in Canada by the sanitary engineer to the Alberta Provincial Board of Health, under the name of "The Live Earth Bed System."

I have read certain descriptions and explanations of the working of the plant sent out by the Alberta Provincial Board of Health, and it is claimed chiefly that the presence of the slabs in the tanks will effect the retention and collection of the solids contained in the sewage, which will be transformed into some substance resembling live earth, because of the great number of worms and other living organisms which will be germinated in the retained solids. It is claimed that these organisms have the faculty of turning the solids into an inoffensive material and that the sludge difficulty is thus obviated. I suspect that what is really meant is that the sludge undergoes very rapid decomposition and is charged into a humus state resembling the thoroughly septicized material resulting from a septic tank or tanks of the Emscher design, where decomposition of the sludge is aimed at.

I was informed that no analyses of the effluent had been made up to the date of my visit, and no actual data existed as to the results, but that it was acknowledged that the capacity was too small for the amount of sewage under treatment.

On entering the building in which the tanks are located, the odor peculiar to septic tanks, when covered in, was at once apparent. In the primary tanks the top slabs, which only were visible, were well covered with sewage solids. The secondary tanks presented a sewage which appeared to be highly charged with solids also. The ditch leading away from the tanks was very black with sewage solids and slime, and the slough at the terminus of the ditch was simply a lagoon of sewage solids. For all practical purposes the tanks did not appear to be doing anything more than might be expected from an ordinary septic tank and the effluent had all the appearance of an ordinary septic tank effluent. Owing to the lack of any collected data relating to periodic examination of the raw sewage and effluent, nothing more can be said as to efficiency in this particular instance, except that the samples which I personally took showed distinct signs of septic action, but that owing to distance of travel they were of little value for basing conclusions.

With Reference to the System in General.

The system is termed by the Alberta Provincial Board of Health to be essentially one of contact beds, with laminated concrete slabs in lieu of ordinary filtering material. The action of filling the beds and retaining them full of sewage for a period of time excludes all oxygen, and tends to rob the sewage of any dissolved oxygen it may originally contain. The action is essentially septic and not one of oxidation as with the percolating filters, where air is always present. It is universally acknowledged that the percolating system has decided advantages over the contact system, see Dunbar's "Principles of Sewage Disposal," fifth report of the British Royal Commission on sewage disposal and recent research work of the Lawrence Experiment Station, Mass.

The tanks may be described as merely septic tanks with the exception that they are periodically emptied, when oxidation may take place in connection with the matters retained on the slabs. The object of the system cannot be to obtain a non-putrescible liquid effluent, as such cannot be done without oxidation.

I do not consider that there is any efficient or economic reason for the use of the slabs, which add a very great expense to the tanks, and must in the case of large installations make it difficult to clean out the tanks. I believe that just as satisfactory results are obtained by such tanks as the septic tanks at Moose Jaw and Indian Head which are being superseded by more modern methods. The method of disinfecting the sewage by means of a pipe filled with chloride of lime and laid in the flowing sewage is too crude and so obviously inefficient, that it is not necessary to remark further with regard to this unless to say that I was informed that the pipe was freshly charged with the lime once a week, and it is apparent that the whole of the disinfecting efficiency of the lime must be lost almost immediately it came into contact with the sewage liquid. Except for about one half-hour during the week this disinfecting process must be valueless.

Assuming the present installation to be sufficient for 300 people (it is acknowledged that it is not) then the cost per head for sewage treatment is over $20. At the same proportion the cost for 4,000 population would be $80,000; and for 10,000 population $200,000. As the system requires doubling in capacity it really works out at $40 per head. Efficient sewage disposal consisting of removal of solids, putrescibility and disinfection should not exceed $5 per head unless under very exceptional circumstances. It may be pointed out that small installations cost more per head than large ones, at the same time with the ideal situation as presented at Ponoka, it is safe to estimate that an efficient system of sewage disposal could have been installed at a cost of under $3,000. In fact, the Northumberland and Durham Counties have a system of sewage disposal in vogue consisting of sedimentation, sprinkling filters, and slow sand filtration for removal of bacteria for a similar institution at a cost of less than $2,000.

I may conclude by stating that I cannot recommend the system as an efficient one from what I saw at Ponoka or from what one would naturally expect as results from such a system. It does appear apparent that the system even as one for the treatment of solids is not in accordance with modern recognized sedimentation tanks. The principle which is being adopted very generally in connection with sedimentation tanks and removal of solids is to separate immediately precipitated solids from all contact with flowing sewage, so that the flowing sewage may not come into contact with solids which are undergoing decomposition. The opposite of this principle is attained by the Ponoka plant.

Allow me to sum up what I consider the various points of objection to the "Live Earth System" as inspected at Ponoka Asylum:

(a.) That it is only a system for removal of solids and not for treatment or putrification of the liquid sewage.

(b.) That the liquid sewage is certain to be putrescible and septic in character owing to, 1st, no oxidation, and, 2nd, contact with the decomposing sludge.

(c.) That even if a large proportion of the solids are retained by use of slabs inserted in the tanks, that there are other less expensive methods of retaining a sufficient proportion of the solids to allow of the remaining liquid sewage being efficiently dealt with by means of oxidizing filters.

(d.) That even if the retained sludge undergoes decomposition so that it resembles earth of humus, that there are other methods more simple and less expensive of obtaining similar results (as per experiments at Chicago and elsewhere).

(e.) That the system does not lend itself to efficient disinfection, and that disinfection is more efficient and less expensive when an oxidized effluent is obtained.

(f.) That similar systems have been tried and experimented with by the Massachusetts Board of Health and others and have failed in results.

(g.) That a similar system has been tried in Great Britain, but that recent reports are not of a favorable nature unless with very small installations, and that such systems in Great Britain do not pretend to do anything more than treat with the solids contained in the sewage and are not for the final purification of sewage.

(h.) That the cost, owing to the provision of the slabs, causes the system to be prohibitive.

(i.) That the great amount of fall required by the depth of the primary and secondary tanks would in most localities prohibit its use unless the sewage was pumped.

Your obedient servant,

(Signed) T. AIRD MURRAY,
Consulting Engineer.

* * * *

COPY.

May 23rd, 1912.

Mr. T. Aird Murray,
Consulting Municipal & Sanitary Engineer,
303 Lumsden Building, Toronto, Ont.

Dear Sir,—I have yours of the 17th inst., and am glad to furnish you with the results shown by the two samples of sewage which you left with me.

Estimation of the suspended matter gave the following:

No. I. (Influent).

Unfiltered	603 parts per million.
Filtered	570 parts per million.
Difference	103 parts per million.

No. II. (Effluent).

Unfiltered	500 parts per million.
Filtered	448 parts per million.
Difference	52 parts per million.

As the capacity of the beds at Ponoka is, I understand, being greatly exceeded by the daily amount of sewage the above figures cannot be regarded as a test of the work of this type of bed in the removal of suspended matter put through them. This deficiency, however, I believe is being made good by adding more beds.

I shall be very pleased to have the promised copy of your report.

Yours very sincerely,

(Signed) D. G. REVELL.

CANADIAN NORTHERN MAKES OFFER TO LONDON.

Judge Phippen, Colonel Davidson, and Engineer McCrea, representing the Canadian Northern Railway, have made a definite offer in regard to the leasing of the London and Port Stanley road, which is owned by the city.

They offer to lease the road for 99 years at $20,000 a year for the first ten years, and $25,000 a year for the balance of the time. They agree to run a line of steamers to Port Stanley, and make London a divisional point, with shops that will employ from 150 to 250 men. They promise also to place London on their main line.

Michigan Central Railway and Pere Marquette will be given running rights over the system and summer excursions to Port Stanley.

CONSTRUCTION OF CONCRETE-LINED WATER TUNNEL.

The municipal aqueduct tunnel for the city of Santa Barbara through the Santa Ynez mountain range in California is nearing completion. The tunneling, now practically completed, involved many difficulties in the form of poor rock and large inflows of both water and inflammable gas. The tunnel construction was begun under contract and abandoned when about half finished. The following account of how the work then was taken up by the city directly and carried to a successful conclusion under force-account methods is from a paper presented recently before the League of California Municipalities by Mr. Lee M. Hyde, supervising engineer.

The peculiar topographic conditions surrounding Santa Barbara have presented difficult barriers to water development and have demanded expensive and drastic treatment for solution. Paralleling the coast for a distance of 75 miles is the Santa Ynez range of mountains, leaving between it and the ocean a narrow strip of tillable lands. This range at the crest has an average height of from 3,500 to 4,000 ft. elevation, but on account of the steep slope southward affords a very small area of watershed. The creeks are in consequence short, having very little summer flow and on account of their severe grades prohibit reservoirs for impounding winter flood waters.

However, the early water supply was gained by diverting water from two creeks north of the city and later by driving a tunnel 5,000 ft. deep into the Santa Ynez range. This first tunnel is located about 4 miles west of the tunnel now under construction and was projected merely for the purpose of developing water in the Santa Ynez mountains. During construction the constant tapping of new water strata maintained a very good flow, but as soon as work ceased the saturative power of the formation was reduced to a small normal output which would soon be insufficient to meet the city's needs. Moreover, the lowering of the water plane in the mountain depleted the surface flow and the city was soon confronted with legal complications brought by riparian owners on the creeks affected.

It was at this time that public officials, realizing that the city's growth was being jeopardized by an insufficient water supply, called into consultation Mr. J. B. Lippincott, of Los Angeles, who has since been consulting engineer on Santa Barbara's water supply. The result of Mr. Lippicott's investigation was the acquiring of two reservoir sites in the upper Santa Ynez River basin below a water-shed of 210 square miles, the rights of way for a tunnel through the Santa Ynez mountains and the purchasing of power plant locations immediately north of the city.

