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THE PROBLEM OF THE GREAT LAKES

The spread of disease, principally Asiatic cholera and typhoid fever by the use of polluted water supply has caused the Government of the United States through the offices of the hygiene laboratory to conduct serious investigations into the sewage pollution of interstate and international waters, with special reference to the spread of typhoid fever. That section of international waterway which most affects Canada is of course Lake Erie and the Niagara River. Owing to the increase in population of many Canadian municipalities on the borders of these waters and the consequential increase in the water supply and sewage disposal systems we have prepared this article, and present it with a special view of service to Canadian municipalities fronting on international waters.

In a recent address by a Canadian authority it was pointed out how the sewage of Buffalo, N.Y., even after its severe aeration by the falls and rapids of Niagara, seriously pollutes the intake of Niagara-on-the-Lake and the south shore of Lake Ontario.

In discussing the question of pure water supply it is impossible to separate this prime sanitary need from the question of sewage disposal; it is equally impossible in North America to separate these sanitary necessities from a direct relationship with the prevalence of typhoid fever. The coincident drop in typhoid fever rates with an improvement in the water supply has been observed in many instances. Figure 1 shows graphically this reduction of typhoid fever death rates in some large cities of the United States.

However important the relation of water supply may be, there are other factors which occupy no mean position in this respect. The rigid inspection and control of milk in all probability will still further reduce the incidence of typhoid fever. After these factors, water and milk, have been eliminated there will remain, however, a certain reduced typhoid rate, which is due to other causes. This persistence of typhoid fever in a city or town independent of the water and milk supply depends upon failure to dispose of in a proper manner or care for the excreta of persons infected with typhoid organisms. Carriers come into a community and often remain undiscovered. Many mild or ambulatory cases are never diagnosed as typhoid. Often because of poverty or other reasons no physician is called, and the case is unreported. This is especially frequent in the mild or atypical cases of children. Even if a physician is called, he may fail to diagnose typhoid because typical symptoms are absent or masked by other conditions. The physician's diagnosis and institution of preventive measures may be tardy, leaving a period during which the excreta are uncontrolled. Often, too, the case is discovered early, reported promptly, and proper instructions given in prophylactic measures, but cases are known where these measures are not properly executed.

Prof. Wm. T. Sedgwick, an authority in the United States, expresses his opinion that tourists, visiting points of interest such as Niagara Falls, etc., where polluted water supplies are drawn upon often, carry away the seeds of typhoid fever and spread the disease in foreign and distant parts.

The principal international waterways are Lake Erie, Lake Ontario, Niagara River and the St. Clair River. The Canadian population on the shores of these waterways may be placed at 600,000, while that of the United States is approximately 2,400,000.

There are no large cities or municipalities of the United States which seriously infect Lake Ontario, so that any infection other than that received by Canadian sewage is fed from Lake Erie, which water passed Detroit and Windsor, on the St. Clair River.

The importance of Lake Erie as a source of public water supplies can not be overestimated. Lake Erie contains 17,500,000 million cubic feet of water, which affords storage for the water discharged into it for about 920 days.

This great natural reservoir, with capacity for 920 days' storage, assures a high degree of purification by natural agencies, such as dilution, aeration, and sedimentation, besides affording the storage time necessary to permit of the natural death of pathogenic bacteria. The ability of the natural agencies operating in the lake to render sewage in-

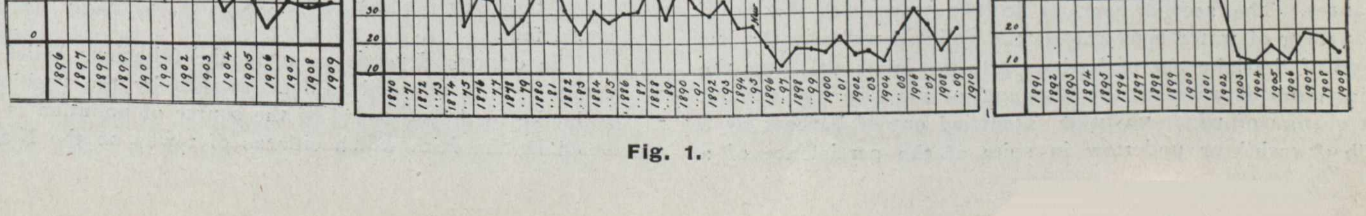


Fig. 1.

nocuous is very great, so that water at the centre of the lake is comparatively pure.

Where the sewage in great quantity is poured into the lake, especially near the mouths of rivers upon which large cities are situated, the zone of polluted water is wide and a greater distance toward the lake centre must be traversed before pure water is secured. With the growth of urban populations on the lake shore, this zone of polluted water is continually widening, and waterworks intakes have been repeatedly moved farther out to secure better water. In the danger of polluted water entering waterworks intakes there is another factor besides the ever widening zone of polluted water, viz., the action of currents.

Direction and velocity of the currents of Lake Erie may be said to depend entirely upon the wind.

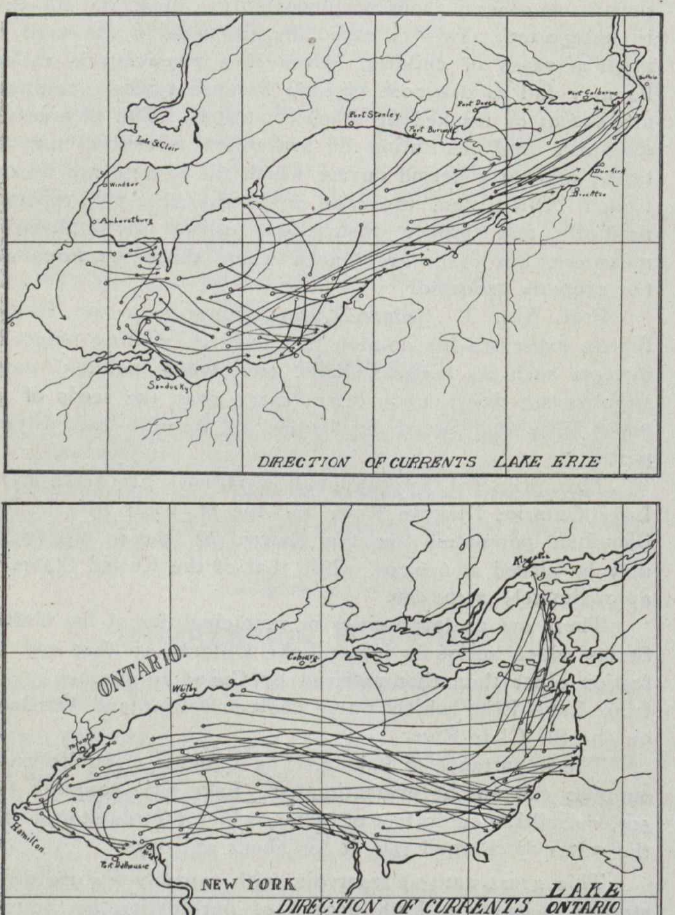


Fig. 2.

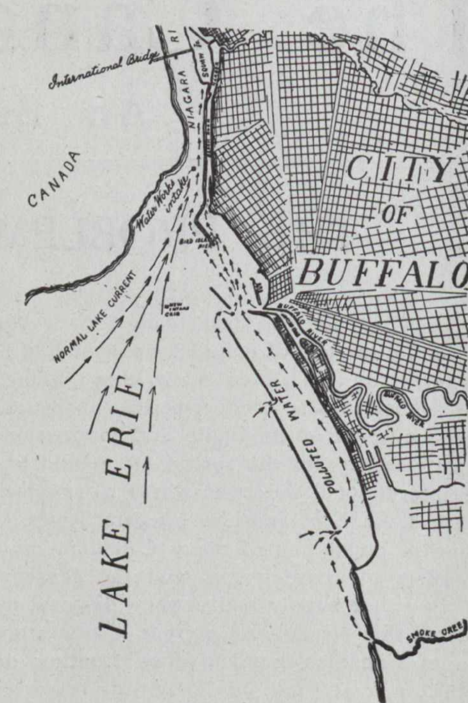
The frictional action of wind upon bodies of water operates in three ways:

(1) Surface current in the direction of or "with" the wind.

(2) Piling up of the water on the shore directly opposed to the direction of the current and lowering of the water at the opposite end.

(3) Alteration of temperature by mixture and by importation of waters of different temperatures.

The first and second effects of wind action are the most important from a sanitary standpoint. The first because of its direct carriage of polluted water for considerable distances. The second operates in two ways—(1) the rapid lowering of water level carries the polluted water in the low end of the lake out of harbors into the lake; (2) after the piling up of water at the high end of the lake and without a change of wind, pollution is carried out of harbors by a "backwash" or undertow in spite of the persistence of a surface current toward the shore. The third effect, alterations of temperature, probably has little sanitary significance.



Currents in Vicinity of Buffalo, N.Y., U.S.A.

When an unusual disturbance of a large body of water occurs due to strong winds, the immediate results are as indicated above—a surface current in the direction of the wind, a piling up of the water on the lee shore, and a fall of the water on the weather shore. The return to stable equilibrium is effected by a series of rythmic oscillations about a central nodal line. These rockings or oscillations are of decreasing amplitude until stable equilibrium is established, and in a comparatively long and narrow lake, with the wind in the direction of the long axis of the lake, resemble the motion of a child's seesaw or teeter.

The report of the deep waterway commission shows that in a period of four years, winds on Lake Erie from the south-west, west and north-west prevailed 56½ per cent. of the period, and winds from the south-east, east, and north-east 27 per cent. of the time. The general observations of meteorological stations show a great lack of dependency on the wind direction across this lake. The supposition that westerly winds protect the intakes entails the assumption that sewage pollution is carried at or near the surface of the water. The surface current near the shore is in the direction of the wind and the general trend of the lake water in quiet weather is toward the east, but only at a rate of one-eighth to one-sixth mile per day.

In time of storm, with strong gales blowing for days in one direction, there is not only a surface current in that direction, but also a deeper current in an opposite direction. The amount of pollution that this deeper current carries depends upon local conditions, but to assume that all sewage pollution is carried at or near the surface is unsafe. It is certain that this deeper undercurrent carries gross pollution out of harbors and river mouths in times of flood even when the wind is blowing directly inshore, making a surface current toward the harbor and raising the level of the harbor water several feet.

The curious dependence upon the fallacious belief that protection was afforded to lake intakes by the position of the intake to the westward of the source of pollution is paralleled by the faith which citizens of towns on the Niagara

River had in the position of their intakes to the westward of a known polluted current. Even when it became generally known that, at best, position of the intake could afford but a slight and insecure measure of protection, seldom was the prompt and obvious remedy, filtration of the water, applied.

Much valuable time was lost usually by attempting every known scheme for preventing pollution at the intake. Many of these schemes demanded removal of sewage outfalls to a greater distance or sewage disposal of some kind involving serious engineering problems and expenditure of great sums of money.

In almost every instance sewage disposal of some kind was a consummation devoutly to be wished. But the problem and expenditure made its immediate accomplishment impossible. As at Erie and Niagara Falls, the citizens continued to drink sewage-polluted water for years, and eventually filtration plants will have to be installed to prevent water-borne typhoid, while the sewage-disposal problem is still unsolved.

Filtration of Lake Erie water used as public water supply is inevitable.

Treatment of a clear water with hypochlorite of lime or other methods is capable of rendering the treated water safe. However, such treatment does not remove the turbidity in roily waters, and there is a growing sentiment for filtration methods which not only furnish a safe water but also remove the objectionable turbidity.

Fig. 3.

In a report to the United States Government, Mr. Allan J. McLaughlin draws the attention of that body to the necessity of controlling the sewage pollution of Lake Erie. The zone of polluted water, he states, should be lessened and not widened. No crude sewage should be discharged into the lake without treatment. Existing faulty sewer systems should be eliminated as rapidly as engineering and economic problems connected with the change can be solved. Inasmuch as the development of these sewer systems has extended over a number of years, and their existence to-day represents capital invested, their elimination will be correspondingly low.

There are six points of pollution of Lake Erie and Niagara River that are seriously viewed by United States officials. They are:—

(1) The lake shore from the New York State line to the City of Dunkirk.

(2) The City of Dunkirk.

(3) The lake shore from Dunkirk to the City of Buffalo.

(4) The City of Buffalo.

(5) The cities of Tonawanda and North Tonawanda.

(6) The City of Niagara Falls.

From the City of Dunkirk to the state line, Lake Erie receives the water of numerous creeks and streams. These are usually short and of torrential characteristics. The most important of these is Chautauqua Creek, and in flood times carries a great deal of farm and roadside drainage.

The City of Dunkirk has about twenty outlets, ranging in size from 12-inch to 48-inch.

The entire sewage of the city, probably 2,000,000 cubic feet daily, is poured into a shallow harbor, which is estimated to contain not more than 100,000,000 cubic feet of water. The excessively polluted water is carried out of the harbor entrance and given certain abnormal conditions of wind, could readily reach the waterworks intake.

That portion of Lake Erie from the City of Dunkirk to the Buffalo city line receives numerous creeks, and upon this shore line are several towns and villages of importance from the standpoint of lake pollution. About ten miles north-east of Dunkirk, Silver Creek and Walnut Creek discharge into the lake by a common mouth. At this point is situated the village of Silver Creek, with a population of 2,500. Walnut and Silver Creeks drain a combined area of about 59 square miles. There are no towns or villages above Silver Creek contributing sewage in any considerable amount to these streams.

The sewage of Silver Creek will be cared for according to plans approved by the State of New York Board of Health. These plans provide for screening and septic tank treatment, with some form of treatment of the effluent to be carried out later. Provisional authority was granted, February, 1908, by the New York State Board of Health to discharge the effluent from the screening plant into Silver Creek without further treatment for the present.

Silver Creek takes its water supply from Lake Erie. The intake is located near the mouth of Silver Creek and a little to the west.

Cattaraugus Creek rises in Wyoming County and flows west into Lake Erie. It has a watershed of about 560 square miles. Its watershed is hilly and contains some of the highest ground and the greater part of the forest area existing in the western part of the State. The watershed is rather sparsely populated, but the development of the waterpower means increased population and an increasing amount of pollution carried to Lake Erie by this stream.