The city immediately prepared for the construction of the tunnel 19,560 ft. in length, and contracts were let in accordance with the provisions of the city charter. The contractors drove a little less than 50 per cent. of the tunnel and were then forced to relinquish their contracts by the city Water Commissioners and Council. Their inability to prosecute the work properly, Mr. Hyde states, was partially the result of adverse conditions of formation, gas and water encountered, which had not been given sufficient weight in preparing their estimates, but for the most part was the direct result of inefficient equipment. For economical and rapid progress there must exist a high state of organization, both as to equipment and labor forces, and to this end the best of mechanical appliances should be purchased and duplicate plants installed, to eliminate delays from breakdowns of machinery. Such delays are expensive and have a discouraging effect on the workmen. To secure and retain the most energetic and skilled workman the camp should provide clean boarding houses, comfortable and sanitary quarters and good change rooms.

The city after taking over the work was occupied for some time in the installation of equipment, both surface and underground, and also in remodeling and adding to the camp quarters. On the north portion of the tunnel poor ventilation had resulted in a fungus growth vigorously attacking the timbers, causing dry rot, and it was necessary to line immediately with concrete about 2,600 ft. The timbers, in a great many places where heavy ground was being supported, were dangerously weak, and great care was necessary to protect the workmen as well as the tunnel. In certain portions, smaller sets, reinforced by sprags, were put in and the weakened 8 x 8-in. sets removed. In many places it was also necessary to centre post the caps. Under ordinary conditions the original lagging was not removed, although there were places where the fungus had caused such a severe rot that the ground had broken through. In these places the lagging was replaced and such additional timbering done as was necessary to withstand the ground weight during concreting.

The tunnel section is 6 ft. wide at the bottom, 4 ft. 6 in. wide at the top and 7 ft. high in the clear. The concrete forms, therefore, required a design occupying as little space as possible. The forms consisted of steel ribs placed on 5-ft. centres which supported 2-in. lagging. These ribs were made of 5-in. channel steel with 1½-in. web and were bent to conform with the tunnel section, being cut in two in the centre of the arch and the two halves joined together by an iron strap and four bolts. Form setting and concreting followed very closely the timber repair. The steel ribs were set on wooden foot-blocks and at the bottom were braced from the track rails. They also had additional braces at the spring line and arch centre, only these braces were to the rib and back of the tunnel. Before the forms were set a trench was excavated on each side of the tunnel to solid formation for the foundation. The width of this excavation depended on the thickness of wall to be placed, although it was always from 6 in. to 2 ft. wider than the wall.

When ready for concrete the bottom board behind the steel rib was not placed lower than the grade line of the tunnel floor. This allowed the concrete to fill the foundation excavation outside of the forms. The concrete was delivered to the shovelers in a specially designed watertight galvanized-iron box, built on a flat car. This box was 3 ft. wide, 14 in. deep and 9 ft. long with an outward slope at each end of 1 to 1, which facilitated shoveling. This car also was used to remove the foundation trench cleaning, being hosed out before again filling with concrete. After the foundation was in the walls were carried up to a point that left about 14 in. of key. Then the lagging was placed over the arch and the key of 5 ft. in length rammed from the end. A stiffer mix of concrete was used in the key than the walls. The average thickness of concrete lining was from 6 to 8 in., although in some of the loose or swelling formations the lining was heavily reinforced with steel and had a thickness of 12 to 20 in. It was in these sections and where temporary sets were used that centre posts and sprags were placed.

In order to get a good uniform thickness of lining it was necessary to take out sets of 10 x 10 in. and 12 x 12 in. or trim them down to one-half or even one-third the original size. The sprags were placed above the cut to be made and supported the weight until the weakened portions could be covered with concrete. If necessary, these sprags could be concreted in and removed after the forms were taken down. Considerable precaution was taken when concreting a section where the water inflow was a perfect rainstorm.

Sections have been concreted where the flow of water in 5 ft. of tunnel was 25 or 30 miners' inches. In these places wood strips of ½ or 1 in. in thickness were nailed to the lagging of the timbers and then covered with sheets of tin. This tin would entirely cover the section and the water was conveyed down the sides to the foundation trench. Here pipes were placed to carry the water through the concrete wall. Ordinarily, a hole was cut through the timber lagging and the pipe placed so the intake was on the outside. Then a rich concrete or cement filled the trench above the tin and forced the water through the pipes.

The average cost of placing 4,614 ft. of concrete lining in the north portion of the tunnel was $9.79 per foot. This included a teaming charge from Santa Barbara to the north portal of $3.75 per barrel of cement and $28.12 per 1,000 ft. on lumber. Gravel from the Santa Ynez River bed was hauled about three-quarters of a mile. The divisions of cost were as follows:

Cost of Lining Per Foot of Tunnel.

Administration and labor	$4.63
Cement	3.64
Forms	.18
Sand and gravel	.24
Miscellaneous supplies	1.10
Total	$9.79.

Santa Barbara's tunnel has presented many expensive and difficult problems. The Santa Ynez range generally is a highly stratified shale and sandstone alternating from one to the other in layers of a few feet to several hundred feet in thickness. The tunnel attack is at a strike and dip, ranging from 75 to 85 deg. The formation at contact points is ordinarily quite shattered and this loose condition is aggravated in water-bearing sections. When the north portion had been driven to a depth of 4,800 ft. from the portal a highly inflammable gas in large quantities was encountered. This gas section extended for a continuous distance of 1,300 ft. The formation for the first 700 ft. was shale, followed by 400 ft. of oil sand. Here the formation was badly faulted at its contact with the shale, which was the formation to the end of the gas section.

The quantity of gas at first was not alarming, although as a safeguard against accident safety lamps were used to test the heading after each blast. Small accumulations of gas located in the higher portions of the tunnel would then be burned out by touching them off with a torch. This done, the seepages would be lighted and if the inflow was sufficient would maintain a constant flame during the next shift, being extinguished by the next blast in the heading. As the heading neared the oil sand gas was encountered in larger quantities, and finally when this formation was opened up a larger amount of gas accumulated in the tunnel immediately following the blast and was accidentally exploded by the workmen. The force of the explosion was terrific and those not severely burned were hurled along the tunnel. Besides one killed, all the men were seriously injured. This was an exceptionally large quantity of gas, being about 25,000 cu. ft., and had been released by opening up 5 ft. of ground in the heading. It was not the seepages of gas in the tunnel that gave trouble, but the unknown quantity that was released by advancing the heading.

To guard against and safely dispose of this unknown inflow, Mr. Lippincott and Mr. Hyde placed a system of electric arcs in the tunnel which were used to ignite the gas after firing a round in the heading. The arcs were specially made, being designed to withstand the concussion of the blasts and explosion of gas. When the round was ready to fire these arcs were placed in high points along the tunnel about 200 ft. apart, the first one being located about 150 ft. back of the heading. The round was then fired and the crew retired to the portal. A fire boss and helper then took charge of the tunnel and 4 hours were consumed in testing before the next heading crew went on shift. The fire boss waited for about 30 min. after the blast before turning an electric current into the arcs from an outside switch. This wait allowed a better chance of gas removal by the blowers, which were always reversed to exhaust from the heading after blasts. An ammeter was used at the switch to indicate whether the arcs responded or not, and all the arcs were connected in series.

After obtaining results of arcing from the portal the fire boss and helper advanced to another arcing station 3,500 ft. from the portal. Here the electricity was again turned into the arc circuit. If there was no gas explosion the fire boss with a safety lamp tested the entire tunnel ahead. If no large pockets were discovered he returned to the station, where he again switched the electricity through the arcs. This time with the arcs burning, he returned to the heading and placed torches at intervals of 100 ft. through the gas section, which were kept burning during the next shift.

Ordinarily the muck pile would burn like coal for some time, and on one occasion was ablaze for fourteen hours. Drilling and firing a round of holes was often quite spectacular and required a great deal of care. As soon as the hole was drilled the gas from it would be lighted, sustaining a good sized flame. I have seen as high as six out of eight holes on the top round burning like blow torches. Before loading a round the holes had to be cooled. For this purpose two lines of water and two of air, each under 100 lb. pressure, were turned into them. This extinguished the flame, and as soon as the accumulation of gas reached a point 20 or 30 ft. back of the breast it was exploded and then immediately put out at the holes again by the air and water. This operation was repeated until the holes were cooled sufficiently to load and were then immediately fired. Driving through the gas section using the sparking devices was comparatively safe and not very expensive. Two heading shifts were maintained, and aside from the two 4-hour periods of fire boss shifts the work was uninterrupted.

The north portions of the tunnel required timber for about 71 per cent. of its total length, and although spiling and breast-boards were necessary in a great many places, most of the timbered sections offered no particularly severe problems on account of the absence of water. Good average progress was maintained by city force account during the entire work, and one very good record was made when the heading was advanced 337 ft. in thirty days by two drilling and three mucking shifts. About 48 per cent. was timbered.

After passing through the gas section, water was continually encountered until the inflow was taxing to their capacity the pumps and water columns. This meant the installation of larger pumping equipment or abandonment of the tunnel. As the distance to be driven did not justify the expense and moreover could be easily accomplished from the south side, the latter course was followed. Before abandonment the tunnel was concreted in sections where the ground was loose and heavy. The equipment was then transferred to the south portion of the tunnel and all work has been prosecuted from this end since.

The cost of driving 2,779 ft. of the north portion was $25.55 per foot, including the cost of timbering 1,736 ft. The distribution of this cost was as follows:

Cost of North Tunnelling Per Foot.

Administration	$ 1.68
Labor	10.90
Power	3.81
Explosives	1.39
Timber	2.25
Track and pipe	1.76
Miscellaneous supplies	2.94
Drill parts	.62
Bonus	.20
Total	$25.55

The south portion of the tunnel differs very little in formation from the north, only larger bodies of sandstone have been penetrated. The sandstone contains crevices, and large water courses have been opened up in this formation. This blocky ground is the saturated portion of the mountain, and the intervening shale bodies act as the sides of what might be termed vertical reservoirs. The average flow for the past two years has been from 350 to 400 miners' inches.