Hamburg has a population of about 2,000, and is situated upon Lake Erie and Eighteen Mile Creek, 20 miles south of Buffalo. The State Board of Health approved plans for sewage disposal, September, 1908. This system provides for settling tanks (8-hour retention), and discharge of the effluent into Eighteen Mile Creek. Hamburg gets its water supply from two wells. One of these is a well 20 feet deep, furnishing satisfactory water. The other, located outside the village, furnishes a highly sulphuretted ground water, aerated to get rid of the odor, and filtered mechanically after treatment with alum. An analysis of this water made by the State hygienic laboratory showed a low bacterial count and absence of B. coli. The raw water seemed to be as good as the filtered sample.

North-east of Hamburg on the lake shore drainage area are situated Athol Springs, Bay View, Woodlawn Beach, Blasdell, and the industrial towns of West Seneca and Lackawanna. The pollution from the last two is the most important.

The City of Buffalo has a population of about 425,000. Its sewage is discharged into the Niagara River by means of four principal outlets. The sewage discharge of Buffalo is problematical, but is placed at 160,000,000 gallons per diam. The sewage from the Tonawandas, a community of over 18,000, ultimately goes into the Niagara River. The City of Niagara Falls discharges its sewage matter directly into the same river in addition to 10,000 tons of garbage and refuse yearly. All this waste material is dumped into the Niagara River through a steel chute.

Dr. Horton, city bacteriologist of Niagara Falls, N.Y., examined water from the municipal water supply daily from October 21, 1910, to January 1, 1911. The lowest bacterial count was 3,100 per cubic centimeter, and counts reached as high as 36,000.

The intakes of the Tonawandas and Lockport, further out in the stream, are very much better placed than the Niagara Falls intake. The sewage-polluted water is known to

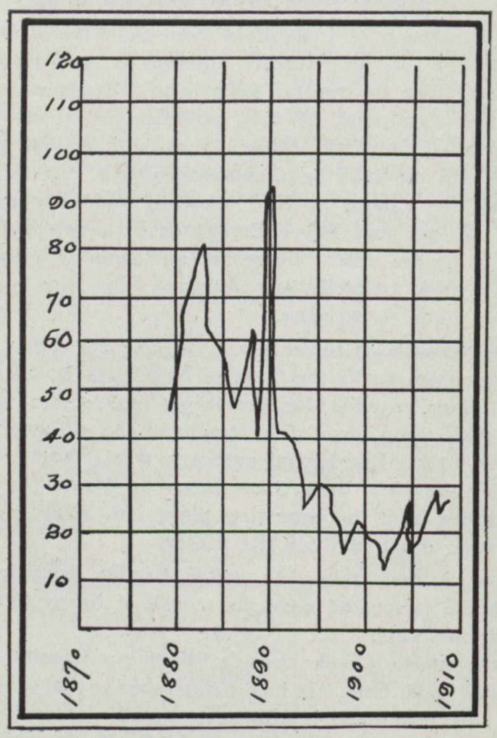


Fig. 4.

"hug the shore," as shown in analyses made by Dr. Bissell, city bacteriologist of Buffalo, N.Y., in 1904, and by Mr. Theodore Horton in 1907. At Buckhorn Island a sample of water showed a bacterial count of 800 per cubic centimeter; 300 yards from the United States shore the count was 860 per cubic centimeter; 100 yards from the shore the count was 10,000, and directly offshore there were too many to count.

It may be readily seen in what condition, bacteriologically, the water of Niagara River reaches Lake Ontario. A report from the laboratories of the Ontario Government show a continuance of B. coli in samples forwarded from Niagara-on-the-Lake, Ont., although, unfortunately, no systematic examination has been undertaken. It would prove of interest to obtain figures showing counts made at Buffalo and Niagara Falls, N.Y., simultaneously with counts made at Niagara-on-the-Lake, Ont., and frame an opinion as to what extent the oxidation and aeration of the falls affected the two municipalities below, and at which season this churning of the liquid reached its maximum and minimum influence on organic life.

A reference to Fig 2 will demonstrate the fact that the currents of Lake Erie as a body are uniform in the direction of their flow, from west to east; however, in the case of Lake Ontario there is a decided swirl in the western portion of the waters which does not appear to flow any definite course. Some years ago a series of experiments were carried out in the vicinity of Toronto, Ont., to ascertain the course of lake currents at that point. Ten floats were launched from Victoria Park, to the western part of Toronto Island; these were not surface floats but were carried by the current at depths varying from 16 to 30 feet. Fig. 3 is a chart showing the direction taken by the various floats; the course of float 9, which may be seen to cut the four launched from a point opposite Leslie Street, was nearer the surface than the average of those taking a south-westerly course; the depth of float 9 was 20 feet; that of float 1, 20 feet; float 3, 30 feet; float 4, 25 feet; float 5, 25 feet; and float 6, 30 feet. The depth of float 2, which was launched near the spot of No. 9, but which travelled toward the beach, was 16 feet. From these experiments it was clearly proved that the general direction of the currents is parallel to the coast line from Victoria Park to the western extremity of the island. North-east, east, and south-east winds as a general rule produce currents flowing south-west, while south, south-west and west winds give north-easterly currents, and north and north-west winds give rise to variable currents.

Instances of currents are known in the vicinity of Niagara-on-the-Lake; fishermen have often made mention of their nets out in deep water during the prevalence of strong easterly winds, would be strongly clogged with sea weed on the western parts, showing an undercurrent from the west.

Contamination from sewage around Toronto may be safely stated to depend on the wind; easterly winds forcing the matter in Toronto Bay out the western gap and westerly winds reversing the process. An authority, who has made a considerable research into this question, found, under certain conditions, that a sample taken off Humber Bay could be duplicated off Scarborough twenty-four hours later; the reverse was found to act similarly, so that under average conditions the lowest counts of B. coli and bacteria generally have been found off the Island, the location of the present intake.

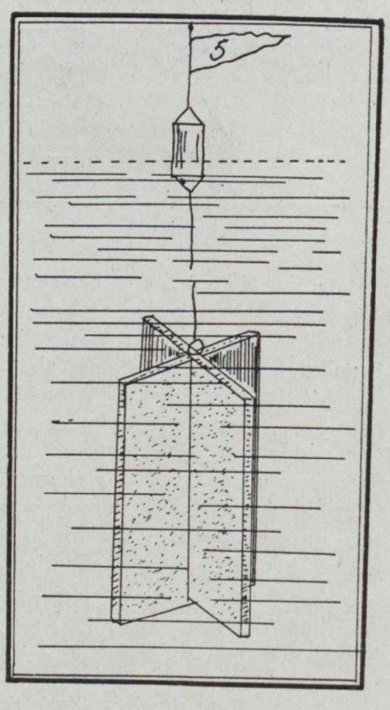


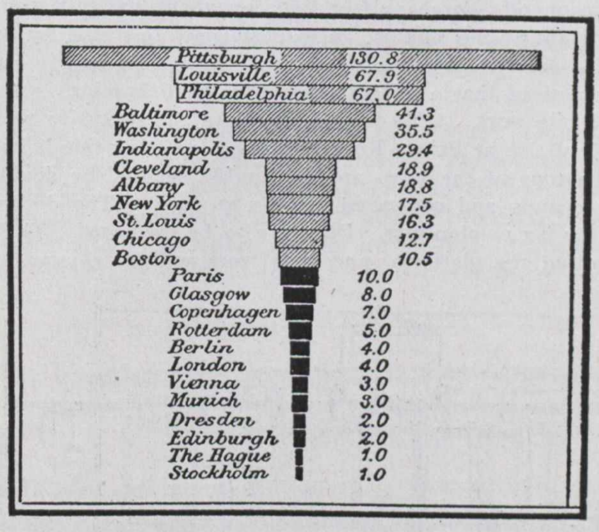
Fig. 5.

The typhoid fever death rate in Toronto is represented in Fig. 4, the figures on the left being deaths caused by this disease per one hundred thousand inhabitants. It is in that period after 1890 that serious consideration to the water and sewage problems has been given. This assumed the form of a tunnelled shaft under the bay and other engineering works of considerable magnitude.

The means and methods adopted in the research of these currents in the vicinity of Toronto consisted of a number of floats or drags made to the design of Fig. 5. These consist of two cross brackets of wood covered with linen, a rope of from twenty to sixty feet attached, and a tin float surmounted by a flag and numbered.

A couple of sextants, a good marine glass, a sounding line, a supply of glass stoppered bottles with weights, etc., for taking deep water samples, and a couple of self-registering thermometers completed the outfit used.

In view of the fact that a report will shortly be issued dealing with Toronto water supply, these maps and charts will doubtless prove of interest.



Typhoid Death Rate of Some United States Cities Compared with European Municipalities.

PEAT UTILIZATION IN GERMANY.

Efforts are being made in Germany to improve the cultivation of marshes and moorland. The success attained in this direction in the Netherlands has attracted attention in Germany. The German marsh and moorlands cover an area of about five million acres. The largest districts by far are in Prussia, especially in the provinces of Hanover and Schleswig-Holstein, and also in Ponerania, Brandenburg, Posen, and Ost-Preussen. The best quality of peat from German soil, so-called air-dry peat, contains about 45 per cent. of carbon, 1.5 per cent. of hydrogen, 28.5 per cent. of chemically-combined water, 25 per cent. of hygroscopic water, and small amounts of nitrogen. If the ash exceeds 25 per cent. the peat is deemed not adapted for fuel purposes. The percentage of ash can vary from one-half of 1 per cent. to 50 per cent. In collaboration with Professor Frank, of Charlottenburg, Dr. Caro discovered a method for the economic utilization of peat which he claims avoids former mistakes, and which he describes as follows:—The generator consists of shaft-like ovens, where the burning of the peat is conducted in a way admitting limited quantities of air. Thus also, a dry peat in pieces can be treated, and produces a gas strongly impregnated with tar fumes, which gas, after purification from tar, will furnish a useful heating and power gas. The inventor found that if the gasification process was properly conducted, peat containing as much as 60 per cent. of water could be used. Peat having a percentage of water above 60 could be dried down to this figure by storage in the open air. This process, Dr. Caro asserts, permits the manufacture of a good heating gas during the entire year, and he claims that it can be used in connection with the generation of electricity. Another result of the discovery is the extraction of nitrogen by this process, 85 per cent. of this element contained in the peat being recovered therefrom. This nitrogen can be converted into ammonia by the introduction of steam. The method admits of the production of ammonium sulphate, and thus furnishes agriculture with a valuable fertilizer.

THE MARINE TERMINAL OF THE GRAND TRUNK PACIFIC RAILWAY, PRINCE RUPERT, BRITISH COLUMBIA.*

By Frank E. Kirby, Esq., and William T. Donnelly, Esq.

When, in 1910, the authors of this paper were retained to visit the Pacific Coast for the purpose of studying the shipping and marine repair facilities and to visit Prince Rupert, the western terminus of the Grand Trunk Pacific Railway, they were at a loss how to proceed, for not only was Prince Rupert beyond their geographical knowledge, but it also failed to appear upon any available map or chart. However, with an abiding faith in the Grand Trunk Pacific, they undertook the commission.

Proceeding to the Pacific Coast over the Northern Pacific, they visited Portland, Seattle, Tacoma and Bremerton in the United States, and Victoria, Vancouver and New Westminster, British Columbia, finally proceeding from Vancouver on the Canadian Pacific steamer northward through the inland passage, and after three days' steaming through the narrow waterways which were literally the submerged valleys of the Coast Range, they arrived on the evening of the third day in the harbor of Prince Rupert and were, for the first time, fully convinced that such a location actually existed.

Those who are especially interested and desire to extend their geographical knowledge, are referred to the most recently published charts of the Northern Pacific and Alaskan Coasts, on which Dixon's Entrance, north of Graham Island between 54 and 55 degrees north latitude, can be readily located. To the east of Dixon's Entrance, Brown Pass leads to Chatham Sound and across this to the east, between Digby and Kaien Islands, is found Prince Rupert harbor. So hidden away and unprepossessing is the entrance that until 1906 it was supposed to be unnavigable. Actual surveys show it to be one of the most easily entered and satisfactory harbors on the Pacific Coast. The entrance, which is from the south, is about three-eighths of a mile wide. It is entirely unobstructed with a depth of water nowhere less than twenty fathoms. The entrance may be said to extend northward for three miles, when the harbor is reached, extending northeast for four miles, with an unobstructed width of from one and one-half to three-quarters of a mile.

The city of Prince Rupert is located on Kaien Island which forms the right of the entrance and the southeast shore of Prince Rupert harbor. The city proper is laid out over an area three and one-half miles in length by one mile in breadth, on the shore of the island, with a background rising to an elevation of from 1,600 to 2,000 feet, the general characteristics reminding one very forcibly of the city of Montreal with Mount Royal behind it.

The Grand Trunk Pacific Railway will reach the coast by the Skeena river valley about 15 miles to the south, and crossing to Kaien Island at its southern end, will closely follow the shore to and along the water front of Prince Rupert.

The general character of the shore of Prince Rupert is bold and rocky, falling off very rapidly to a depth of approximately 20 fathoms. A careful examination of the entire length of the harbor front of Kaien Island determined Hays Cove as the only practical place for such a development as

*Abstracted from paper read before the Society of Naval Architects and Marine Engineers, New York, November 16 and 17, 1911. Copyright.

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was contemplated; that is, a floating dry-dock of 20,000 tons lifting capacity, so designed as to be capable of operating in sections as a number of smaller docks, an adequate shore plant comprising electric power generating plant with air compressors, machine shop, boiler and blacksmith shop and covered construction shed under which the pontoons of the floating dry-dock could be built.

The dock is to be of such a design and construction as to be almost entirely built upon the site. To accomplish this, the general plan provides for the practical completion and equipment of the shore plant before the dry-dock is commenced.

One of the controlling features in the general plan of this development was the fact that the city of Prince Rupert will be 600 miles from the nearest base of supply or point where any considerable assistance, mechanical or otherwise, can be obtained. It was therefore determined at the outset that the mechanical equipment, large tools, etc., must be of the very best and most complete. Also, that on account of the high price of labor on the Pacific Coast, ample provision for the use of power in every way possible should be made. This has resulted in the design of an electric power generating station with ample capacity for all present needs and with a large possibility of extension.

As the plans were laid out in such a manner as to make the development progressive, constructing those parts first which could, when completed, be used in the construction of the remainder, this outline will be followed in the description.

Pier and Platform Work.—The first work to be undertaken will be the pier, marked "Pier No. 1" on the general plan. This will be 420 feet in length and 60 feet in width, the piling being on 10 x 5-foot centres. The pier will require about 600 piles.