In passing through sandstone, particularly after the tunnel had gained a depth of about 1,000 ft. vertically from the surface, the pressure of water in drilled holes has at times been very severe. Instances where drill steel was forced tight against the machine, requiring two or three men with Stilson wrenches to release it from the chuck, were frequent, and jets of water shooting down the tunnel in a horizontal line for a distance of from 25 to 75 ft. are not uncommon. Some of the main crevices yielded a flow when first tapped of from 75 to 150 miners' inches of water, and one main water course released a flow of 350 miners' inches. This drained down rapidly and within a week had diminished to about one-half this volume.

In driving from one point of contact to the other in sandstone the water follows the heading to a large extent and is a general handicap to the work. In drilling rounds, extra holes are required to release the pressure of water from the ones to be loaded. Even then it is necessary to load the holes by inserting stick after stick without tamping and then wedging at the collar. Mucking and track laying is also a task on account of the shifting sand which collects along the floor of the tunnel and over the rails for hundreds of feet back of the heading. All of the large water strikes were made in loose caving formation and greatly increased the difficulties of timbering problems. Through these sections spiling was necessary, and sometimes breast boards.

The large volume of water constantly flowing through the tunnel has had a severe effect on transportation of muck trains, as the track is always covered with water from 8 to 12 in. or more in depth. It is difficult to do repair work on the track, and besides floaters are being constantly encountered, causing wrecks. The depth of water is also a hardship on the motor cars, causing shorts and grounds in the fields, armatures, resistance and wiring, which have to be continually repaired. Water has been the most embarrassing feature of the construction. However, good progress has been maintained, the heading having been advanced 439 ft. during one period of thirty days, the average progress by city force account in the last 4,800 ft. being about 275 ft. per month at a cost of $26.16 per foot.

On April 7 of this year one of the timbered sections caved in at a point 7,360 ft. from the portal. The total collapse of the entire string of timbers 33 ft. in length occupied but a short time, and the workmen at the heading 4,500 ft. beyond had barely room to escape by the time they reached the caved portion. Special mention is due Frank Fizer for his presence of mind and heroic action in notifying the workmen of their danger. Mr. Fizer was acting as motorman and discovered the case on his outward trip. On account of breaking a trolley pole it was necessary for him to wade through water to the heading. A short time after the crew reached the portal side the tunnel filled with muck. The total water flow of the tunnel at this time was 395 miners' inches, of which about 300 miners' inches was coming into the tunnel on the heading side of the cave. This water was immediately shut off by the impervious nature of the muck pile which was mostly a mixture of soft clay and running shale. In a few hours the large volume of water had entirely filled the tunnel between the cave and heading and then on account of the small displacement necessary to resaturate, the formation above gained headway rapidly and soon exerted a pressure against the muck pile. This carried the muck pile toward the portal of the tunnel and forced the workmen back. The water then would gain a greater pressure, which would again overcome the resistance of this muck pile and move it down the tunnel. This process continued until the tunnel was filled with muck for a distance of 437 ft., at which point further action was blocked by two bulkheads, a temporary wooden one to protect the workmen while the permanent concrete bulkhead was placed.

By placing a pressure gauge on the compressor air line some idea of the pressure was gained during the early stages, but on account of the line giving way few readings were obtained. However, these showed a gain from 19 to 122 lb. per square inch in 14 hours.

A side drift was then projected around the caved and filled portion of the tunnel, and opposite the soft caved stratum was 100 ft. distant. At this point 12 x 12-in. timbers with 4 and 6-in. spiling and 3 x 12-in. breast boards were used. It was necessary to hold every inch of ground in place, as a slight movement might allow the terrific water pressure in the main tunnel to cause a general movement of the loose muddy formation, separating the two bores, and in this case the muck could very quickly slide into the side drift and duplicate the muck shifting process following the cave. The progress through this section was very slow, but the results obtained were most satisfactory. However, it was necessary to concrete this timbered section immediately after passing through the ground to insure safety.

The side drift was then advanced and turned toward the main tunnel again so the approach was at an angle of 41 deg. The side drift is 785 ft. in length, some of this distance being necessary to gain a location in the old tunnel where the formation was considered solid enough to tap through. When the side drift had gained a location that left 18 ft. of wall between the two tunnels the heading was stopped and preparations made for tapping the main tunnel. The formation was a tight and tough slate shale and was practically dry, but owing to its brittle nature was flaking off with loud, quick reports for the last three days before the tap on account of the water pressure, which was probably 500 lb. per square inch. In order that the attack might be at right angles with the main tunnel, a cross cut of 7 ft. in length, carrying a 3-ft. 6-in. bench, was made. The tapping holes, 11 ft. long, were drilled in this face. Four holes were drilled from a cross-bar. These were collared about 20 in. apart and brought together at the bottom. A pilot hole was kept 2 ft. in advance of these four to indicate the exact location of the main tunnel rib. When this was determined the holes then about 12 in. from the rib were charged with 50 lb. of 40 per cent. powder and fired. Fifty-foot fuse was used, which allowed plenty of time for the shift to get out of the tunnel. The results of the blast were particularly successful, the water being gradually reduced. The connection of the side drift with the main tunnel was then made and the clearing of the main tunnel to the heading started. The main tunnel has suffered somewhat on account of the action of the long storage of water, the full extent of which has not yet been determined.

Timbered and untimbered sections have been affected, and it will probably be sixty days before the heading is reached.

The cost of driving 6,215 ft. in the the south portion was $26.16 per foot, including the cost of timbering 1,075 ft., distributed as follows:

Administration	$ 1.55
Labor	12.15
Power	2.98
Explosives	2.35
Timber	.57
Track and pipe	1.41
Miscellaneous supplies	3.30
Drill parts	1.32
Bonus	.53

THE DURABILITY OF GROUTED GRANITE PAVEMENTS.*

By William A. Howell.

In the city of Newark, N.J., on November 1 there were 12.54 miles of completed grouted granite pavement covering 235,825 sq. yd., laid under public contract at a cost, including inspection and advertising, of $922,214. About 0.8 mile of this pavement has been in service three years and 3⅔ miles is at least two years old. The important part of the work of producing a satisfactory grouted granite pavement, with close joints, is the preparation and application of the grout mixture. In Newark the specifications for grouted granite pavements are those adopted by the Association for Standardizing Paving Specifications. The grout mixture must be at least as rich as one part of cement to one part sand; the exact proportions depend upon the hardness of the granite used, and this quality should be ascertained by experiment so as to produce a grout which will wear down uniformly with the granite.

The very hard granites are not well adapted to this type of pavement, but there is no question as to the durability of the grouting where comparatively soft granite is used and where the specifications are rigidly adhered to. Horses very seldom fall on grouted granite block pavement, even when the grades are moderately steep. The grouted granite pavements in Newark are wearing exceedingly well under heavy traffic, and even along street railway tracks the results are good. The New Hampshire granites appear to give the best satisfaction, for they are soft enough to wear down without polishing and becoming slippery.

To secure good grouted pavement of granite blocks, the following points should be kept in mind: Be sure the sub-grade is well rolled and all soft places eliminated. The concrete base should not be too rough and there should be a uniform thickness of 2 in. of sand under the blocks. The blocks should be carefully culled and well rammed. A small percentage of loam in the sand, not over 5 per cent., is desirable as a builder. The sand and cement should be mixed in the proper proportions, and the mixture should be continually agitated. The blocks should be thoroughly sprinkled immediately before grouting. Grouting should not be attempted during cold weather; good results are seldom secured after November 15 in the latitude of New York City. If grouting is done during very hot weather the finished work should be covered with ½ in. of sand and kept moist. Traffic should be kept off grouted pavements for at least seven days after completion. The use of a moderately soft granite, similar to New Hampshire granite, is recommended.

* Abstract of paper delivered before American Society of Municipal Improvements, Nov. 12-15.

FACTORY GROWTH IN WESTERN CANADA.

Some figures relative to factory growth in Western Canada are given and are of interest, showing as they do that real estate is not the only form of investment open to the residents in that section.

Manitoba.

(1910 Compared with 1905).	Per cent.
Establishments: Increase	24
Capital: Increase	74
Employees: Increase	70
Salaries and wages: Increase	100
Value of products: Increase	90

Saskatchewan.

(1910 Compared with 1905).	Per cent.
Establishments: Increase	116
Capital: Increase	77
Employees: Increase	125
Salaries and wages: Increase	170
Value of products, Increase	151

Alberta.

(1910 Compared with 1905).	Per cent.
Establishments: Increase	142
Capital: Increase	432
Employees: Increase	241
Salaries and wages: Increase	265
Value of products: Increase	266

Manitoba.

The following tabulates the specific details:—

	1900.	1905.	1910.
Establishments	324	354	439
Capital	$ 7,539,691	$27,517,297	$47,941,540
Employees	5,219	10,333	17,325
Salaries and wages	$ 2,419,549	$ 5,909,971	$10,912,866
Value of products	$12,927,439	$28,155,732	$53,673,609

Saskatchewan.	1905.	1910.
Establishments	80	173
Capital	$3,973,075	$7,019,951
Employees	1,444	3,250
Salaries and wages	$ 721,875	$1,936,284
Value of products	$2,520,172	$6,332,132

Alberta.	1905.	1910.
Establishments	120	290
Capital	$5,545,821	$29,518,346
Employees	2,045	6,980
Salaries and wages	$1,167,107	$ 4,365,661
Value of products	$5,116,782	18,698,826

SUBWAY AND BRIDGE COSTS.

A reinforced concrete highway bridge spanning two railway tracks, waterproofed, paved with vitrified brick and designed for a moving weight of 100 lbs. per sq. ft. of floor area, or a 10-ton road roller, can be built for $1.65 per sq. ft. of floor, including the spans, supports and ordinary foundations, according to a statement made by H. N. Rodenbaugh, assistant engineer, Southern Railway, Atlanta, Ga., in a paper read before the Engineering Association of the South. Such a structure is only slightly higher in first cost than the typical steel girder bridge of similar capacity with a wooden floor, which costs about $1.50 per sq. ft. of floor area complete. A very satisfactory wooden Howe truss bridge of modern design has been built by one railway at a total cost of $45 per sq. ft. of floor area, and as between the latter two structures. Mr. Rodenbaugh very much favors the wooden bridge. Commenting on shallow floors, which are very common in subway design, he states that a typical open floor—that is, one having ties resting on steel stringers without ballast—will have a depth from base of rail to under clearance of about 3 ft. 4 in., and will cost about $1.20 per sq. ft. of floor area. A transverse steel I-beam construction with ballasted deck on flat plates will have for the same span a depth of 3 ft. 1 in., and will cost about $1.90 per sq. ft. of floor area. A transverse steel rectangular trough floor will have a depth of 2 ft. 10 in., and will cost about $2.50 per sq. ft. of floor area. The last two designs are assumed to have waterproofed floors with a minimum of 8 in. of ballast under the ties, the cost given being for the steel work only.