At the same time, there will be built the platform at the shore end of this pier 80 feet wide by 930 feet long, having an area of 74,400 square feet, and will require about 1,600 piles on 5 x 10-foot centres.

At the western end of this platform there will be an extension off shore 350 feet long by about 100 feet wide and at right angles to this, an extension 560 feet long by 80 feet wide for the attachment of the floating dry-dock. It will be noticed that a double line of diagonal bracing is used in the pile work. This is on account of the excessive rise and fall of tide at Prince Rupert, which for spring tide is 25 feet. The tops of the piles are thoroughly secured by double 6 x 12 clamps and connected by 12 x 12 caps. The decking is to be 4 x 12 planking. Piles are to be creosoted. The total area of the platform and pier work will be 181,400 square feet. The completion of this work, it is expected, will provide ample space for the landing and handling of materials for the rest of the plant.

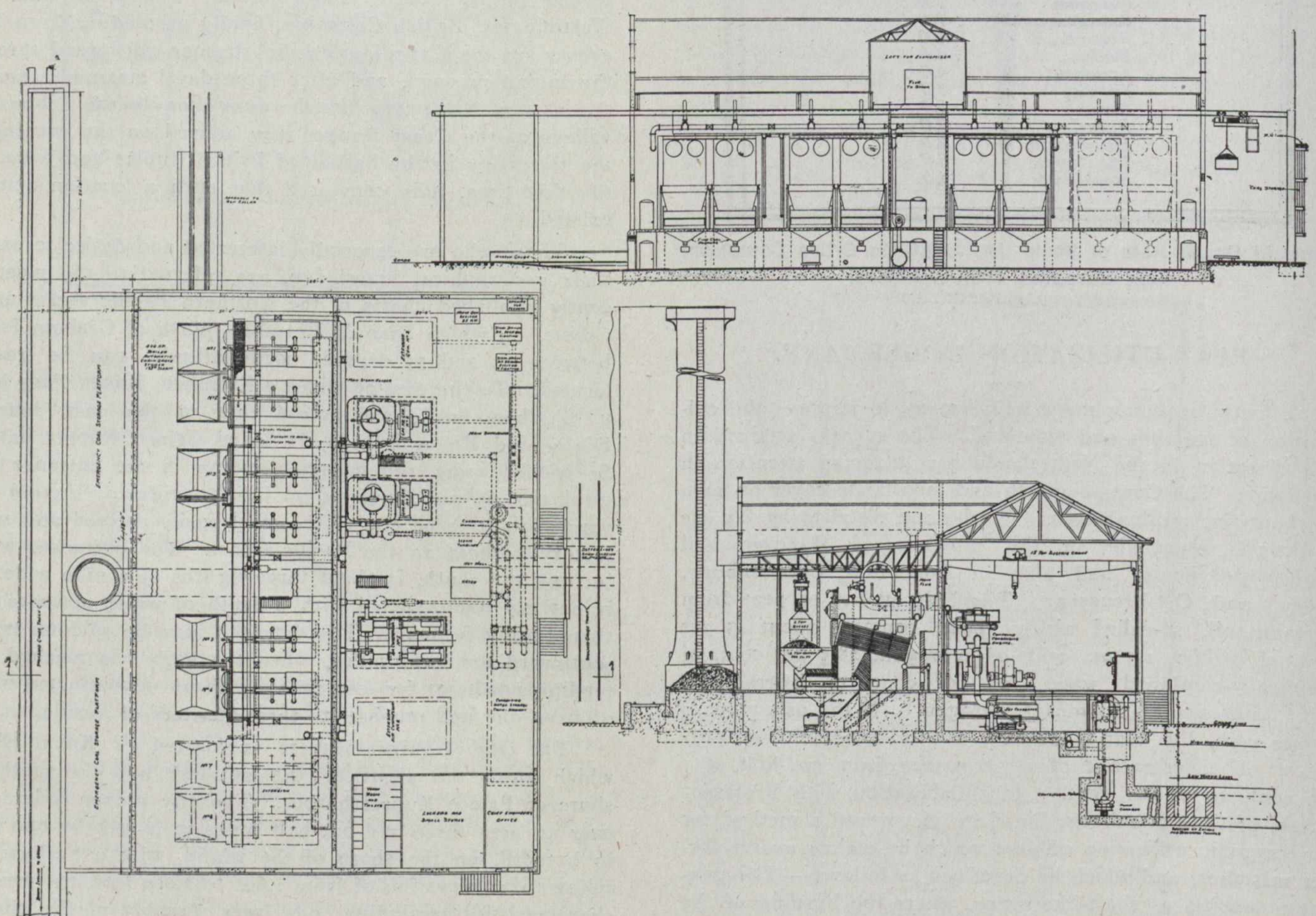

Fig. 1—Power Station for Prince Rupert Dry-Dock Ship-Repair and Shipbuilding Plant, Prince Rupert, B.C.

Launching Platform.—In front of the main platform, east of the pier, there will be built a launching platform for side launching. This will be 80 feet wide by 440 feet long and will be carried on 16-inch piles on 5 x 10-foot centres, braced and reinforced by heavy piling along the edge over which the launching will take place. The general arrangement and bracing of this piling can be seen by referring to Plate 2, showing the platform in connection with the building shed. It will be noticed that the outer half of the building platform has a slope of one and three-fourth inches to the foot, which is approximately the launching grade for side launching.

Power-House.—The interior arrangement and equipment of the power-house can be seen by reference to Fig. 1. Electric power is to be furnished for operating the pumping machinery of the floating dry-dock, for compressing air and to operate machinery in the various shops, also for furnishing electric lighting for the plant.

The building is to contain both boilers and power plant under one roof with fireproof dividing walls, and is to be 104 feet wide by 148 feet long, having a covered area of 15,392 square feet. The building will be of modern steel-frame construction, the walls and roof to be of reinforced concrete.

There will be installed six 400 horse-power water tube boilers, supplied with automatic stokers, chain-grate type, such as are known to give good satisfaction with Pacific Coast coals. Provision is made for adding two extra boilers. There is also a provision for the installation of an economizer, in case it it found that the load factor warrants the expense. Draught will be obtained by a steel or concrete chimney 175 feet high and 11 feet in diameter. An overhead trolley is provided for handling coal from storage to hoppers above the stokers and also for handling ashes.

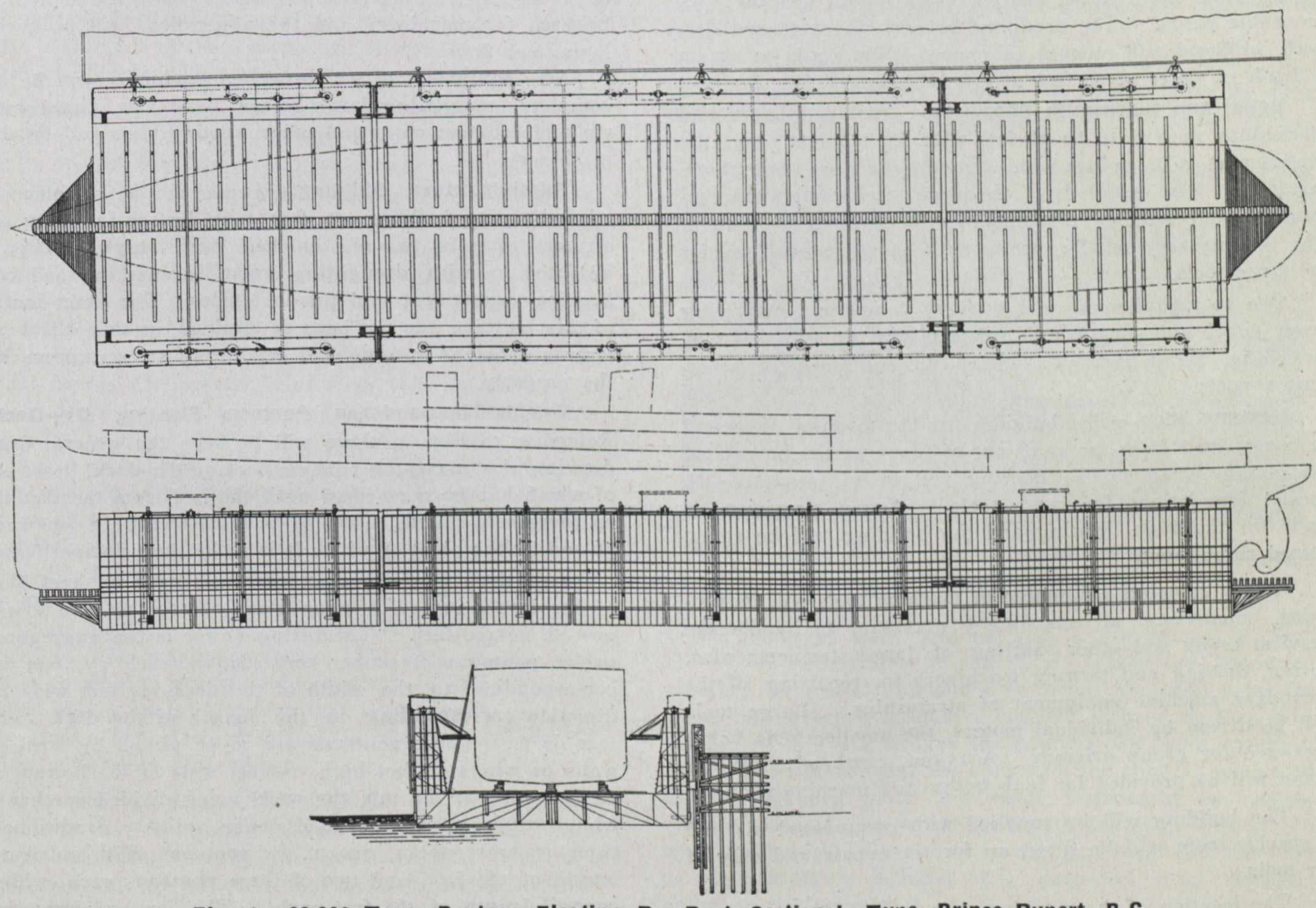

Fig. 2.—20,000 Tons, Pontoon Floating Dry-Dock Sectional Type, Prince Rupert, B.C.

Coal Handling and Storage.—Provision is made for receiving coal both by water and rail. Coal by water will be received at the outer end of the pier for the unloading cf which there is provided a standard grab-bucket installation, so arranged as to load cars beneath the hoppers, the cars to be handled by small yard locomotives to the coal pocket of 1,000 tons capacity, located adjacent to the boiler house. Coal received by rail will be delivered direct from the cars of the Grand Trunk Pacific Railway, which pass at the rear of the property to the coal pocket approached by an incline.

Main Engines.—There will be two main engines of 900 horse-power each and while vertical reciprocating compound engines are shown and specified, using steam at 175 pounds pressure and 258 revolutions per minute, turbine engines will be considered as an alternate.

Condensers.—Jet condensers are shown, but alternate figures will be taken for service condensers. The type to be used will depend upon local conditions as to the cost of water at the time of installation. Condensing water will be obtained through the rock cutting and shaft sunk within the power-house, the circulating water being handled by a vertical centrifugal pump operated by an electric motor.

Generators.—Electric generators are to have a capacity of 600 kilowatts, 3-phase, 25-cycle, 550-volt alternating current. For these generators there will be provided two steam-driven exciters, one of 50 kilowatts and one of 25 kilowatts capacity. These machines are to be direct current, 220 volts. There is also to be a motor-driven exciter of 25 kilowatts capacity, the motor for this machine to be a 35 horse-power, 3-phase, 25-cycle, 550-volt alternating-current squirrel-cage-type motor.

Cranes.—There will be provided for the erection of this machinery in the power plant, a 15-ton overhead traveling crane. This will be operated by electricity and the current supplied will be from one of the steam-driven exciter sets.

Air Compressor.—For furnishing compressed air to the shops of the plant, there will be provided a compound Corliss air compressor having a displacement of 1,580 cubic feet of free air per minute when operating at 150 revolutions. This compressor is to be designed for a steam pressure of 175 pounds per square inch and for an air pressure of 100 pounds. The distribution of the air will be by means of underground piping through the yard.

Switchboard and Distribution System.—The entire system of light and power throughout the plant is to be controlled from the switchboard located on the main floor of the power-house. The switchboard is to consist of 15 panels. The construction throughout is to be most substantial and thorough, fully meeting the best standards of central station distribution.

Cut and Fill and Foundations.—From the natural conditions of the site the ground is very difficult, all the property either having to be cut down or raised to grade by fill. The location of the power-house was determined by the condition of the ground, which, at this location, is of rock which will have to be reduced to the grade required. The cut and fill work is intended to go forward at the same time as the pier work, and the power plant will be commenced as soon as the site can be leveled.

The rock cut for the power-house and yard grading will amount to 18,000 cubic yards, the rock fill for retaining walls, 57,000 cubic yards, and the earth fill for grading, 73,000 cubic yards. The dredging between the pier and dry-dock bulkhead will amount to 100,000 cubic yards to obtain a depth of water of 20 feet at low tide.

Boiler and Blacksmith Shop.—The combined boiler and blacksmith shop is to be 76 feet wide by 150 feet long, the central part to be 33 feet wide, provided with a 15-ton traveling crane. The design is of the usual steel-frame shop construction and will, in this instance, be covered with wood. The flooring will be of concrete with heavy foundations for the large tools.

The tool equipment will be very complete, comprising heavy punch and shears, rolls, plate planer, flanging clamps, etc., heavy steam-hammer and a full equipment of blacksmiths' tools.

Machine Shop.—The building for the machine shop will be constructed from the same set of plans as the boiler and blacksmith shop. The flooring will be of concrete with special foundations for large tools. Ample provision is made for thorough lighting and the building will be steam heated throughout.

A very complete equipment of machine tools will be provided, comprising all machinery necessary to handle the heaviest crank and other shafting of large steamers; also, boring, drilling and turning machinery for repairing all the secondary machine equipment of steamships. Large tools will be driven by individual motors, the smaller tools being arranged for group driving. A 15-ton overhead traveling crane will be provided for both boiler and machine shops.

The building will be supplied with compressed air and a special room will be fitted up for the repair and care of air tools.

The location of the machine shop is such that ready access may be obtained from the dry-dock and water front, and it will be noticed that provision is made for entering the boiler and machine shops with railroad cars. Provision is also made for the extension of these shops as the business develops.