INCREASED PRODUCTION OF STRUCTURAL MATERIALS

Canada's mineral production includes these important and valuable structural materials:—Cement; clay products of various kinds, such as brick, sewerpipe and tile pottery, etc.; lime; sand-lime brick; sands and gravels; slate; and stone for building and other purposes, including granite, marble, limestone, sandstone, etc. No complete record of production of sands and gravels throughout Canada has been obtained, but statistics of exports are published. The statistics of stone production do not include the stone used in making cement or lime, but are as complete as possible for all other established stone quarries; but there is a large production of stone for foundation work, road-making, and railway construction of which no record is available.

The total value of the production of these structural products in 1911 according to the record obtained was $22,709,611, as compared with a value of $19,627,592 in 1910, an increase of $3,082,019, or 15.7 per cent. The total production in 1909 was valued at $16,533,349, as compared with which the 1910 production showed an increase of $3,094,243, or 18.7 per cent.

The Canadian consumption of products of this class is apparently increasing at an even more rapid rate than the production. The consumption based upon the above figures of production in conjunction with the record of exports and imports was in 1911 only a little less than $30,000,000, as against about $25,250,000 in 1910 and $20,350,000 in 1909, the increase in 1911 being 18 per cent. and in 1910, 24 per cent.

The large increase in production and consumption of structural materials is only a natural accompaniment of the great national development taking place in Canada. The normal growth of population supplemented by the large immigration now constantly in progress has resulted in a great wave of construction in the building up of cities, the construction of railways, highways, and public works of all kinds.

The building permits issued in a number of the principal cities and towns are but one proof of this growth.

Building permits in thirty-four cities in 1911 aggregated nearly $32,000,000 in value, as against $29,000,000 in 1910, an increase of over 28 per cent. and the year 1910 shows a similar increase over 1909 in permits issued of nearly 46 per cent.

A summary of the production of structural materials and clay products since 1907 is shown below:—

	1907 $	1908 $	1909 $	1910 $	1911 $
Cement	3,781,371	3,709.954	5.345,802	6,412.215	7,644,537
Clay Products	5,772.117	4,500.702	6,450.840	7,629,956	8,359,933
Lime	974,595	712.947	1,132,756	1,137.079	1,517,599
Sand-lime Brick	167,795	152,856	201,650	371,857	442.427
Sand & Gravels (exp'ts)	119.853	161,387	256,166	407,974	408,110
Slate	20,056	13.496	19,000	18.492	8,248
Stone	2,027,262	2,088,613	3,127,135	3.650,019	4,328,757
Total	12,863.049	11,339,955	16,533,349	19,627,592	22,709,611

The increase in the value of cement sales in 1911 over 1910 was 19 per cent.; clay products show an increased production of 9.6 per cent.; stone an increase of 18.6 per cent.; lime an increase of nearly 29 per cent.; sand-lime brick an increase of 15.6 per cent. The production of slate is at no time large, but shows a falling off in 1911.

The export of products of this class is comparatively small being valued at only $484,047 in 1911, of which over 90 per cent. was made up of sand and gravel. The imports, on the other hand, aggregated $7,710,552 in value, and included Portland cement, $834,876; clay products, $5,156,544; lime, $161,985; sand and gravel, $246,613; slate, $169,685; and stone, $1,140,846.

CANADIAN CAR AND FOUNDRY REPORT

Gross sales amounting to $16,500,000 are shown in the Canadian Car and Foundry Company's third annual report, and the profits for the year available for dividend purposes after providing for the first instalment of the bond sinking fund, as shown by the profit and loss account, were $1,040,000.

At the close of the fiscal year, the unfilled orders amounted in value to over $15,000,000, and at the date of the report the value of unfilled orders is $16,000,000.

An analysis of this year's statement shows that the total capital assets have grown from $11,607,734.91 to $13,384,212.65. The current assets have increased from $5,217,699.36 to $7,334,492.82. The capital liabilities amount to $15,088,306.67 as against $13,875,000 in the previous report. Current liabilities are increased $1,784,710.90 to $3,561,418.79. An increase of $383,932 is given in the balance carried forward.

A further increase in working capital is shown will be a need of the company, but until the Fort William plant is completed the directors prefer temporary banking accommodation to supply the requirements.

The comparative figures for 1912 and 1911 of the company's assets and liabilities follow:

Assets.

	1912.	1911.
Property account	$10,652,747.95	$10,147,297.41
Investment account	2,621,299.39	1,460,437.50
Cash in hands of trustees for bond sinking fund	275.31	....
Current assets	7,334,492.82	5,217,699.36
Deferred charges to operations	188,396.25	199,918.01

Liabilities.

Capital stock	$10,075,000.00	$ 9,975,000.00
Bonds	3,933,306.67	3,500,000.00
Platt & Letchworth Co.	780,000.00	....
Purchase money notes	400,000.00	400,000.00
Canadian Steel Foundries Bonds	3,650,000.00	3,650,000.00
Current liabilities	3,561,418.79	1,784,710.90
Reserve funds	707,219.47	309,307.14
Surplus	1,440,266.00	1,056,334.00

When the Fort William works are finished the company will own eight complete plants, in addition to the Rhodes-Curry building and contracting business, extending from Sydney, Cape Breton, N.S., to Fort William, Ontario, and will probably be the most self-contained car building company in the world, manufacturing, as it does, nearly everything that enters into the construction of railway cars.

The number of employees on the pay rolls and its subsidiary companies at the present time is about 7,500, and this number will be materially increased when present enlargements are completed and the Fort William Works are in operation. The pay-rolls aggregate about $500,000 per month.

The Canadian Porcelain Company, Limited, has been incorporated with a capital stock of $300,000 to manufacture vitrified white porcelain for electrical and other purposes. They have purchased a 20-acre site in Hamilton, Ontario, and will erect a plant, the first unit to cost $150,000. The buildings will be of steel and brick and will be ready for operations next spring. Messrs. John Alden and Chas. Palmer, of Rochester, N.Y., and Mr. Fred D. Palmer, of Galt, Ont., are the principal directors.

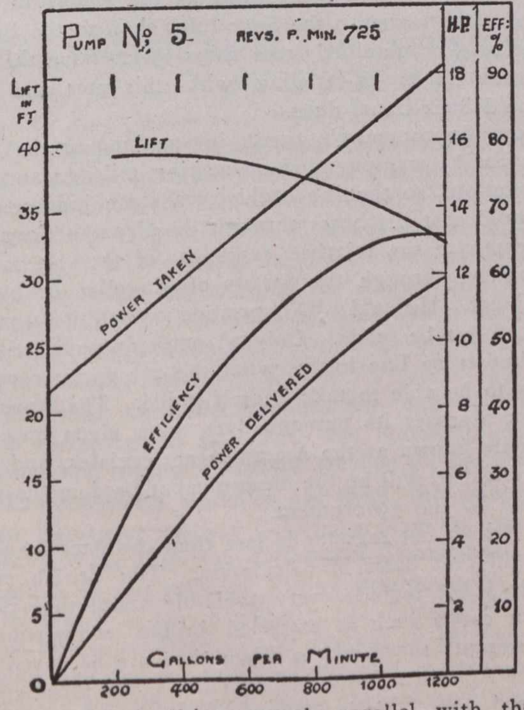
COAL OF THE UNITED STATES.

The known coal fields of the United States embrace a total area, according to the U.S. Geological Survey, of 310,296 sq. mi., to which may be added something over 160,000 sq. mi., of which little is known, but which may contain workable coals, and about 32,000 sq. mi. where the coal lies under heavy cover and is not considered available under present conditions. The supply of coal before mining began is estimated to have been 3,076,204,000,000 short tons, of which 1,922,979,000,000 tons were considered to be easily accessible and 1,153,225,000,000 short tons to be either so deep or the beds so thin that they are accessible only with difficulty. Classified according to the character of the coal, the original supply consisted of 21,000,000,000 short tons of anthracite, 1,661,457,000,000 tons of bituminous coal, 650,157,000,000 tons of sub-bituminous coal, and 743,590,000,000 tons of lignite.

The total production of coal to the close of 1911 has amounted to 2,270,798,737 short tons of anthracite and 6,468,773,690 tons of bituminous coal, or an aggregate of 8,739,572,427 tons. This total production to the close of 1911 represents including the waste of coal in mining, an exhaustion of the beds equal to 14,181,980,000 short tons, or somewhat less than 0.5% of the original supply. In other words, the quantity of coal still remaining to be mined amounts to 3,062,022,020,000 short tons, or a little more than 99.5% of the original supply. The annual rate of exhaustion at the present time as represented by the production in 1910 and 1911 is 0.025% of the supply. The quantity of coal still in the ground at the close of 1910 was 6,000 times the production of that year, or, estimating a half ton of coal lost for every ton recovered, the supply is equivalent to 4,000 times the present annual rate of exhaustion.

THE STEREOPHAGUS PUMP IN OPERATION.

An eight-inch Stereophagus pump, manufactured by Messrs. Hathorn, Davey & Co., Limited, of Sun Foundry, Leeds, has been installed at The Knostrop Sewage Purification Works, of Leeds, England, with the object of testing



its action under conditions exactly parallel with those prevailing with the centrifugal pumps of ordinary type now in use.

The Stereophagus pump is placed in such a position that its suction pipe dips into the stream of crude sewage issuing from the main sewer before the sewage is subjected to any screening or treatment whatever. A quantity of sewage, amounting to 500 gallons per minute, is lifted by the Stereophagus pump and deposited into a tank where it can be examined and measured.