Building Shed and Woodworking Shop.—On account of the excessive rainfall in Prince Rupert, it will be necessary to do the work of building the pontoons for the floating dry-dock under cover.

In laying out the general plan for the property and in view of its future development, the possibility of shipbuilding was carefully considered, and while there is no immediate prospect for the building of steel vessels so far from the base of material, it was thought advisable, in preparing for the building of the pontoons under cover, to make the construction of a permanent nature, suitable for shipbuilding, to be used in the immediate future for wooden shipbuilding and later on for steel shipbuilding. To accomplish this, a building shed has been developed. This building is located over the launching platform and over part of the general platform extending eastward from Pier No. 1, with foundations carried down to rock.

The property is laid out for side launching, this being the only practical development that was possible under existing natural conditions. The building about to be described is the result of these conditions.

While side launching is unusual in Europe and generally in America it is practically universal on the Great Lakes, and the general design of this structure is the result of experience there.

The shipbuilding portion of the structure is designed to have a covered width of 86 feet by 300 feet long, with a clear height under cranes of 50 feet and under girders of 56 feet. The shop section of this building is to have a width of 80 feet and a length of 300 feet. The ground floor will be used for machinery and the upper floor will be used as laying-out floor.

The equipment of woodworking machinery will be most complete, comprising large re-saw band saw, timber sizer, rip and crosscut saws and other woodworking and finishing machinery.

Administration Building.—There will be an office and administration building 40 feet wide by 100 feet long, constructed of wood two and one-half stories high. This will be fitted up with draughting room, accounting and book-keeping department and private offices. The exact location of this building has not been determined, as this will depend largely upon the opening and grading of streets approaching the property.

Twenty-Thousand-Ton Pontoon Floating Dry-Dock.—Referring to Fig. 2, there will be seen the general design drawing of a 20,000-ton pontoon floating dry-dock, description of which has been reserved until the last from the fact that, as previously stated, it was to be almost entirely constructed at and by the plant of which it is to be the principal feature.

This dock is to have an over-all length on keel blocks of 604 feet 4 inches, a clear width of 100 feet and a width over-all of 130 feet. The lifting power is the aggregate of twelve pontoons of timber construction, each 130 feet long corresponding to the width of the dock, 44 feet wide in a direction corresponding to the length of the dock and 15 feet deep. These pontoons are to be united by steel side walls or wings 38 feet high, 15 feet wide at the bottom and 10 feet wide at the top, the walls being divided so that the whole structure may be used under ordinary conditions as three separate docks, one of six pontoons, with an over-all length of 269 feet, and two of three pontoons each, with an over-all length of 164 feet each. The largest commercial ship upon the Pacific Coast at the present time is the Minnesota, the outline of which is shown on the dock. The vessel would have a dead weight in ordinary unloaded condition of approximately 18,000 tons.

The machinery for pumping the dock will consist of centrifugal pumps operated by electric motors, the capacity of the equipment being sufficient to pump the entire lifting power of the dock in less than two hours. A detailed description of the pumping machinery will be given later.

The structure as a whole is secured to the shore by the engagement of clamps on the dock with a vertical truss secured to the pile platform or pier in such a way that it is free to rise and fall with the tide, and when being raised or lowered with a ship. The location of these attachments is such that when it is desired to use the dock in three separate sections, the bow section may be detached and moved around the corner of the pier work located as shown on the general plan alongside the platform, and secured in the same manner as provided for in its original position. To make the other two sections available as separate docks, it is only necessary to detach the middle section, comprising six pontoons, from the pier work and advance it the length of the detached section, when the sliding clamps upon the wings will coincide with those used for the previous section when the dock was operated as a whole. This will allow ample space between the centre and stern sections for the overhang without interference of vessels which may be docked on them.

As the feature of a sectional dock to be used as a whole or separately is somewhat new, it is desired to call attention to the fact that the three largest commercial docks in the United States, namely, the 10,000-ton floating dry-dock of The Tietjen & Lang Dry Dock Company, built in 1900, the 12,000-ton dock of the Morse Dry-Dock Company, built in 1902 (both in New York Harbor); and the 10,000-ton dock of the port of Portland, Oregon, are sectional docks in five sections each. All of these docks are of timber construction and are giving excellent service.

Pontoons.—As previously stated, the pontoons for this dock are to be twelve in number, constructed entirely of timber. By referring to Plate 2, there will be seen the design and construction plan of these pontoons. They are to be 130 feet by 44 feet by 15 feet deep, with a crown of 3 inches at the centre, and will have 15 trusses spaced on 3-foot centres. There will be a centre water-tight bulkhead 12 inches thick and above this bulkhead the centre will be reinforced for carrying keel blocks. There will be three partial bulkheads on each side to stiffen the pontoons. All diagonal braces are heavily reinforced with anchor stocks. The arch brace is made up of planking through-bolted with screw bolts and is intended to take the reverse stresses when the dock is floating light. This is a considerable amount when it is considered that the wings are superimposed weights carried at the extreme ends of the trusses, supported by an evenly distributed pressure over the entire bottom. Six by 12-inch deck beams are worked across the upper and lower truss members, carrying the 5-inch deck and bottom planking parallel to, and reinforcing the truss members for the maximum stress. This construction also makes it possible to get in double vertical tie rods alongside of bulkheads in such a manner that they may be replaced at any time. The whole structure is made water-tight by caulking with white pine wedges.

To protect the exterior from toredo and other marine worms, it is first thoroughly graved with tar poisoned with arsenic, then sheathed with two layers of hair felt, each thoroughly saturated with tar and arsenic, and then with creosoted lumber, also treated with arsenic and thoroughly secured with galvanized nails. This treatment, together with the facility for inspection afforded by the possibility of detaching and docking any pontoon, has been found to give satisfactory protection.

Each pontoon will require approximately 330,000 board feet of lumber or a total, including outrigger or prow on the end pontoons, of 4,000,000 board feet. The entire bill of lumber will be of selected grade of Oregon pine or Douglas fir.

As previously stated, it is the intention to have these pontoons built upon the launching platforms under the building shed, using the tools and equipment provided for the plant. Sufficient room has been allowed to build three pontoons at the same time. As soon as they are launched they will be moved into the basin between the pier and dry-dock platform and temporarily united together in correct relative position by timber clamps, when they will be ready for the erection of the steel wings.

For further information relative to the use of wood for the construction of floating dry-docks, parties interested are referred to a paper on "Floating Dry Docks in the United States—Relative Value of Wood and Steel for their Construction," appearing in the Proceedings for 1910 of the Society of Naval Architects and Marine Engineers.

Steel Wings.—By referring to Figs. 2 and 3, showing the completed structure and the design of the wing trusses and plating, a general idea will be gained of the construction of the wings. They consist of channel and angle frames on 3 foot centres corresponding to the trusses of the pontoons, and a covering of plating varying in thickness from one-half to five-sixteenths inch. The construction is greatly facilitated by reinforcing the plating against water pressure on the outside by horizontal angles. This does away entirely with troublesome intercostal connections and gives the material used very much greater value in the construction as a whole.

By referring to the table of weights it will be seen that there are required about 2,200 tons of steel. Where the wing meets the deck of the pontoon there is a steel shoe secured

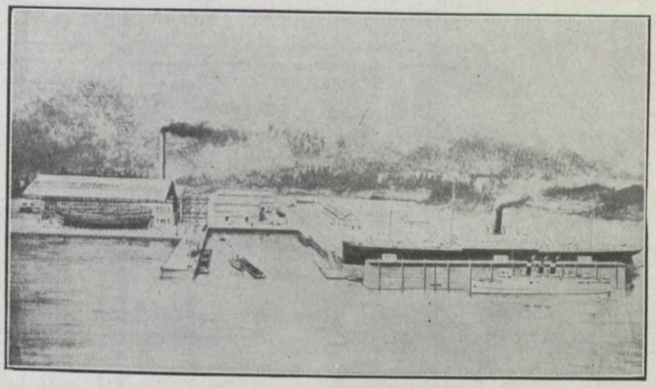

Fig. 4. Ship Repair and Shipbuilding Plant at Prince Rupert, B.C.

to the frame of each pontoon and a corresponding shoe riveted to each frame of the wing. These are connected together by a steel link about 15 inches long and pins, the upper one of which is tapered one-half inch to the foot. The driving of this pin wedges the pontoon and wing together. At the point of contact, the bottom of the wing is reinforced by a 12 x ½-inch plate and made water-tight by canvas packing saturated with red lead. On the outer side of the wing the method of securing is similar, except that the shoe on the pontoon is replaced by a cast-steel strap through-bolted to the pontoon.

Provision is made for multiple punching on uniform centres of 3 inches and 6 inches throughout and the intention is to have the material fabricated in Europe or the eastern part of the United States, all frames assembled and shipped by water to Prince Rupert. The erection of the first section is to be commenced as soon as the first three pontoons are launched, the compressed air machinery of the plant being used for pneumatic riveting.

Pumping Machinery.—The dock will be pumped by twenty-four (24) 12-inch centrifugal pumps, one in each end of each pontoon. By referring to Plates 6 and 8, the general arrangement and detailed construction of these pumps will be seen. The pump suction will take water from the bottom of the pontoon, the suction being protected by a liberal area of screen. Delivery will be directly through the flood-gate used in lowering the dock.

The pumps will operate at approximately 275 revolutions per minute, being driven by a vertical shaft. All the pumps on each side of each section will be driven through gearing and horizontal shafting by one electric motor, as shown in Fig. 2. A jaw coupling is provided in the wing at about the level of the top of the pontoon for disconnecting the vertical shaft when the pontoon is removed for self-docking.

There will also be seen in Fig. 3 the indicator for determining the level of water in the wings. This consists of a counterweighted float in vertical guides and a vertical rod extending through the deck of the wing. As the water enters the wing, the float rises and the height of the rod above the deck will indicate the depth of the water in the wings.

A similar device, not shown, is provided to show the depth of the water in the pontoon. The flood-gates are operated to control the lowering of the dock and also to control the pumping collectively and individually of the different pumps, it being understood that with the pumps running, no water will be delivered if the flood-gates are entirely closed, and that, by a regulation of the gates without altering the speed of the pumps, any degree of control or any distribution of control can be accomplished. In case one side is rising too rapidly, the partial closing of the gate on that side, without disturbing the operation of the machinery, will effect the control, or the gates may be left at the same opening and the machinery stopped.

By this method, a much quicker and more powerful control may be obtained, as not only will the discharge of water from the dock stop, but will immediately commence to enter, thus doubling the power of control which would be obtained by closing the gates.

Electrical Equipment.—As previously explained, the group of pumps on each side of each section of the dock will be operated through horizontal and vertical shafting by one electric motor. Thus, for the two smaller sections of three pontoons each there will be required four 100 horse-power motors and for the larger section of six pontoons there will be required two 200 horse-power motors. The motors are to be alternating current, 3-phase, 25-cycle, 550 volt and will operate at approximately 500 revolutions per minute. They are to have round rotors and slip rings for variable speed control. The armature shaft is to be extended on both ends and will operate the distribution shafts through reduction gearing at a speed of approximately 275 revolutions per minute.

There will be two motors on each section, one on each wing. The power circuit on the pier is connected to the power circuits on the sections by flexible cables. The power circuits of each section are independent from the main circuit, so that each section receives its power independently. but the control system is to be so arranged that the two motors on any section may be operated from one master panel or the combination of any two sections may be operated from the master panel on either of the two sections, and, lastly, when all three sections are used together, all six motors are to be controlled from the master panel on the middle or larger section.

Master Panel.—The master panel is to consist of a panel or drum having suitable contacts or switches for independently starting or stopping any of the motors. The starting or stopping of any one motor or a number of motors will not affect other motors at rest or in operation. The provision is also to be made for operating any or all motors at one-half, three-quarters and full speed.

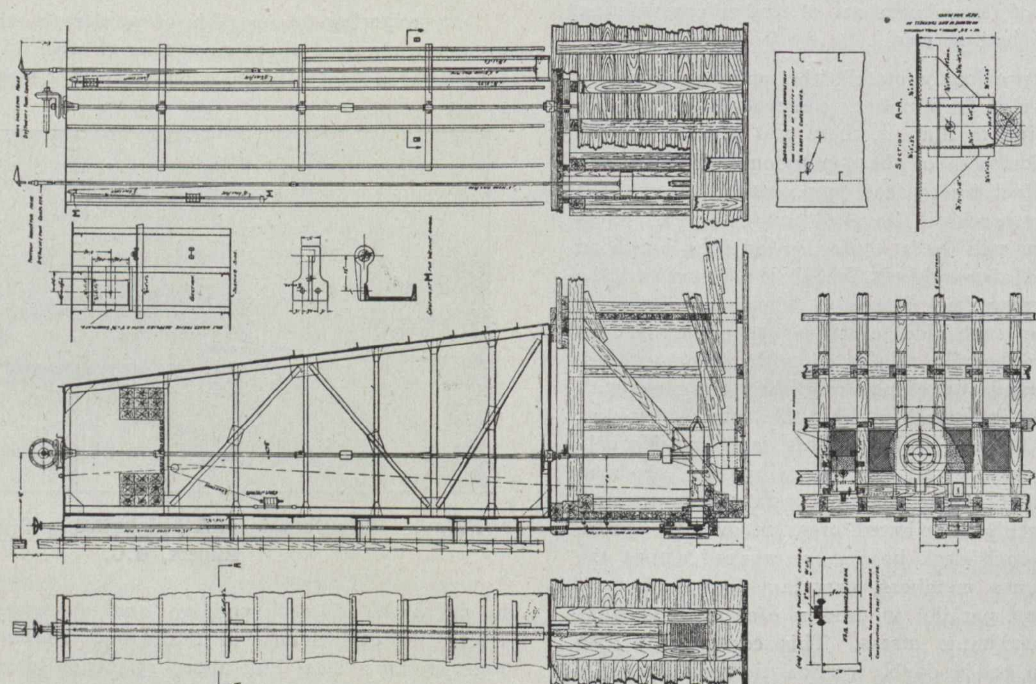

Fig. 3. General Plan Showing Locations of Pump, Wing and Pontoon Floats, and Gate Rod Protection for 20,000 Tons, Pontoon Floating Dry-Dock Sectional Type, Prince Rupert, B.C.

Compressed-Air Equipment.—While steam-driven air compressors are provided in the power plant to furnish compressed air for the shops, it was deemed advisable on account of difficulty due to the extreme rise and fall of tide, to make flexible air connections to the floating dry-dock and to provide an electrically-driven air compressor upon each section.

On one side of each section there will be provided an electrically-driven air compressor having a capacity of 500 cubic feet per minute. The air will be delivered to a receiver in the wing below, and from this to air piping carried along the bottom to each side of the wing, with multiple outlets for the connection of air hose to the pneumatic tools. Provision will also be made for connection between the sections of the dock when they are operating together.

Electric current for operating the air compressors will be taken from the circuits supplying the motors for pumping the dock, and as air will be used only after the dock is pumped up, the capacity of these circuits will be more than ample.

Operating Equipment, Bilge Blocks, Keel Blocks, Etc.—Referring to Fig. 2 there will be seen the arrangement of keel blocks and bilge blocks. The keel blocks are to be of oak 12x16 inches x 4 feet long and are to have a height of 4 feet. The bilge blocks are to be on about 12-foot centres and operated according to the usual American practice by means of a galvanized chain on the floor of the dock and a leading rope through 6-inch sheaves secured to the wing near the deck, leading up and returning over the pipe railing around the tops of the wings. The return rope leads to the tail dog and is used in tripping the dog and pulling the block out when the ship is leaving the dock. The bilge blocks are provided with an elevating screw which has been found to be of great service for removing blocks one at a time for painting.

In the American practice of handling floating drydocks, side shoring is not used. There is a general practice, however, of using centring trams for locating and steadying the vessel in position until firmly at rest upon the keel and bilge blocks. The arrangement of these trams can be seen in Plate 6, showing the general design of the dock.

Illustrative Display Drawing.—There is also submitted herewith, an illustrative display drawing or perspective view (Fig. 4), carefully prepared as to relative scale and proper angular projection from the plans, the background being worked in from actual photographs taken approximately from the viewpoint of the illustration.

The vessel as shown, requiring the full lifting power of the dock, is the Minnesota, and lying alongside, to convey more clearly the scale of the structure, is shown the new steamer Prince Rupert of the Grand Trunk Pacific Railway, now running between Prince Rupert and Vancouver.

While such a drawing is unusual, its value as a ready means of conveying information must be apparent to all. The use of similar illustrative plans is customary with architects, and it is believed that the practice may be adopted to advantage by engineers generally.

SMOKE PREVENTION IN LARGE POWER STATIONS.*

By H. S. Vassar.

The steam demand in a central station is very different from that of a factory; the load is apt to fluctuate rapidly and sometimes as much as 50 or 60 per cent. of the boiler capacity must be "broken up" within perhaps 30 minutes.

Sometimes the sudden approach of a summer shower will so increase the lighting demand as to call for six or eight extra boilers in about as many minutes. Again an accident at a congested point in the street railway system may cause a blockade that will relieve the load so promptly as to start all the safety valves blowing. Perhaps within a few minutes the load may return with an even larger demand for steam, and fires must be forced to meet it.

Other causes too numerous to mention might be given for the occasional erratic behavior of the load; it suffices to say that the modern central station engineer is continually on the lookout for such changes and, so far as it is possible, strives to anticipate load variations by bringing up the banked boilers slowly, if time permits. But time is often lacking, and then, regardless of the smoke-preventing devices in use, the hurried breaking up of banked fires produces smoke.

One of the frequent structural difficulties with which many boiler plants, built up to six or eight years ago, have to contend is the small combustion space over the fire. Although this may be sufficient if hard coal is burned, it is usually lacking when bituminous or semi-bituminous coal is used. With a building designed for low-set boilers, it is often impracticable, if not impossible, to rebuild the furnaces for the use of soft coal, whether for hand firing or automatic stokers.

The ease with which a soft-coal fire responds to changes in steam requirements, together with the rapid rate at which it can be burned, makes it particularly desirable for central station use. Moreover, hard coal, when the smaller sizes are used with forced draft, is open to the objection of the cinders being distributed over the surrounding area. This is considered by many almost as great a nuisance as soft-coal smoke. When it is necessary or desirable to use soft coal with these old settings, some of the numerous steam-jet devices will sometimes lessen the amount of smoke produced. The gist of the matter is that such a setting is absolutely unfitted for either smokeless or efficient operation with soft coal. For this reason, few of the large central stations of to-day build new furnaces without carefully considering the nature of the fuel to be burned and providing, to the best of their ability, the proper combustion space over the grate.

Efficient or smokeless combustion is more or less handicapped by hand firing, such firing requiring open fire doors during from 10 to 20 minutes of each hour when firing soft coal. Automatic stokers, however, are continually growing in favor; and, although each type has its own particular disadvantages, the gain in efficiency resulting from their use is a strong argument for their installation in almost any plant burning 75 tons or more per day. Some of the qualifications which should characterize the mechanical stoker for central station use are:

1. Simple but substantial construction.
2. Small scrap pile.
3. No hand manipulation of the fire.
4. The rejection of a minimum amount of combustible with the ash.
5. Ability to burn varying grades of fuel economically at any rate up to 50 lbs. per sq. ft. of grate per hour, and to meet the varying steam demand promptly with a limited amount of skilled attention.

There is at present a movement for skilled boiler-room supervision, brought about partly because of a demand for the elimination of smoke, but to a larger extent as the result of an attempt to secure higher boiler-room efficiency. The principal reason for this increased attention to the matter of boiler-room operation is evident. The central station is in reality only a factory, its raw material being coal and its finished product electricity. In the older plants fuel constitutes from 40 to 60 per cent. of the cost of electrical en rgy at the switchboard and in later installations it is much higher.

A few years ago the boiler-room economy was supposed to be looked after by the superintendent or the chief engineer. These men, however, have enough on their hands in most stations without tackling, other than superficially, problems that are worthy of the undivided attention of at least one first-class man. By supervision is not meant an occasional trip through the boiler room, or a few maledictions heaped upon the heads of the firemen by a water-tender; but continuous hour-to-hour supervision by a trained man whose principal duty is the economical burning of fuel.

*From a paper delivered before the International Association for the Prevention of Smoke.

PROVISION FOR UPLIFT AND ICE PRESSURE IN DESIGNING MASONRY DAMS.*

By C. L. Harrison, M. Am. Soc. C.E.

There has been much discussion recently by engineers and the technical press on the upward pressure of water and ice thrust in dams. The following brief statement is written to bring the subject before the society in the hope that it will be fully discussed.

Uplift.—For convenience in discussing this subject, reference is made particularly to masonry dams on rock foundations. The principles involved will apply equally to other foundations and to dams built of other materials. The upward pressure may be due to water getting into the foundation of the dam or into the dam itself.

Foundations vary so much in character, that it is necessary to study each particular site before deciding to what extent water may get into them.

(1) In the case of a foundation of hard, sound rock, without either horizontal or vertical seams, there is no reason to expect that water will get into it and produce an upward pressure, and, in the design, no allowance should be made for it. In such cases the junction between the masonry and the foundation can easily be made water-tight.

(2) In the case where the foundation is well stratified with well-defined horizontal seams, and the dam is located near a fall or rapids in the stream, so that the water may flow from the seams at the toe of the dam as freely as it enters them from the reservoir, the upward pressure will be approximately equal to the static head at the heel and gradually decrease to zero at the toe of the dam.

(3) Take a foundation similar to the foregoing in every respect except that the water in the seams of the rock cannot escape freely near the toe of the dam, but must flow some distance down stream through rock or other materials before it reaches the surface of the ground, or must rise vertically to the surface: Then the upward pressure at the heel will be equal to the static head, and that at the toe will be equal to the head required to overcome the resistance to the water escaping at that point.

While these three cases present well-defined conditions, it is probable that at most sites the conditions will lie between those presented in Case 1 and in Cases 2 and 3, that is, the water will not be in the foundation throughout its entire area, but will cover only a part of this area. This makes it necessary to study the foundation carefully at each site in order to determine to what extent water may get into it. When this upward pressure exists, weight must be added to the dam by additional masonry to counterbalance it. Generally, it will be found cheaper to make large expenditures to provide a cut-off in the foundation, which will not only reduce the uplift, but will also save the water. Such a cut-off should be located at the heel of the dam. If it is located under the middle of the dam, there would be an upward pressure under the up-stream half of the dam, due to the full head of the water in the reservoir.

A thorough investigation, by borings and otherwise, should be made of the foundation at each site before the dam is designed, and a liberal margin should be allowed over what the engineer (basing his figures on his experience and best judgment) believes to be safe.

In order to determine what allowance to make for pressures due to water which gets into the dam itself, one must first decide on the character of the construction. With suitable stone, sand, and cement, it is possible to build a masonry dam which will have no horizontal cracks or seams, and it is also possible to provide against vertical cracks, to a large extent, by expansion joints. Water in vertical cracks, however, does not produce an upward pressure. In such structures very little, if any, allowance should be made for the upward pressure due to water getting into the masonry.

If the materials for building water-tight masonry are not to be had at the site of the dam, and it is very expensive to import them, it is generally advisable to adopt a different class of masonry, which will probably be more pervious and also more difficult to construct without horizontal cracks or seams, thus allowing the water to enter the dam, and resulting in upward pressures. The extent of such pressures will depend on the character of the masonry and the care with which it is built, all of which must be known before an estimate can be made of the extent to which the water will get into the dam. The effect of this upward pressure, however, must be counteracted, either by increasing the section of the dam or by increasing its height above the water level in the reservoir, or by both. In many cases it may be advisable to provide drainage wells near the up-stream face to intercept the water and carry it off through pipes at the toe of the dam, thus reducing or eliminating its effect in the main body of the dam. After determining the type of masonry to be constructed, it is still a question of judgment, based on observation, tests, and experience, as to what the upward pressure in the dam will be.

The upward pressures in the foundation, and in the dam itself, should be considered separately before a decision is reached.

Ice Pressure.—After ice has formed on a reservoir, it contracts under a lower temperature and expands under a higher temperature. The contraction due to the cold weather of winter results in cracks which fill with water that freezes and produces a continuous sheet of ice over the surface of the water. Under the higher temperatures of the late winter and early spring, the ice is warmed up and expands. On reservoirs this results in the ice being forced up the banks, unless the inflow of water should raise the level sufficiently to provide the increased area. In case the banks are vertical or nearly so, the expansion produces a pressure on the sides of the reservoir and results in the ice being compressed to some extent and buckling up out in the reservoir. In some cases the ice may be crushed.

In designing dams, the ice pressure should be considered, but it is of less importance than the upward pressure of water in the dam and its foundations. The ice is in sight and can be cut along the face of the dam, and thus relieve the pressure. Generally, in storage reservoirs, the period of heavy ice pressures is also that of low water, and the pressure would come against the dam at a point considerably below the high-water level, where the dam is strong enough to resist it. In many cases, the dam is located in a narrow gorge where the full effect of the ice field cannot reach it. The dam should be strong enough to resist the water pressure and the additional pressure caused by the ice, but what this will be depends on the thickness of the ice and other local conditions at each site, and no general rule can be made to cover all cases.

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CONTENTS OF THIS ISSUE.

GEORGIAN BAY CANAL.

Mr. Hopewell, mayor of Ottawa, thinks that Canada is big enough and sufficiently wealthy to begin immediately the construction of the Georgian Bay Canal. Such a waterway, linking the Great Lakes with the Atlantic ocean, would, he says, be not only a national but an Imperial advantage, for great ocean-going vessels could be taken into the lakes at any time without resulting in any complications, for the canal would be entirely in Canadian territory, and consequently not subject to the international waterways agreement.

He also advocates the route on the grounds that it would give a stimulus to the coal mining industry of Nova Scotia, as the vessels using the canal could bring Nova Scotia coal up and return with corn, as a result of which Canadian coal could be laid down at Fort William fifty cents a ton cheaper than from the United States. In his estimation the canal would result in a large proportion of United States trade for Europe coming through Canada, as the route would be shorter than any now existing and more economic for shippers.

The Georgian Bay Canal project is not having unanimous support, because, unfortunately, certain sections of the country have schemes which are dearer to their hearts. A larger portion of Ontario, for instance, is advocating the enlargement of the present Welland Canal, while many in Western Canada concentrate their desires upon the building of the Hudson Bay Railway. In Ontario, opinions are divided respecting the Georgian Bay and the Welland enterprises, respectively, simply because, we believe, it is thought that the Dominion government will proceed with only one and not both projects. If it were thought that an appropriation would be placed in the estimates for the deepening of the Welland Canal and the necessary improvements following that, and for the building of the Georgian Bay Canal also, we would probably witness a unanimous Ontario.

Mr. Hopewell quoted figures showing that the trade which comes through the Welland Canal at present is small, but he did not give the reason, which is that the big lake boats are now barred from the canal. He also spoke of the report of an engineer employed by New York State, which said that, as the Canadians were about to deepen the Welland Canal, there was a great chance for New York State to derive the greatest advantage therefrom and eliminate the St. Lawrence route by building a ship canal from Oswego to Syracuse and connecting with the Erie Canal, which, in turn, joined the Hudson River at Albany. Thus vessels from the head of the lakes could pass through the Welland Canal and then proceed directly to New York via Oswego, which, being in United States territory, would not be affected by any international agreement.

There is little danger of this, as even if such a canal were built, which is unlikely, no sane shipper would take such a route, when he can ship now from Fort William direct to Buffalo and thence to New York.

Before proceeding with the construction of the Georgian Bay Canal, every engineering and commercial phase of the project should be thoroughly investigated. An expenditure of $200,000,000 or more should not be made by a country such as Canada, which is yearly adding to its debt, unless there is ample justification. The Monetary Times supports the immediate enlargement of the Welland Canal, and will support the Georgian Bay project if it can be proved that such a costly undertaking can be well borne, and that its probable results will justify the expenditure.

PURE WATER AND SEWAGE DISPOSAL.

The large outlay on water purification plants in connection with water supplies drawn from the Great Lakes has become of great importance recently. In the article, entitled "The Problem of the Great Lakes," appearing in this issue of The Canadian Engineer, will be found some exceedingly pertinent matter connected with the question of water supply drawn from the Great Lakes. In this article it will be noted that all facts shown point to the necessity of the elimination of contamination by sewage disposal in these bodies of water. The time appears not far distant when municipalities must devote as much attenton to their sewage disposal problem as they are now devoting to the water supply question. To those who are using the Great Lakes as a source of supply there comes the necessity of closely considering the direction and action of currents. The necessity of careful, scientific observation of both a chemical and bacteriological nature is becoming more and more apparent, and much careful investigation must be done before the engineer will be in a position to design most efficiently for the water supply of our municipalities.