The remaining sewage is passed on to the main centrifugal pumps, which are of large size, but before arriving at these pumps the sewage is carefully screened, so as to remove from it all substances likely to impede the action of these pumps. In spite of this, however, they require opening out for cleaning almost daily, while the Stereophagus pump, on the other hand, has not once needed cleaning, although the sewage pumped by it is unscreened.

The Stereophagus pump, which is driven by an electric motor, gave, when installed, an efficiency of over 60 per cent., as is shown by fig. 1, and that this has been maintained is proved by the fact that the quantity of sewage delivered is undiminished. The speed of the pump, and consequently the power, have, therefore, remained constant, showing an unimpaired efficiency in the pump, although during the trial a considerable amount of road grit has passed through it.

The Stereophagus Pump and Engineering Co., Ltd., 39 Victoria St., Westminster, S.W., have acquired from the Hon. R. C. Parsons the rights for the sale in Great Britain and abroad of the Stereophagus pump which was patented by him. They therefore control the Canadian rights.

CANADA SOUTHERN RAILWAY BOND ISSUE

The holders of the first and second mortgage bonds of the Canada Southern Railway Company are being given the opportunity to reinvest the proceeds resulting from the payment of their maturing bonds in the company's new issue of $22,500,000 consolidated guaranteed fifty-year 5% gold bonds, Series A, dated October 1, 1912, and maturing October 1, 1962, at 105¾ and accrued interest, for each $1,000 bond of the new issue. At this price the new bond, if held to maturity, yields approximately 4.70% per annum. Messrs. J. P. Morgan & Company are authorized to handle the matter.

The consolidated guaranteed fifty-year 5% bonds upon the payment early in 1913 of a total of $20,000,000 first and second mortgage bonds now outstanding will become a direct first mortgage lien upon all of the property of the Canada Southern, except for the first mortgage of $130,000 upon the Leamington Branch, about fourteen miles in length.

Subject only to this divisional issue, the consolidated mortgage bonds after March 1, 1913, will be a first mortgage upon the 380 miles of railway lines extending with branches from the Niagara to the Detroit River. Two hundred and twenty-six miles are standard double-track trunk line railway of exceptional strategic importance, being the integral indispensable part of the Michigan Central Railroad Company route, connecting the manufacturing and distributing centres of Buffalo and Detroit, and forming with the Detroit Tunnel Company and the Michigan Central Railroad Company a part of the shortest line of the New York Central system from New York to Chicago.

The property of the Canada Southern Railway Company includes the entire main line between Suspension Bridge, Ontario, and Windsor, Ontario, opposite Detroit, with branches running to Courtright, Leamington, Amherstburg, Old Fort Erie and Niagara-on-the-Lake. Its road is of modern construction, with low gradients, easy curve, and is equipped with electric automatic block signals, etc. The lines of the Canada Southern were leased to the Michigan Central Railroad Company for a period of 999 years from January, 1904.

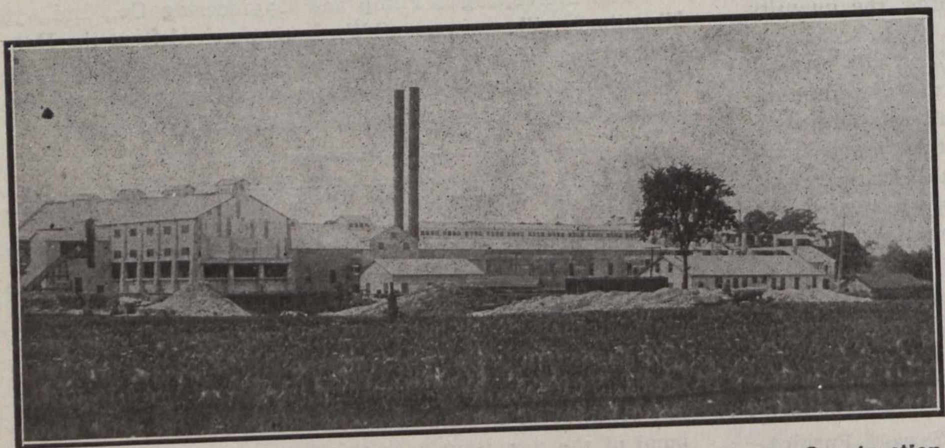
THE PLANT OF THE ST. MARY'S PORTLAND CEMENT COMPANY.

The plant of the St. Mary's Portland Cement Company is located at St. Mary's, Ontario. Its daily capacity is 1,500 barrels, and storage capacity has been provided for 75,000 barrels.

The illustration shows the buildings, but the photograph was taken before they were completed.

The quarry for limestone and the clay beds are contiguous to the mill. The plant is operated by hydro-electric power, 550-volt, 25 cycle, three-phase current being used. The company have their own substation, and find the power very satisfactory.

At the raw end a No. 8 Kennedy crusher is set over a No. 5 Jumbo Williams mill. The limestone is crushed by this to 1½ inches down. The clay is washed as it goes to the mill. The machinery includes two large size kominuters with Trix separators; two large size Smidth tube mills, and five concrete tanks. The kilns are two in number, and are 8 ft. by 160 ft. The coal is brought in on elevated tracks, is dried in a Cummer dryer, and is ground in a 42-inch Fuller Lehigh mill. Two coolers, 6 ft. by 70 ft., are provided, with a fan attachment which is used for blowing the cold air in at the lower end and using the hot air from the upper end of the cooler both for the kilns and drying the coal.



View Showing Plant of the St. Mary's Portland Cement Company During Construction.

In the finished product end, there are three Dreadnought Fuller Lehigh mills for finishing the cement.

The mill is provided with two electric cranes, one in the raw end and the other for handling the clinker. For shipment by rail, the company has both Grand Trunk and Canadian Pacific Railway connections.

The president of the St. Mary's Portland Cement Company, Limited, is Mr. Geo. H. Gooderham, and the secretary-treasurer is Mr. Mark H. Irish, both of Toronto. Mr. John G. Lind, the manager of the plant, is located at St. Mary's.

ROLLING STOCK FOR THE C.P.R.

The Canadian Pacific Railway will spend $48,000,000 in new rolling stock ordered this year. This money will secure them 467 locomotives and 28,671 cars of various descriptions. When this large order is completed the company will have in commission 2,225 locomotives and 98,804 cars. The new locomotives ordered cost nine millions, the balance of forty-eight millions being expended for cars of various kinds. This equipment will be operated over a trackage of more than 12,500 miles.

PANAMA CANAL TOLLS

Now that President Taft has proclaimed the basis of the Panama Canal toll rates to be paid by foreign shipping and ships under the American flag trading with foreign ports, steamship men in the New York shipping offices are busy figuring out estimates of what total sum an average ship may have to pay.

Owing to the many technical considerations involved it has been impossible for shipowners to make their calculations with any degree of assurance.

The provisions of the proclamation as regards merchant vessels are:

On merchant vessels carrying passengers or cargo, $1.20 per net vessel ton—each 100 cubic feet of actual earning capacity.

On vessels in ballast without passengers or cargo, 40 per cent. less than the rate of tolls for vessels with passengers or cargo.

This still leaves many important points still in doubt, and the proclamation must be taken as merely the preliminary announcement, since the rules for the measurement of vessels have still to be drawn up by the Secretary of War. Until it is known definitely whether the Panama rules of measurement will follow the British, American or Suez Canal systems of measurement for calculating the net vessel tonnage, only rough estimates can be made.

The basic rate is made to correspond closely to the Suez Canal toll, the $1.20 being practically the equivalent of the 6.75 francs, the rate which is to become effective on the first of the new year, showing a reduction of 50 cents from the present toll. It is probable that the American system of measurement will be followed, and as the American measurements come nearer to the Suez rules than to the British some clue may be obtained from ships which have the American measurement as trading with this port and have actually paid Suez Canal dues.

A steamship company's agent, in speaking of the subject, said that he was engaged on making mileage and tonnage calculations so that he could form some judgment on what it would cost his boats through the Panama Canal in order to compare the relative expenses of the alternative routes, namely, through the Straits of Magellan or by the Panama Canal. He said: "No positive or definite working criterion can yet be made. Only a rough approximation is possible, but every line knows what the net register means sufficiently to be able to take it as a guide. The American government assesses its tonnage dues on a given measurement capacity known as the American net register, and this, as I understand it, will be the measurement used in the rules to be issued by the government.

"The British net register is less than the American owing to a different basis of calculation. The British measurement does not include every available space that might be used for cargo such as extended bridge compartments, etc., but exempts those spaces when they are not used for cargo. The American measurement charges for those spaces whether used or not. It is an important technical point that should a vessel at any time go through the Suez Canal with merchandise of any kind, or lumber, coal, or stores of any description, the whole of that space is added to the net tonnage and can never more be exempted from measurement.

"The consumption of coal and the use of temporary or permanent bunker space are important items in the calculation, and shipowners using the canal for their boats will probably have to allow for permanent bunkers, as they will wish to make use of every foot of space for the cargo the ship can carry."

Another New York shipowning firm gave as a specific instance the case of a steamer having a measurement capacity of 392,958 cubic feet. Allowing 100 cubic feet as the arbitrary unit for a register ton the amount of the toll to be paid, at the rate of $1.20 a ton, would be $4,716.

Professor Emory Johnson, in his evidence, January 30, 1912, before the House Committee on Interstate and Foreign Commerce, printed in Volume II. of the Hearings, gave this rule for determining the net register tonnage of a vessel:

"There is deducted from the entire capacity of the hull the space occupied by the crew, master's cabin, steering and anchor gear below deck, boatswain's stores, chart house, and spaces occupied by propelling power (engines, boilers, shaft, tunnel, fixed coal bunkers). These deductions having been made, the net registered tonnage is ascertained by dividing the number of cubic feet in the remaining space by 100. In an up-to-date freight steamer, as measured by British, American or German rules, the net register is somewhat less than two-thirds the gross register. In the case of a high speed passenger vessel, so much of the ship is taken up with propelling machinery, fixed coal bunkers, crew space, etc., that the net register tonnage may be less than half, sometimes not more than one-third of the gross register."

To this evidence of Professor Johnson, it may be added, were appended exhibits showing tables of distances via the Panama Canal and alternative routes, number of days saved from various ports, Suez Canal data, comparative data of a ship, the Santa Rosalia, built in 1911, showing net tonnage on all three systems, viz.: British, 3,488; American, 4,392; Suez, 4,452; average price of coal at Panama and detailed statements on the relation of tolls to the volume of Panama Canal traffic.

RAILWAY RECEIPTS AND EXPENSES FOR SEPTEMBER.

The business of the railways for September while showing a considerable improvement over that of September, 1911, does not maintain the rate of increase set by the record-breaking month of August. The total net operating revenue of 90 per cent. of the steam railways increased $5,896,840 for September, while the increase for August was $13,865,622. This increase in net operating revenue was at the rate of $21 per mile of line for the month or at the rate of 70 cents per mile of line per day.

The total operating revenues per mile of line for the month increased 6.5 per cent., the operating expenses 7.3 per cent. and the net operating revenue 5.1 per cent.

The foregoing statistics are from the summary made by the Bureau of Railway Economics from the reports of the railways to the Interstate Commerce Commission. A special committee of the railways having headquarters in Chicago reports that bills now pending in the Federal Congress providing for an increase in the number of employees of the railways and for the rapid substitution of steel for wooden equipment will, if enacted, place the railways under an additional expense of approximately $12,000,000 per annum for the former, and a total expense of $632,746,900 for the latter purpose. Without compulsion, the railways in the course of three years have increased their steel equipment 750 per cent. and their steel underframe equipment 256 per cent.

UNIT COSTS OF FILTERING WATER IN FOUR SLOW SAND PLANTS AT PHILADELPHIA.

The data here given with reference to the unit costs of filtering water in four slow sand plants at Philadelphia are abstracted from the annual report of the Bureau of Water for 1911. The Queen Lane plant was not put in service until the first of December, so no results are here given for that plant. The costs and other operation data follow for the four plants in service in 1911:

Upper Roxborough Filters.—This plant comprises a storage reservoir giving a sedimentation period of 9.71 days, eight covered filter beds, and a covered clear water basin. The average rate of filtration throughout the year was 238,000,000 gals. per acre per day. The average cost of filtration was $2.98 per 1,000,000 gals., which included 65 cts. per 1,000,000 gals. for the laboratory cost. The average cost given includes all items connected with the operation of the station, but does not include the cost of pumping water from the storage reservoir to the filters. The average number of cleanings for the year was five for each filter. The average amount filtered between cleanings was 159,320,000 gals. per acre. The filters were washed for the entire year by the Brooklyn method. The cost of labor and wash water was 57 cts. per 1,000,000 gals. of water filtered, and 1,870 gals. of wash water were required per 1,000,000 gals. filtered. The results of the preliminary sedimentation in the storage reservoir are very good, the turbidity being reduced from 45 to 17 by the sedimentation. The filter removed 99.9 per cent. of the bacteria in the raw water drawn from the Schuylkill River.

Lower Roxborough Filters.—This plant consists of a storage reservoir which gives a sedimentation period of 1.29 days, five covered filter beds, eleven preliminary filter tanks, and a covered clear water basin. The average rate of filtration was 3,800,000 gals. per acre per day. The filters were operated at a rate of 508,000,000 gals. per acre per 24 hours. The cost of operation, including the preliminary filters, but not including the cost of the wash water, was $5.55 per 1,000,000 gals. filtered. This figure includes 85.4 cts. for laboratory expense. The preliminary filters were operated at an average cost of $2 per 1,000,000 gals. of water filtered by the sand filters. The sand filters were washed for the entire year by the Brooklyn method, the number of washings averaging 12.8 per filter. The average time between scrapings was 26.2 days, and the average amount filtered between cleanings was 107,550,000 gals. per acre. The average reduction of the bacteria in the raw water was 99.73 per cent. The corresponding figure for reduction of turbidity was 99.82 per cent. These figures refer to the complete treatment.

Belmont Filters.—This station is composed of a sedimentation basin giving 1.69 days' sedimentation, preliminary filters consisting of 9 filter tanks having a capacity of 40,000 gals. per 24 hours, 18 covered sand filters, and a covered clear water basin. The filters were operated at an average rate of 293,000,000 gals. per acre per 24 hours. The preliminary filters were started on October 23, 1907. They were operated at a rate of 75,000,000 gals. per acre per 24 hours this year, and have materially increased the length of runs or time between scrapings of the slow sand filters without any decrease in efficiency.

The cost of operation was $2.90 per 1,000,000 gals. filtered, which included a charge for operation of the preliminary filters and for laboratory expenses, the cost of preliminary filtration being 52 cts. per 1,000,000 gals. and the laboratory charge 33 cts. per 1,000,000 gals. The reduction in turbidity and bacteria by the action of the preliminary filters was 44.4 per cent.and 48.0 per cent., respectively.

There were 151 runs or cleanings during the year; 142 of these runs were on filters cleaned by the Brooklyn method and nine by the other methods. The average length of runs was 40.18 days, the amount filtered between runs being 94,-146,000 gals., or 125,194,000 gals. per acre. While the length of runs and quantity filtered with the Brooklyn method was not so large as with the usual method, it proved economical on account of the short time it was necessary to have the bed out of service, the low labor cost of cleaning and the saving in not having to replace the sand.

Seventeen filters were operated for the entire year by the Brooklyn method. The items of cost, etc., in the process of cleaning were as follows.

Number of runs	142.
Average length of runs, days	40.4
Average m. g. filtered per run	94.53
Average m. g. filtered per acre per run	125.71
Average cost of water to wash per m. g. filtered	0.05
Average cost of labor to wash and spade per m. g. filtered	0.55
Total cost of washing and spading sand in place (water and labor) per m. g. filtered	0.60
Average gallons water used to wash sand in place per m. g. filtered	4,109

One filter yas operated during the year by the "Nichols Separators" method.

Number of runs	9.
Average length of runs, days	37.38
Average m. g. filtered per run	88.02
Average m. g. filtered per acre per run	117.05
Average cost of labor, scraping, raking and spading per m. g.	0.262
Average cost of labor washing per m. g. filtered	0.266
Average cost of water per m. g. filtered	0.02
Average cost per m. g. labor, spading, scraping, washing, water, etc.	0.55
Average gallons of water used to wash per m. g. filtered	1.336
Depth of sand scraped per run, inches	1.42
Cu. yds. sand scraped per m. g. filtered	1.590
Daily average turbidity of applied water	14.0
Daily average bacteria in applied water	21.630

Comparing the effluent from the Belmont filters with the applied water, the reductions were as follows:

	Per cent.
Average reduction, turbidity	99.34
Average reduction, bacteria	99.19

Comparing the efficient from the plain sand filters and the water from the Schuylkill River, the reductions were as follows:

	Per cent.
Average reduction, turbidity	99.74
Average reduction, bacteria	99.66

A Blaisdell Filter Washing Machine installed in 1909 for cleaning the preliminary filters has been in operation for the entire year, and has been of great benefit to the filters.

Torresdale Filters.—The Torresdale Filter Station consists of 65 0.75 acre covered beds, a covered clear water basin, preliminary filter plant consisting of 120 concrete tanks, approximately 60 x 20 ft. each, containing 1,140 sq. ft. of filtering surface, with a capacity of 240,000,000 gals. of water per 24 hours; a low lift pumping station, containing eight 40,000,000 gal. centrifugal pumps; three 150 kw. generators and four sand washing pumps, with full complement of boilers, economizers, mechanical stokers, etc.

The amount of water filtered during the year was equivalent to an average rate of 4,270,000 gals. per acre per day. The entire cost of operation, not including the expenses of the low lift pumping station, or the cost of the wash water, which are included in the expenses of the pumping station, and which amounted to $2.17 per 1,000,000 gals. of water filtered, was $1.66 per 1,000,000 gals. of water filtered, making the total expense of pumping the water from the river and filtering it, $3.83 per 1,000,000 gals. filtered, a reduction of 16 cts. over 1910. Of this amount 28 cts. was for operating the preliminary filters, and 16.8 cts. the cost of the laboratory. The filters are operated at rates approximating 6,000,000 gals. per day per acre.

The number of runs or cleanings was less than ten per filter per year, and the average length between cleanings was 35.33 days.

The standard method of cleaning adopted for 1911 was washing the sand in the filters by ejectors and Nichols Separators, the cost of which was as follows:

Number of cleanings by Nichols method	613.
Average lengths of runs, days	35.31
Average m. g. filtered per run	121.21
Average m. g. filtered per acre per run	161.61
Cost of water to wash per m. g.	0.01
Cost to rake, scrape and wash per m. g., labor	0.62
Total cost to clean	0.63
Average gallons water used to wash per m. g.	1,924.
Cubic yards scraped per m. g. filtered	1.62
Average turbidity of applied water	5.
Average bacteria in applied water	2,610.

The resanding was done during the year by Bureau labor, using Nichols Separators. There were replaced 11,017 cu. yds. in filters, at a cost of 30.6 cts. per cu. yd.

Comparing the effluent from the Torresdale final filters with the water taken from the Delaware River, the reductions were as follows:

	Per cent.
Average reduction, turbidity	99.58
Average reduction, bacteria	99.67

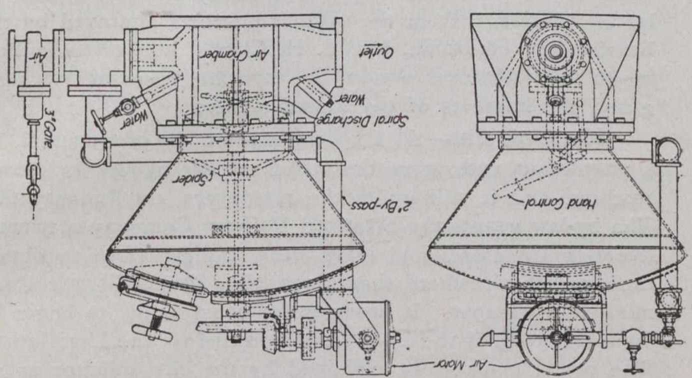
The Torresdale preliminary filters were placed in service on January 21, 1909, and since this date all water filtered by the sand filters has passed through these filters. They normally filter at the rate of 80,000,000 gals. per acre per day, but have given satisfactory results from rates of 100,-000,000 gals. per acre per day. The daily average reductions in turbidity and bacteria for the year were 66.98 and 65.45 per cent. respectively. The average turbidity of the applied water to the pre-filters was 16 and the maximum 97. The per cent. of wash water used for the year averaged 0.57 per cent. of the amount filtered. The number of cleanings for the pre-filters was an average of 190 cleanings to each filter, or about 1.9 days between cleanings for the year.