Much of this investigation work is, no doubt, within the province of the Medical Health Officer, for he is equipped from the nature of his training for the most efficient bacteriological investigatons. There has been noticeable, however, a tendency on the part of the Medical Health Officer, to deal with questions which are outside his province, and which are rather in the dominion of the engineer. While it is true that the best results can be secured only by the greatest co-operation between the two, at the same time it must be remembered that the most efficient results will be secured when the Medical Health Officer confines his attention to what is his own peculiar province. The design and construction of water supply and sewage disposal plants is the business of the engineer, and he should not be handicapped and harassed by continuous suggestion on the part of the Medical Health Officer.

ENTRANCE REQUIREMENTS TO ENGINEERING SCHOOLS.

With the increasing requirements necessary for the engineer of to-day to compete with his fellows, the question may arise, How are the engineering schools of Canada striving to meet this additional need? To everyone acquainted with the engineer in practice it is surprising how many of these are unable to successfully use and apply the mathematics necessary for the solution of engineering problems. No doubt a great deal of this lack of ability is due to the way in which mathematics at the Engineering Schools are taught; but, on the other hand, we feel that a good deal is due also to the way in which the applied mechanics and applied mathematics are mingled. For instance, elementary mathematics are at present taught in the first year of the curriculum of the engineering school, and the calculus is given in the second year. At the same time as the student is receiving instruction in the calculus he is also being taught applied mechanics, which demand a knowledge of the calculus. In other words, in his applied mechanics course he must accept certain statements as true until the end of the year has come, with its instruction in calculus. How much better would it be if the elementary mathematics were removed from the course and calculus given in the first year. A working knowledge of the calculus is a most decided asset in almost any branch of engineering, and, unless the fundamental ideas are firmly seized during a college course, it will only be with considerable difficulty that the subject can be appreciated afterwards. The student should have instilled into him in his course the calculus method of looking at things, and this mental training is most valuable in strengthening the powers of observation and the ability to solve problems by logical deductions from certain given premises and data.

Granted that the above statements are true, it is easily seen that the solution of the problem is to teach the elementary mathematics in the continuation school and collegiate institutes before entering the faculties of engineering. This would be a decided improvement also, for there is no question but that subjects such as algebra and trigonometry are much better taught in the lower schools, where the classes are small, and consequently the attention of the teacher is confined to a fewer number.

Obviously, then, the higher standard of entrance would increase the teaching efficiency of the university. It would keep many from entering who now discover in the first year they have made a mistake, and it would turn out men who are better able to solve the different problems occurring in their profession. President Falconer, of the University of Toronto, has stated his views on this subject, and his opinion, as expressed in his report for 1911, is that it is only a question of time as to how soon this change may be effected.

EDITORIAL COMMENT.

We question very much whether there would be so much work done by day labor in our cities and towns if a proper system of accounting showed all the costs incurred on the work. The chances are all in favor of items being omitted in the cost total, and on all occasions this shows a lower unit cost than is strictly true.

* * * *

In this week's issue will be found the discussion on "Engineering Problems connected with Biological Sewage Treatment," a paper by Mr. T. Aird Murray, which was delivered at the annual meeting of the Canadian Public Health Association and printed in The Canadian Engineer of December 14th.

* * * *

We are publishing this week the second instalment of "Contracts for the Supply of Electric Power from the Purchaser's Point of View." The first instalment came out in the issue of November 16th, and the whole subject will be covered in six issues. This is a most important subject, and Mr. Kensit is well qualified from training and experience to present the subject in a logical and clear manner.

A STRONG CONVICTION.

A report from Boston, Mass, U.S.A., states that a reward of $1,000 awaits the person who can prove to the satisfaction of Charles W. Morse, of Brookline that the earth is round. The money is on deposit in a Boston bank. Mr. Morse says he has proved by scientific principles that the sun revolves over the earth. Ships sailing around the earth cannot drop over the edge, he explains, because of the immense ice barrier which surrounds the habitable portion of the earth, which is a circular plane.

THE DESIGN OF IMHOFF SEWAGE TANKS.*

By Charles Saville.

Although the principles on which these tanks are based are simple and easily understood, the tanks should be carefully designed. This becomes specially important when it is remembered that sewage-disposal works are often sadly neglected or operated by persons having no proper training.

The tanks are usually built as deep circular wells 25 to 30 ft. in diameter and 20 to 25 ft. deep. A deep tank is likely to give better sludge because more gas is developed per square ft. of horizontal cross-section than in shallow tanks. This gives a better stirring action to the decomposing sludge. And the sludge after decomposition is permeated with small gas bubbles held there (so long as the sludge remains in the tank) by the pressure of the water above. With deep tanks there is a more uniform temperature in the sludge decomposing room, and it might be mentioned here that as large a proportion as possible of the total depth of the tank should be below the slots. These slots—in deep tanks—are comparatively short with respect to the total volume of the tank and there is practically no tendency for currents to develop between the sedimentation and sludge-decomposing chambers. The circular form has been adopted because with deep tanks it is cheaper to build, especially if there is much ground water or quicksand.

The sedimentation chamber may be arranged for a horizontal flow as shown in Figs. 1 and 2, where the flow is at right angles to the plane of the drawing, or for a radial flow—Figs. 3 and 4—where the conditions of flow are somewhat similar to those in a so-called Dortmund tank. With horizontal-flow tanks the sedimentation chamber may be continuous over two or three sludge wells, and in such cases the inlet and outlet weirs are so arranged that the flow can be reversed periodically. This gives a sludge of uniform character in each of the wells. The horizontal-flow sedimentation chamber is perhaps best for large plants or where there are large variations in the quantity of sewage, such as we find in many American cities. In radial flow tanks the velocity with which the sewage passes through the sedimentation chamber is an important factor in the sedimentation of the suspended matters. In the portion of the chamber where the flow (after passing under the baffle) is vertically upwards the velocity should be less than one mm. per second.

In each of the sketches (Figs. 1, 2, 3 and 4) the cross-hatched portions of the tank "A" represent the sedimentation chamber. The rest of the tank is devoted to sludge decomposition. It will be noticed that in Figs. 1 and 2 the sludge-decomposing chamber extends up on both sides of the sedimentation chamber. In the radial flow tanks (Figs. 3 and 4) the upper part of the sludge chamber is an annular space in the centre of the sedimentation chamber. In both cases the upper part of the sludge-decomposing chamber (shown at f) serves as an outlet for the rising gases and provides space for floating sludge particles which have been stirred up and have risen under the action of the gases. Scumpipes, shown at e, are sometimes provided for removing floating sludge if this becomes necessary. Certain kinds of sludge have a tendency at times to float, and the space f above the slots should be large enough to prevent its overflowing into the sedimentation chamber or working back into this chamber from below through the slots. This consideration may not be found important with weak sewages; but in general it is well to err on the side of having too much space for the floating sludge (or scum), instead of too little. In the plants of the Emschergenossenschaft the portion of the sludge-decomposing chamber located above the slots is one-half to two-thirds as large as the portion below the slots. To have nothing but small ventilation pipes for the gases is not likely to be sufficient.

The relative size of the sedimentation and sludge-decomposing chambers depends on the character and strength of the sewage as well as the quantity to be treated. The former is usually designed to give a period of sedimentation for the dry-weather flow of from one to two hours—seldom as long as three hours, even with a weak sewage. At times of storm the tanks treat three or four times the dry-weather flow. The portion of the sludge-decomposing chamber below the slots should be large enough to provide a decomposing time of at least two or three months. It is usually designed to hold an accumulation of sludge (in a thoroughly decomposed condition) representing deposits entering from the sedimentation chamber during a period of six months or more. The volume of the sludge (after decomposition) had been found in the Emscher district to be about 0.1 liter per head of population connected with the tanks per day. This figure refers to a "separate" system of sewers which does not receive exceptionally large amounts of trades wastes. With a combined system of sewers the quantity of sludge per capita is figured at double the above amount. With a dilute sewage having large variations in flow and a comparatively small amount of sludge the tanks would be designed somewhat as shown in Fig. 2, or, for radial flow, in Fig. 4. But for a strong sewage containing much suspended matter, as is the case in many German cities, the tanks would be built

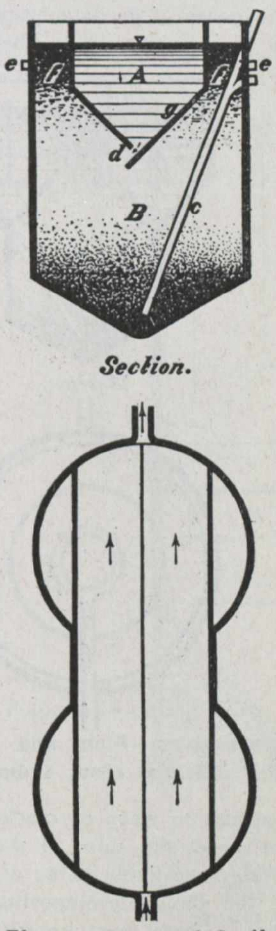


Fig. 1.—Plan and Section of Horizontal Flow, Imhoff Tank.

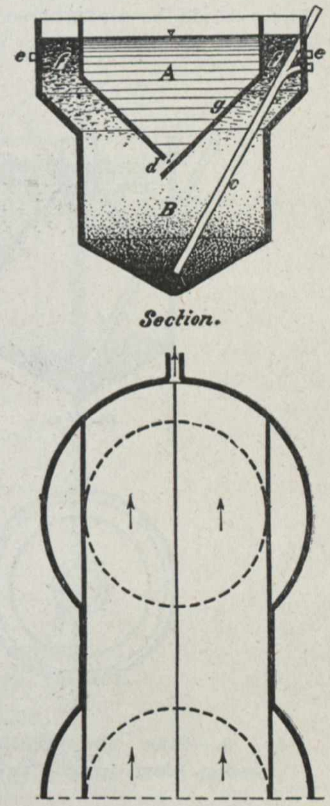


Fig. 2.—Plan and Section of Horizontal Flow, Imhoff Tank.

*From a paper read before the Boston Society of Civil Engineers, and printed in the Journal of the Association of Engineering Societies for July, 1911.

as shown in Figs. 1 or 3. The depth of the tanks is the same, whether the sewage be strong or weak; but as is evident from the figures, the sludge-decomposing chamber must form a larger per cent. of the entire tank when the sewage to be treated contains much suspended matter than is the case if the sewage is comparatively dilute. A large sludge chamber has the important advantage that the decomposed sludge may be allowed to accumulate in it until the weather is most favorable for drawing out and drying the sludge.

The slots between the sedimentation and sludge-decomposing chambers are 6 to 8 inches wide. The sides and bottoms of the sedimentation chamber must be smooth so that the deposited sludge will slip easily towards the slots. They should be air-tight so that the gases of decomposition cannot work through them into the flowing sewage. They hold small amounts of sludge, thus making the sewage septic. Necessary pipes and horizontal surfaces must be pointed up with cement so that the suspended matters as they settle will slip readily off, and pass down through the slots into the sludge room. Baffle boards in the sedimentation chamber are necessary to prevent floating matters passing out with the effluent, and when properly designed will so guide the flow of the sewage as to make effective the entire chamber. They should not be carried too deep, however, because the quiescent sewage just above the slots will then be disturbed by the current.

Although the circular type of tank has been used almost exclusively in Germany, it is perfectly feasible to build rectangular tanks. In some instances old rectangular tanks, after being operated for a number of years as septic tanks, have been remodeled according to the Imhoff idea simply by

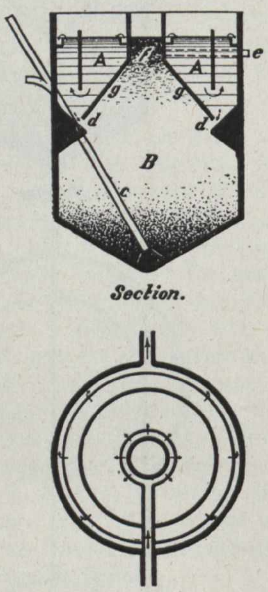


Fig. 3.—Plan and Section of Radial Flow, Imhoff Tank.

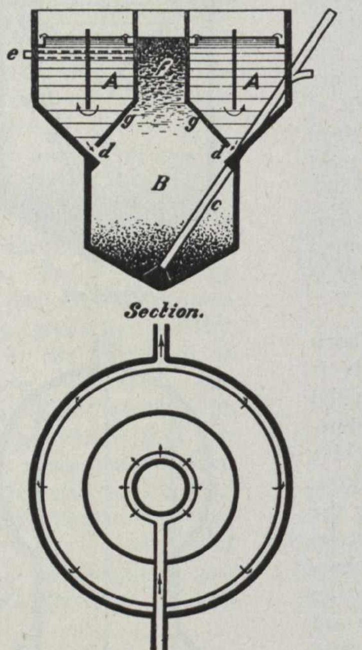


Fig. 4.—Plan and Section of Radial Flow, Imhoff Tank.

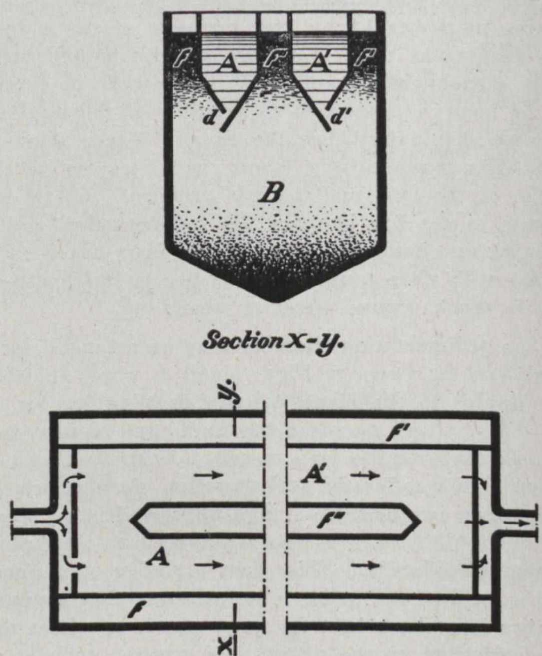


Fig. 5.—Common Septic Tank Remodeled as Imhoff Tank.

ought also to be strongly built so as not to warp or crack. Both wood and concrete have been used, the slope of the bottoms being 1.5 to 1. Iron and zinc are likely to be attacked by the gases and sewage in the sludge-decomposing room and have proved unsatisfactory. There must be sufficient overlap at the slots to prevent all possibility of gas bubbles and sludge particles rising from the sludge room into the sedimentation chamber.

The inner surfaces of the sludge chamber are made smooth, and the main walls of the tank are built with a slight batter (the diameter of the tank being greatest at the bottom) so that there will be as little opportunity as possible for sludge to stick to them. The sludge pipe shown at (c) in Figs. 1 to 4 should be about 8 inches in diameter. It has a bell mouth at the lower end, and is elevated a foot or more above the bottom of the tank, which is built as an inverted cone with a smooth surface sloping towards the centre. Small perforated water pipes are placed around the bottom of the well and near the mouth of the sludge-pipe, so that if necessary the sludge may be loosened by forcing water under pressure into it. A connection with the water mains is also provided at the upper end of the sludge-pipe. It has been found that with a tank 25 or 30 ft. deep a head of 3 to 4 ft. is necessary to force the sludge easily out through an 8-inch pipe.

The sedimentation chamber should be kept as free as possible from pipes, braces, etc., which might collect and

the installation of the necessary division walls. The sedimentation chamber of such a tank may be arranged in two parts A and A', as shown in Fig. 5, which is a cross-section at right angles to the sewage flow. With an arrangement of this sort there is space f'' for a gas outlet and for accumulations of floating scum, in the centre as well as at the sides f and f'. The important thing to consider here is that the space f'' must not extend the entire length of the tank. It is essential that the two sections of the sedimentation chamber A and A' shall be connected (preferably at both ends). Otherwise an uneven distribution of the flow between them could give rise to currents through the sludge -decomposing room B from one row of slots d to the other d'.

MIXTURE TO PREVENT MOTORS FROM FREEZING.

Alcohol, glycerin and water, properly mixed, will keep a motor from freezing when applied with caution. The mixture should be approximately one-quarter alcohol, one-eighth glycerin, and five-eighths water, which will stand a freezing test of 10 degrees below zero. Rubber hose connections must be watched because of the deteriorating effect of the glycerin and alcohol, and the system must be watched for evaporation in the cooling system. When the motor is to stand in the cold for a lengthy period the water should be drained from the circulating system.

DISCUSSION OF ENGINEERING PROBLEMS CONNECTED WITH BIOLOGICAL SEWAGE DISPOSAL.

Canadian Public Health Association.

Mr. Langdon Pearse, (by letter):*

I have been much interested in reading the paper of Mr. T. Aird Murray, and am glad to furnish some discussion thereon, in the light of the experimental work which I am conducting for the Sanitary District of Chicago, as well as our engineering investigations.

Unless very greatly mistaken, Great Britain had a Royal Sewage Commission as early as 1860. Later, in 1888, the Lawrence experiment station was established by the Massachusetts State Board of Health, serving as a pioneer in the experimental field in the United States. From Lawrence came many ideas, adopted abroad as well as in the U.S. In later years experimental stations have been operated at Columbus (O.), Gloversville (N.Y.), Waterbury (Conn.), the Massachusetts Institute of Technology, Philadelphia (Pa.), and Chicago (Ill.). In Germany and France much has been done. Conditions abroad, however, differ radically from those in the U.S. From these experimental stations much definite data has been accumulated.

Septic Tanks.—From the available data, I agree with Mr. Murray that it has been abundantly proven that the early claims of the promoters of the septic tank were greatly exaggerated. In general I believe, however, that as regards the amount of sludge found in a septic tank, less will be found than in a settling tank, and more than in an Emscher tank. The accompanying table of some of the results at 39th Street is taken from a report made by me to our Chief Engineer, Mr. Wismer. **The difficulty with the septic tank is the control of the unloading of the sludge by violent action. Our septic tank has, at times, over a period of two days, delivered five times as much suspended matter as in the effluent,** eventually blowing out all the sludge. In an examination of the sewage disposal facilities of a small town near Chicago, I recently found a septic tank eight years old which had never been cleaned. Half the tank was full of peaty scum. The sludge was being unloaded into a ditch, making a nuisance for a mile or more below the tank.

Mr. Watson, in Birmingham, has sensed this trouble, and was the first to introduce secondary settling basins and then scrubbing filters between the septic tanks and the sprinkling filters. I believe that his idea is correct, and that in any sprinkling filter scheme, a screen or scrubbing filter between the tanks and the filters is well worth trying to reduce the care of maintenance.

I do not believe, however, that separate sludge digestion in itself is a complete solution of the problem. A double deck tank of the Emscher type is desirable in order to have the settling matter always entering in small amounts. At the 39th Street testing station the sludge digestion tank (into which fresh settling basin sludge has been blown at frequent intervals) was the only nuisance on the grounds.

Emscher Tank.—We have been operating on Emscher tank at the experimental station for over 18 months, with very satisfactory results. The tank was recently remodelled, and is shown in the diagram attached in its present form (Fig. 1). The sludge dries readily, is practically odorless, and is thoroughly digested in about six months. The principle seems excellent. Recently a second tank of slightly different design (Fig. 2) was put in operation to handle the effluent of the coarser sprinkling filters. In the Emscher tank, it seems immaterial whether the flow be radial, or straight away, as in the diagram in Mr. Murray's paper. We are using a radial flow type on the grit chamber sewage with a flow of 20,000 gallons per 24 hours, with success. Depth is however essential, I believe, for a compact sludge, full of gas, to facilitate drying. This is a point which Mr. Murray has overlooked.

Lethbridge Tank.—I have examined the design of the "Lethbridge" tank with much interest, inasmuch as Dr. Imhoff apparently designed a similar tank over three years ago, as shown by a drawing given me by him, dated 1907

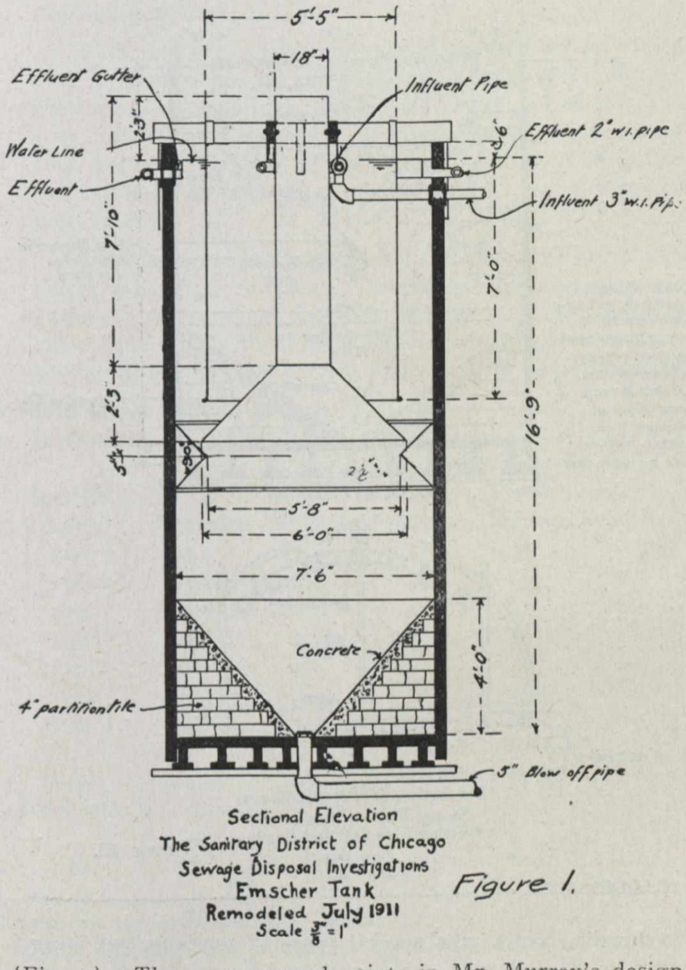


Figure 1.

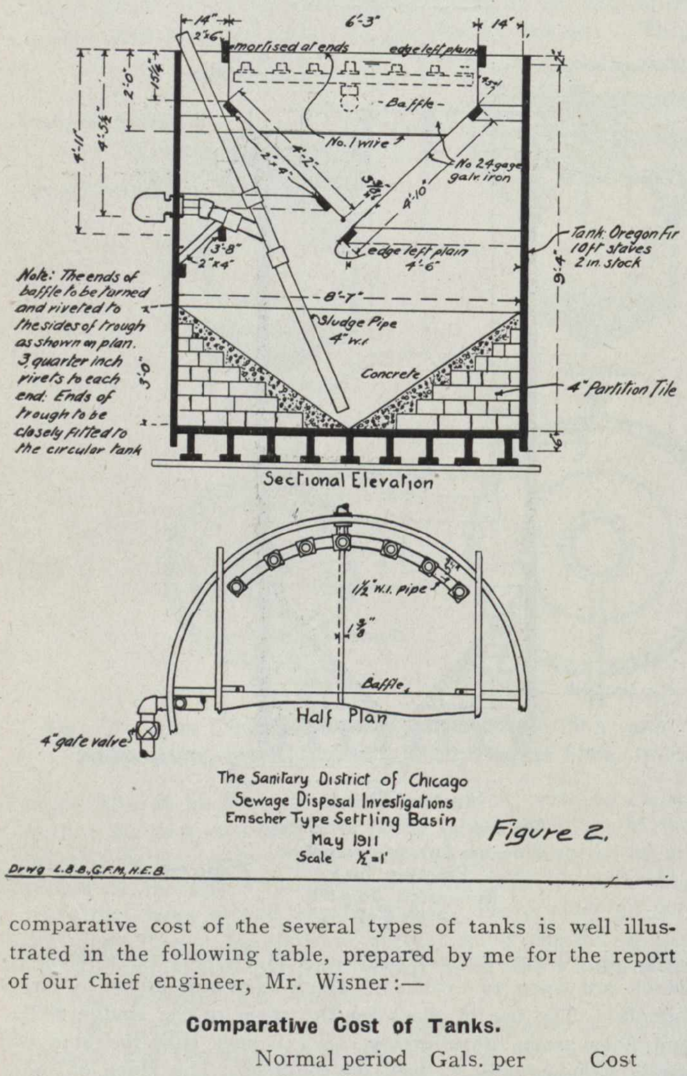
(Fig. 3). There are several points in Mr. Murray's design which are open to criticism, which does not apply to Dr. Imhoff. The use of glass for the cover of the sludge well and floor seems unnecessary, as I believe that the sludge would slide equally as well on concrete. The slope of the floor is too flat, I believe, for successful operation, without means for scraping the sludge into the digestion chamber. Dr. Imhoff has provided such a scraper, to be used several times a day, preferably. In Mr. Murray's design only small gas outlets are shown. From the writer's experience with various forms of tanks, these vents are too small, and would rapidly choke with the "swimming" sludge or scum. A larger area for gas vents would seem necessary. No dimensions are given on Mr. Murray's sketch. The sludge storage well, however, appears too shallow in depth to obtain the density of sludge which Mr. Murray claims. In the experimental tank at 39th Street, with a depth of over 16 feet, the moisture content of the sludge is rarely below 88 per cent. water. Depth is required to obtain a dense sludge. That is why Dr. Imhoff advocates depths of 30 to 40 feet.

So far as I can see, the principles involved in the Lethbridge tank are identical with the Emscher; and if the matter

* Assistant Engineer, The Sanitary District of Chicago In charge of Sewage Disposal Investigations.

of depth be included, as it should, the factor laid down by Mr. Murray of depth excavation is of no consequence.

The sedimentation problem depends on velocities of flow, either forward or upward, and not on the shape of the tanks, as such. With a knowledge of the critical velocities at which the desired size of particle is to be deposited, a designer should be able to build a tank equally effective, in either a rectangular straight flow, or circular upward flow form, so far as mere removal of settling suspended matter is concerned. For the purpose of ease in cleaning in purely sedimentation tanks, the writer has advised the trial of the Dortmund type, with hopper bottoms, to settle a very heavy industrial sewage in the stockyards. The



The Sanitary District of Chicago
Sewage Disposal Investigations
Emscher Type Settling Basin
May 1911
Scale ½"=1'

Figure 2.

Drwg L.B.B., G.F.M., H.E.B.

comparative cost of the several types of tanks is well illustrated in the following table, prepared by me for the report of our chief engineer, Mr. Wisner:—

Comparative Cost of Tanks.

Type of Tank	Normal period of settling	Gals. per capita daily	Cost per capita
Emscher	3 hours*	200	$1.44
Dortmund	4 hours*	200	0.84
Straight flow	8 hours	200	0.77
Straight flow	6 hours	200	0.58

Despite the greater cost of the Emscher tank, we have recommended its use for improving the condition of the domestic sewage in Chicago, because we believe it is the best type to-day for removing the settling suspended matter, with a minimum loss of freshness, and a means of producing the minimum amount of sludge, thoroughly digested and easy to dry.

Sprinkling Filters.—I have been much interested in Mr. Murray's remarks on distribution. At our experimental station we have been operating five open filters, one of which has rubble sides, and one covered filter through two winters. During the second winter the covered filter gave consistently better results, both in stability and nitrification. The crude sewage (from an area of 22 square miles) was never below 43 deg. Fahr., and the maximum loss of temperature (through the rubble sided filter) was 16 deg. Under the winter conditions at Chicago, we believe open filters can be operated with success. Owing to the restricted localities for sites, light covers may eventually be necessary to prevent aerial nuisance.

Our distribution has been made extremely uniform by the use of a Taylor nozzle, fed by a dosing tank, the outlet of which is controlled by a butter-fly valve actuated by a revolving cam cut out to give uniform distribution. The writer has been interested in the revolving distributors but has felt that no definite data has ever been presented to determine whether the claims are substantiated. Exact data on plants of two types working side by side are required to settle the question. The writer understands that at the experimental testing station of the Massachusetts Institute of Technology in Boston, the traveling distributor of the Ham Baker type (tipping buckets) has not been found to give as good satisfaction as the fixed spray distributors working under variable heads. On practical grounds alone, the conclusion is borne out, since in the writer's opinion it is desirable to dose the beds as uniformly and as continually as possible in order to keep the rate of application as close as possible to the average yield. With a travelling distributor giving a large dose once only in five to ten minutes the effect certainly can not be obtained. Where land is valuable the circular beds cause a lost space.