GRAND TRUNK AND NEW HAVEN RAILWAYS.

In connection with the proposed traffic agreement between the Grand Trunk and the New York, New Haven & Hartford, it is stated that the final settlement of the points at issue is remote. The agreement is still in the hands of Mr. E. J. Chamberlin, president of the Grand Trunk, and his officials, and any changes which they may consider necessary will have to be submitted to the directors of the New Haven and approved by them. When all interested parties in Montreal and New York are in accord, the agreement must then be sent to London for ratification by the Grand Trunk board of directors. It is felt that all difficulties will be overcome in time since some kind of arrangement between the two roads is desirable for both.

IMPROVED DEVICE FOR DELIVERING CONCRETE.

The management of the firm of W. Van Whitall, New York, are the perfectors of a new system for concrete distribution by means of compressed air furnished by a blower as illustrated in the accompanying illustration. The blower consists of a steel drum or receiving hopper bolted to a cast steel discharging pan. A shaft, passing through the drum, is connected by suitable gears and bevel to an Ingersoll-Rand four-piston air motor. The air is admitted through a hand-controlled valve to a flanged pipe leading directly to the air



Blower for Transporting Concrete by Compressed Air.

chamber. A 2-in. by-pass leading to the air motor is placed in this pipe in front of the air chamber. In this way the operation of the machine starts simultaneously with the admission of air to the line. Globe valves are placed on this by-pass line to permit of proper control of the pressure. Water is admitted through two connections at the front and back of the air chamber. The concreting materials are spread in alternate layers of stone, cement and sand and shoveled directly into the drum. As they pass from the latter into the air chamber the water spray is encountered and the combination of air and water results in a thorough mixing.

CROSS-WISE BENDING TESTS OF RAIL FLANGES.

The failure of the rail which caused the wreck on the Wabash Railroad near West Lebanon, Indiana (U.S.A.), on March 7th, seems to have been caused by the seaminess of the metal in the base of the rail. Mr. James E. Howard, engineer-physicist of the United States Bureau of Standards, in a report of his investigation issued by the Interstate Commerce Commission, writes: "The steel was seamy, and the initial line of rupture occurred along the line of a seamy streak. Herein is exhibited a structural defect which is prevalent, to a marked degree, in many rails. It is a defect, the presence of which is well recognized and admitted. Notwithstanding these circumstances, rails are accepted under specifications and tests in which this, the most comman cause of breakage, is not guarded against." Mr. Howard mentions the fact that this seaminess of the metal can be revealed by cross-wise bending of the flanges. About 27 per cent. of the head of the rail in question was worn down, and careful track inspection should have revealed this, but the seamy streak in the base, which, no doubt, caused its rupture, could not have been detected by inspection. As the author states, this was a defect of manufacture which current specifications and tests are not adequate to discover, though not less than 80 per cent. of broken rails reported, covering certain periods, are of the type here encountered.

COMPRESSED-AIR SEWAGE DISPOSAL.

Some interesting details concerning the compressed-air plant for removing the sewage of the small town of Allenstein, in Eastern Prussia, are given by R. Luckhardt, the director of the municipal gas and waterworks of the town, on the strength of thirteen years' experience. The town of Allenstein, though still a small country place of not more than 35,000 inhabitants, has rapidly grown in the last four decades; in 1870 the population barely amounted to 6,000 people. The River Alle, on which the town is situated, runs through a hilly country. and there are level differences of more than 100 ft. in the main streets. The Shone system of canalization having been shown at the Berlin Trade Exhibition of 1896, its municipality sent a committee over to England to study this system, and the contract was entrusted to the Gesellschaft Hydow, of Berlin. The plant was completed in 1899. There were difficulties at first, but on the whole the system has answered, and, as little has been published on the subject, Luckhardt's report in the "Zeitschrift des Vereines Deutscher Ingenieure" of November 2nd, 1912, will be found of interest. The working expenses amount to 0.67 mark per head per year, and the annual cost of the whole plant, including interest and depreciation and settling-tanks is estimated at 2.66 marks (58 cents) per head.

LARGE GAS ENGINE ORDERS.

The Mesta Machine Company, Pittsburg, Pa., have received two orders for gas engines in the past month which are worthy of particular mention on account of some features not usually encountered in this class of work.

The first order comprises three single tandem, horizontal double-acting, four-cycle engines, having cylinders 28-inch diameter by 36-inch stroke, to operate at a speed of 150 r.p.m., each arranged to drive direct connected a 500-kw., 60-cycle, 3-phase, 600-volt, alternating current generator. These engines are to be installed by the Canadian Car and Foundry Company, at their new Fort William, Ontario Province, plant, and will be the largest producer gas engine plant in Canada.

The main gas plant consists of four double bituminous coal generator sets furnished by the R. D. Wood & Company, Philadelphia, Pa. The gas plant was originally intended for fuel gas purposes, but as it is necessary to intermittently change from water gas operation to producer gas it was decided to utilize the waste, or producer gas, for power purpose. This gas will contain more than 10 per cent. hydrogen by volume, and is particularly suitable for use in gas engines.

The fuel gas which will be used for furnace work will have a heat value of 300 B.t.u. per cubic foot, and will contain 50 per cent. H and 30 per cent. CO. The operation of the producers will be such that it will be practically impossible to mix the gases, that is to say, the regulation of the gas will be automatic, eliminating any liability of water gas being carried to the engines. In the use of double generator sets the gas is drawn off the top of one generator and down through the incandescent mass of the other, the tar being consumed and converted into gas, thereby increasing the efficiency of the plant. Soot, of course, will be the resulting deposit. This soot will be disposed of through Thiesen washers.

The other order comprises three engines of exactly the same size for the Alpha Portland Cement Company, Easton, Pa. The engine will be located at Cementon, N.Y., near Catskill, and will operate in parallel with four producer gas engines now in service. Gas is generated through R. D. Wood & Company's superimposed pressure type producers, using bituminous coal as fuel.

COAST TO COAST.

Montreal, Que.—The Montreal harbor revenue for the past season was $461,396.43, an increase of $30,000 over those of 1911.

Calgary, Alta.—Payment of a small fee as rental to the city for the use of the street while building operations are being carried on is being considered by the commissioners.

Brantford, Ont.—Slush and ice clogged the intake of the power house supplying this municipality with light, and as a consequence the town was in darkness during the nights of December 11th and 12th.

Sydney, C.B., N.S.—The output for the Dominion Iron and Steel Company for the month of November was as follows: Coke, 46,660; pig iron, 28,670; steel ingots, 28,010; blooms, 27,060; rails, 15,385; rods, 7,250. Total shipments, 26,520 tons.

Toronto, Ont.—The steady advance in the mineral production of Ontario is strikingly shown by the annual report of the Bureau of Mines for 1911. The total production had a value of $41,976,797, an increase of 6.7 per cent. compared with the previous year. From 1906 to 1911, Ontario's output of minerals increased in value by 87 per cent.

Welland County.—Engineer C. Gardner, who has had charge of the work on the good roads throughout the county, submitted his report to the county council at their last meeting. Five and a half miles of good roads have been built in the county during the past year at a cost of $2,700 per mile. In Bertie township thirty-five days' work was done, in Thorold one hundred and forty-seven days, and in Stamford one hundred and forty-five days.

Dauphin, Man.—The members of the Board of Trade met in session last week, President R. Lilly presiding. The various items of work accomplished, and in hand, were explained, showing much time and labor having been spent in obtaining all particulars for the erection and operation of a hydro-electric power plant at Meadow Portage, where it is estimated 25,000 h.p. can be obtained. Government engineers have interviewed the board and reported favorably, and the city council have now the project in hand with a view of having it installed at the earliest moment. The installation of such a plant will give cheap light and power for manufacturing purposes.

Dauphin, Man.—At the last meeting of the city council a report was brought up by the Fire, Light and Power Committee. It was explained that owing to the rapid growth of the city, the power plant was being worked to its capacity, and it was impossible to undertake any more installations. Various suggestions were made for temporarily relieving the pressure. It was the unanimous opinion of the council that a new plant should be built with three times the capacity of the present outfit, and so arrange that a heating plant be connected for the purpose of supplying heat to the business and residential blocks from the exhaust steam. The contractors of the sewerage and water plant were granted an extension of time to complete the few outlaying points that are necessary to finish their contract. Building permits for the month ending November 31st total $135,425, as against $58,255 for the same time last year.

Victoria, B.C.—To raise the status of the logging engineer and to provide for the training of more men for the industry is the object of Mr. G. M. Cornwall, a well-known lumberman, of Portland, Ore., and proprietor of the "Timberman." With such a purpose, Mr. Cornwall called on Mr. F. L. Carter-Cotton, chancellor of the new British Columbia University, recently, to urge upon him the necessity of establishing a course in logging engineering in connection with the university. Mr. Cornwall pointed out that the Pacific Logging Congress was doing its utmost to raise the occupation of logging engineer to the status of a profession, and that the inclusion of a course designed to turn out qualified men from the university would be a great advance.

Toronto, Ont.—On a report by the engineer, Mr. E. L. Cousins, the consulting engineer, Mr. J. G. Sing, and the secretary, Mr. Alex. C. Lewis, regarding the separation of grades along the waterfront, the Toronto Harbor Commissioners unanimously decided that the property of the commissioners would be irretrievably damaged by any of the proposed solutions of the problem other than the viaduct order of the Dominion Board of Railway Commissioners, or by any deviation from the viaduct plans as approved by the board. The chairman, Mr. L. H. Clarke, was given authority to take whatever action he thought necessary to safeguard the interests of the commissioners.

Stratford, Ont.—At a special session the city council, by a unanimous vote, gave the street railway by-law its second reading, and it will go to the ratepayers on January 6th. The by-law grants the Stratford Railway Company a twenty-five-year franchise, and leaves the builders free to obtain their power elsewhere than from the Hydro-Electric Commission if cheaper. It provides for construction to begin by June 1st, 1913, if the by-law is confirmed by the Legislature. The power clause was explained by the city solicitor as requiring the consent of both council and ratepayers before the company can sell of lease electric power in the city. The Canadian Northern Railway, through Sir Wm. Mackenzie, has pledged itself to build the railway.

Toronto, Ont.—The Toronto Railway Company will be asked by the city to place in service 150 new motor cars of approved modern type, as recommended by the transportation experts, Mr. Bion J. Arnold, of Chicago, and Mr. J. W. Moyes, of Toronto, in their report, as well as to construct the lines in the older portion of the city suggested by the experts. They state that 150 modern motor cars are required at present to give a reasonable service on the lines. They also recommend that the company be asked to undertake to add new motors as fast as it builds new lines. The experts recommended the extension of Victoria Street north to Bloor Street "at any reasonable cost." They say: "This would prevent the crowding of traffic on either Yonge or Teraulay Street, these three streets offering sufficient transportation facilities for many years to come." The company will be asked to construct and put into operation at once a number of other lines.

GOVERNMENT SHIP RETURNS FROM ARCTICS.

The Canadian Government's ship "Arctic," which left Quebec on June 29th last, under the command of Commander Jackson, returned to Quebec on Saturday, November 16. All on board were well, and there were no complaints made by the members of the crew. The commander said he had been employed most of the time taking surveys in Hudson's Bay Straits, and as a result of the work there would be considerable changes in magnetic variations. He also took soundings and observations for ice conditions. He refused to express an opinion as to the practicability of the Straits as a route for grain.

Fort William's new industrial plants are making much progress toward completion. Additional elevator capacity and harbor facilities are being planned. When these various developments are completed the citizens will be claiming largest manufacturing city of the west.

PERSONAL.

JOHN McGILL has been appointed assistant manager by the Berg Machinery Manufacturing Company, Toronto.

A. S. GOING has been appointed engineer of construction for the Grand Trunk Railway System, with headquarters at Montreal, Que.

GORDON KRIBS, B.A.Sc., graduate of the University of Toronto, formerly assistant to the chief engineer of the Pacific Power & Light Company, Portland, Ore., is now assistant to the chief engineer of the Texas Power & Light Company, Dallas, Texas.

SUPERINTENDENT WHITE, of the Eastern Canada Power and Pulp Company's ground wood mill at Murray Bay, Quebec, has been appointed superintendent of the new one-hundred-ton ground wood mill, which will be erected by the Abitibi Pulp and Paper Mills.

T. R. DEACON, O.L.S., M.Can.Soc.C.E., has just been elected mayor of Winnipeg. Mr. Deacon is a graduate of the University of Toronto in civil engineering of the class of '91, and is president and general manager of the Manitoba Bridge and Iron Works, Limited.

G. SYLVESTER, of Calgary, Alta., has been elected one of the executive of five officers representing the various divisions of the American Association of Manufacturers of Sand Lime Products, the annual convention of which was held at the King Edward Hotel, Toronto, December 3rd and 4th.

ALFRED E. ROSEVEAR, recently appointed assistant to vice-president of the Grand Trunk, with headquarters at Montreal, Que., was born on February 20, 1863, at Montreal, and was educated at Montreal Academy. He began railway work on May 1, 1879, as a clerk in the motive power department of the Grand Trunk. The following year he was made clerk in the general superintendent's office, and from 1885 to 1890 was stenographer in the general manager's office. From 1890 to 1892 he was with the West Shore Fast Freight Line at Chicago and at Detroit, Mich., and then for six years was in the accounting department of the Reading Despatch at Detroit, becoming acting manager of the same line in September, 1898. He was appointed freight claim agent of the Grand Trunk in October, 1898, and in April, 1908, was promoted to assistant general freight agent of the same road, which position he held at the time of his recent appointment as assistant to vice-president.

RICHARD COLCLOUGH, recently appointed assistant to the general superintendent of the Intercolonial Railway and the Prince Edward Island Railway, with headquarters at Moncton, N.B., was born on February 24, 1871, at Bic, Que. After leaving the common schools he attended Rimouski College, and in 1888 graduated with the degree of B.A. from Laval University, Quebec. He began railway work on December 9, 1889, with the International Railway as a clerk in the superintendent's office at Moncton, and has been in the continuous service of that company ever since. From 1892 to November, 1901, he was private secretary to the chief superintendent, then to the general manager, and later to the general superintendent and manager. He was subsequently chief clerk in the manager's office until October, 1902, when he was appointed clerk in the general manager's office and in the office of the managing board. From June, 1911, until the following May he was chief clerk in the general superintendent's office, and in May, 1912, was appointed assistant superintendent of the Halifax & St. John division, which position he held at the time of his recent appointment as assistant to the general superintendent.

S. B. WILLIAMSON, since 1908 division engineer of the Pacific Division of Panama Canal Construction, has resigned his position to enter the service of J. G. White & Co., Limited, international engineers and contractors, of London and New York. Mr. Williamson was called to the canal service by Col. Goethals in May, 1907, as division engineer of the Pacific locks and dams. In his later position he had charge of the construction of the gigantic locks at Pedro Miguel and Miraflores, involving the placing of vast quantities of concrete, extensive dry excavating and dredging; the construction of terminal docks at the Pacific entrance, and municipal work in Panama City, and the Canal Zone south of Culebra. Previous to his work in Panama, Mr. Williamson was engaged in railroad and general construction work in various parts of the United States. He was also in the service of the United States government for some time, and in 1900 was in charge of the fortification work at Newport, R.I. In his new field of work, with J. G. White & Co., Limited, he will be associated with their London office in the capacity of principal assistant engineer, directing construction in all parts of the world excepting the United States and its possessions.

DEATH OF NOTED SCIENTIST.

The death is reported of Sir George Howard Darwin, second son of the famous Charles Robert Darwin, who won notoriety through his lectures and publications along the lines of nature and evolution. Sir George Howard Darwin was professor of astronomy and experimental philosophy at Cambridge University, he was 67 years of age.

FIRE LOSS OF THE UNITED STATES AND CANADA.

The fire loss of the United States and Canada during the month of October, as compiled by the Journal of Commerce, shows an aggregate of $13,651,650, as compared with $13,945,000 for the same month of 1911, and with $37,188,300 in October, 1910, when climatic conditions resulted in serious losses from forest fires. The fire losses for the first ten months of 1912 reach the sum of $191,181,600, as against $192,933,800 for the same time in 1911,

	1910.	1911.	1912.
January	$15,175,400	$21,922,450	$35,653,450
February	15,489,350	16,415,000	28,601,650
March	18,465,500	31,569,800	16,650,850
April	18,091,800	17,670,550	16,349,400
May	18,823,200	21,422,000	21,013,950
June	13,183,600	20,691,950	16,103,450
July	26,847,900	25,301,150	15,219,100
August	21,570,550	12,662,650	14,158,800
September	11,700,000	11,333,250	13,779,300
October	37,188,300	13,945,000	13,651,650
Total, for 10 months	$196,535,600	$192,933,800	$191,181,600
November	16,407,000	18,680,600	....
December	21,528,000	22,722,850	....
Total year	$234,470,600	$234,337,250	....

MEETING OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.

The monthly meeting of the society was held on Thursday, December 19th, in the society rooms, 413 Dorchester Street West, Montreal. Mr. H. H. Vaughan, assistant to the vice-president of the Canadian Pacific Railway, read a paper on "Rotary Snow Plows."

MEETING OF ENGINEERING ALUMNI, UNIVERSITY OF TORONTO.

At a dinner of the Engineering Alumni Association of the Faculty of Applied Science, University of Toronto, held on December 17th in Toronto, at which 125 were present, and over which the president, Mr. J. C. Armer, presided, there was a discussion of the research scholarships which the association is founding, and the announcement was made that next year research work would be done by Messrs. W. P. Dobson and M. R. Shaw. Mr. Dobson's work will be that of studying the electrical surges in transmission systems, due to the switching of loads on and off. The University of Toronto and the Ontario Hydro-Electric Commission are working in conjunction to give Mr. Dobson the necessary equipment and assistance. Amongst those who spoke at the dinner were Dean Galbraith, of the University of Toronto; Mr. J. E. Ritchie, president of the University Engineering Society; Mr. C. H. Mitchell, consulting engineer, and Prof. H. W. Price, of the University of Toronto.

COMING MEETINGS.

AMERICAN WOOD PRESERVERS' ASSOCIATION.—Ninth Annual Convention will be held at Chicago. Jan. 21-23, 1913. Secy-Treasurer, F. J. Angier, Mount Royal Station, B. & O. R. R., Baltimore, Md.

AMERICAN INSTITUTE OF CONSULTING ENGINEERS.—Annual Meeting, January 14th, 1912, will be held at The Engineers Club, 32 West Fortieth Street, New York, N.Y. Secretary, Eugene W. Stern, 103 Park Avenue, New York.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annua Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary, Professor C. H. McLeod.

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

OTTAWA BRANCH—177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Brayley, 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, W. D. Baillairge; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright; Secretary, Mr. Hugh B. Fergusson, 911 Rogers Building, Vancouver, B.C. Headquarters: McG University College, Vancouver.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

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. ASSOCIATION.—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, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

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

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

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

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, 57 Adelaide Street, 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, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION—President, John Hendry, Vancouver. 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, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

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

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

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. C. Rous.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

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

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

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5, Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5. Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman, Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.