Size of Filter Material.—The size and depth of the filter material is all important. Undoubtedly the better results can be obtained with material as uniform in size as possible. The most favorable size for higher rates of treatment is 1¼ to 2 inches. With the dilute domestic sewage at the 39th Street testing station yields of 2½ to 3 million gallons (U. S.) per acre can be obtained. With a depth of 6 ft. steady results are obtained. The indications are that graded material or fine surfaces are not economical.

Filter Design.—The usual design for sprinkling filters in the United States is to have the drainage from the outer to the inner portion of the bed. This permits thorough inspection of the underdrains, and flushing if required, since in the most recent designs the tile underdrains open into a gallery through the walls.

Discharge of Sewage into Water Supply.—The writer is firmly of the opinion that wherever circumstances demand that sewage should be turned into a water supply, that the problem should be considered as a whole. Purification of water by filtration and sterilization ensures a water practically free from all bacteria. This is usually much cheaper than the purification of sewage to the same degree of bacterial removal, and far more certain as a protective measure. In many cases the sewage problem must be considered too, first to relieve local nuisance on bathing beaches, and later to relieve the load of pollution on the water purification. Lakes and rivers furnish an excellent means of oxidation for amounts of sewage within their oxidation capacity. Too great concentration without treatment may mean local nuisance. Where a water supply is polluted, however, the writer firmly believes in obtaining a pure water, which to-day can be readily obtained by filtration, either in mechanical filters with a coagulant or on slow sand filters, according to circumstances. A small amount of hypochlorite of calcium makes an excellent sterilizing agent to finish the work of the filters.

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*In both these periods the sludge storage is not calculated in determining the nominal period of settling.

Mr. Murray in reply to Mr. Pearse.

In the first instance I wish to thank Mr. Pearse for the valuable discussion he has contributed with reference to my paper. With reference to his remarks that conditions abroad differ radically from those in the United States, I would here add that conditions in Canada, especially in parts, would prove to differ from conditions both abroad and in the United States. In Canada it is very probable that the pathogenic features of sewage disposal will receive more attention than elsewhere, for the simple reason that Canadian waters have not as yet become altogether unfit for water supply, even in their raw state. Under most conditions of populated areas, it appears reasonable that it will prove cheaper to disinfect surface water supplies than sewage effluents. On the other hand it appears reasonable that the sewage producer should do something more in connection with sewage disposal than merely remove a chemical nuisance in order to protect the individual or isolated water consumer, rural districts and small urban centres, which may not be able to afford the cost of effective water purification in connection with most sewage disposal works now under construction or being constructed in Western Canada, hypochlorite disinfection of sewage effluents is being added to the standard methods for removal of solids and putrescibility.

The sketch attached to my paper is merely a sketch and, unfortunately, does not include many of the essential features of the "Lethbridge Tank," which can only be shown by further drawings. The sketch is given for the sole reason of illustrating the apron method of isolating a sludge storage area in a rectangular tank. Further drawings are being prepared and will probably be illustrated in The Canadian Engineer if the management so consent. Mr. Pearse will be interested to know that it has already been concluded that the fore base is too flat and steps are being taken to remedy this fault.

I am very gratified to know that Mr. Pearse agrees with me in the main principle of the removal of solids from the supernatent liquid in sedimentation tanks and that this principle will prove a great advance upon the so-called "septic tank" where the settled sludge was unloaded back into the liquid sewage.

With reference to the question of depth, I do not consider that it is necessary to provide great depths for sludge concentration. The British Royal Commission, in their 5th Report, lay stress more upon the time allowed for consolidation and decomposition of the organic matter. The ordinary flat septic tanks have given sludge with as low a water content as 80%.

I cannot agree that a concrete surface will prove as efficient as a glass surface. The reasons in favor of a glass surface appear to me obvious. All tests in this connection show conclusively the higher efficiency of a glass surface in providing a minimum friction and nidus for bacterial growth.

Sludge Accumulations at Thirty-Ninth Street Testing Station.

Period October 15, 1909, to October 31, 1910.

	Velocity mm. per second.	Period in hours.	Cu. yds. per million gallons.	Specific Gravity.	Per cent. Moisture.	Nitrogen.	Volatile Matter.	Fixed Matter.	Ether Soluble.
					Calculated to Dry Weight at 100° C.				
Grit chamber	14	0.13	0.32	1.07	84.5	1.5	47	53	6.1
Original	37	0.13	0.33	1.07	85.2	1.9	54	46	6.8
	64	0.13	0.20	1.04	86.3	1.6	57	43	6.2
Remodeled	136	0.01	0.026	1.35	49	0.76	21	79	2.2
Sedimentation	...	8	2.1	1.01	92	2.0	51	49	7.2
		6	2.4	1.02	91	1.9	54	46	8.3
		4	2.6	1.04	89	1.6	47	53	9.3
Septic	...	8	Max. 2.1						
			Min. 0.9*	1.04	89.4	1.7	40	60	7.6
		Period of 8 months, from June 1, 1910.							
Emscher	...	1 to 3	Max. 2.						
			Min. 0.93†	1.04	88	1.6	39	61	4.4

During the present year there has been less sludge retained in the sedimentation tanks.

*This represents amount actually cleaned out after 10 months. It does not, however, represent a digested residue, as a deal of sludge was unloaded by the tank previously.

†This represents the average accumulation over a period of 5 months and is the residue of complete digestion, since no sludge was blown out of this tank by unloading.

CANADA'S TRADE WITH THE WORLD.

The section of the annual report of the Department of Trade and Commerce dealing with trade between Canada, Great Britain, France and Germany has been issued. The report shows that during the fiscal year which closed on March 31 last, Canada's total trade with Great Britain amounted to $247,551,912, as against $245,313,984 for 1910. A considerable increase in imports of British goods and a decrease in exports to Great Britain are shown. The total imports amount to $110,586,801, as compared with $95,679,877 in 1910. Exports last year amounted to $136,065,111, as against $149,634,107.

Canada's total trade with the United States for the same twelve months reached a total of $413,813,003, as compared with $352,221,327 in the previous year.

Both imports and exports increased, the former from $230,070,540 in 1910, to $294,415,202 in 1911, and the latter from $113,150,778 in 1910, to $119,396,801 in 1911.

The duty collected on imports from Great Britain amounted to $24,756,811, and on exports from the United States $37,854,728.

The figures of trade with Germany show a slight increase, the total for the year being $12,750,216, as compared with $10,459,455 for 1910. The import of German goods amounted to $10,687,199, as compared with $7,958,264 for 1910. The figures show that while Canada bought more largely from Germany, the increase in exports from Canada to Germany was very slight, the figures being $2,501,191 for 1910 and $2,663,017 for 1911.

Trade with France increased both ways. The imports amounted to $11,755,493 in 1911, as compared with $10,170,903 in 1910, and the exports $2,782,092 in 1911, as against $2,640,648 in 1910. Canada's total trade in 1911 amounted to $769,443,905, as compared with $693,211,221 in the previous pear, and the duty collected increased from $60,709,707 in 1910, to $72,935,639 in 1911.

CONTRACTS FOR THE SUPPLY OF ELECTRIC POWER FROM THE USERS' POINT OF VIEW.

II.

By H. E. M. Kensit, M.I.E.E.

In the previous article the matter of the power factor of an electric circuit and its effect upon the cost of power was dealt with.

In this article the various methods of measuring and charging for the power will be discussed.

There are three principal divisions into which the subject may be divided, i.e.:

(1). Where the charge is per h.p. year, and the cost depends, therefore, either entirely on the size and duration of the peak load, or on that and the power factor.

(2). Where there is a "service charge" per h.p. for the maximum power taken and an additional charge per kw. hour for the energy consumed.

(3). Where the charge is on a sliding scale per kw. hour, the price varying with the number of kw. hours in a given time.

Dealing first with the case where the charge is based on the h.p. year and which appears to be the most widely used in large contracts. The effect of power was fully discussed in the previous article referred to above.

The following are some sample clauses re measurement taken from important contracts:—

(1). "That for the purposes of measurement of energy and payments therefor, all energy furnished shall be measured by Bristol or other standard curve drawing wattmeters, and the greatest amount of energy thus determined as furnished at any time during any calendar month shall be deemed the amount of energy held for the use of, taken, used and to be paid for by the consumer during all of said month; provided, that in arriving at such determinations, sudden surges not due to the taking of energy by the consummer shall be disregarded."

(2). "The customer shall pay the power company for each electrical h.p. computed by the following formula, i.e.:

$$\frac{\text{Volts} \times \text{amperes} \times 1.732 \times 0.90}{746} = \text{h.p.}$$

the voltage to be measured between any two of the three phases and the amperes to be measured in any one of the three phases, said measurements to be made by recording instruments supplied by the power company and located at the point of delivery. The power to be paid for each month under this contract shall be the highest amount used continuously during any consecutive twenty minutes during the calendar month."

In this instance, in the formula given, volts $\times$ amperes $\times$ 1.732 represent watts consumed in a 3-phase circuit, 0.90 represents the assumed normal power factor, and the product of these divided by 746 equal the h.p.

(3). "The measurements shall be by continuous recording wattmeters supplied at the cost of and remaining in the charge of the power company, and the basis of payment shall be the average of the daily maximum thirty-minute recorded watts, a h.p. being defined as 746 watts."

(4). "The company may, at its option, either agree in writing with the customer from time to time as to the maximum h.p. on which the charge is to be made, or it may instal a curve drawing wattmeter and make the monthly charge on the highest recorded k.w. that have been maintained for ten minutes in that month.

"Should the meter cease to record, then the charge shall be the same as that made for the previous corresponding period, plus an additional charge for any additional power used by any apparatus that the customer may have installed during the interval, or the power company may, at its option, base the charge on the manufacturer's rating of the h.p. of the motors."

(5). "To pay for the three-fourths of the power supplied and held in reserve . . . . . whether the said power is taken or not, and when the greatest amount of power taken for twenty consecutive minutes in any month shall exceed three-fourths of the amount during such twenty consecutive minutes, so supplied and held in reserve, to pay for this greater amount during that entire monh."

Examining these clauses in detail, it should first be stated that all the contracts containing them also contain provision to charge extra for energy supplied on power factors below 90 per cent., but as this point has been dealt with in the previous article it is not deemed necessary to repeat it.

The power factor, however, influences the total payment, possibly increasing it by 20 per cent., or even more, and it is conspicuous that none of these clauses re measurement define how, when, or by whom the power factor is to be measured. The second example shows that power is to be measured by ammeters and voltmeters, and assumes a normal power factor of 90 per cent., but does not state how the actual power factor is to be arrived at. The power factor can be deduced from readings of ammeters and voltmeters compared with a wattmeter or wattmeters, but this involves a number of instruments and calculators, and, therefore, considerable chance of error, and, furthermore, the power factor will vary during every hour of the day.

There appears to be no question that in the case of a contract for any considerable amount of power, and where the power factor is to affect the charge, the only proper way to measure it is by means of a curve drawing power factor meter (recording chart instrument) that will keep a continuous record. This furnishes complete records on which to base the charge and also shows the customer exactly what is occurring at all times, and gives him data to consider what steps can be taken to improve the conditions if they need improving.

The power factor that most affects the power company is that coinciding with **their** peak load. The most favorable arrangement to the customer would be to specify that the power factor affecting the price charged shall be that obtaining during the period of **his** peak load, as this would usually be the best in the 24 hours. The most favorable arrangement to the power company is to charge each customer on the lowest power factor occurring at any time on that customer's load. The usual compromise is to charge on the average power factor, and there is no accurate and reliable method of ascertaining this except the use of a recording chart instrument.

The next most conspicuous point in the sample clauses is that relating to the interval of time during which the peak load must be maintained in order to constitute a basis of charge. This, it will be seen, varies from the maximum momentary peak recorded to peaks maintained for 30 minutes. In practice "peaks" seldom last 30 minutes, and in such cases the user gets a higher maximum than he pays for. In cases of traction, rolling mills, or other very intermittent loads, the "30-minute" clause would mean that the customer would pay for an amount of power much nearer to his average load than to his actual peak.

It is obviously to the user's advantage to have the period during which the peak load must be maintained before it is used as a basis of charge, as long as possible, but it should certainly not be less than 5 minutes, in order that the rush of current in starting a large motor or similar short and temporary conditions may not raise the charge over the whole month. A statement that "sudden surges, not due to the taking of energy by the consumer may be disregarded," is indefinite and not likely to be satisfactory, as the consumer would find it a difficult matter to prove that any particular peak was not due to his load.

Take next the question of actual measurement of the peak load. It may be measured by:—

(1) Indicating ammeters, voltmeters, and power factor meter, keeping a record of their readings. This is the cheapest and most unsatisfactory method, and quite unsuitable for any large amount of power. The ordinary instruments supplied with switchboards by even the best manufacturing firms are frequently very inaccurate and unreliable and should never be used as a basis of charge unless they have been calibrated in position against standard instruments. They are considerably less reliable than ordinary house service meters, which the law almost universally requires must be checked by an independent or official electric inspector before being used as a basis of charge.

(2) Recording chart ammeters and voltmeters and an indicating power factor meter; or in place of the latter a wattmeter, so that the power factor may be calculated. This is better than the preceding method in (1), because the recording instruments are generally of a higher grade than the indicating instruments usually supplied with switchboards and because they give a continuous graphical record.

Both these methods, (1) and (2), possess the disadvantage of needing a number of meters, which therefore increases the chance of inaccuracy, and of requiring calculations to ascertain the actual power, which increases the liability to error.

(3) Recording chart wattmeter and recording chart power factor meter. This brings the number of instruments down to two, and these usually of high grade, eliminates all but the simplest caluclations, and furnishes a continuous graphical record which is valuable to settle all disputes, and to give reliable information as to what actually happens at all times.

The first cost is frequently shirked, though it is a matter or trifling importance in a contract of any size. The cost, $500 or $600, would be equivalent at 10 per cent. to an annual charge of say $60, whereas an annual saving of 10 per cent. on an account of only $1,000 would amount to $100.

In the case of small customers where the cost of these instruments would really be prohibitive, fairly accurate measurements may be obtained in the following manner:

A recording ammeter of the Bristol or similar type may be installed and so connected that it may be switched on to any phase. At the time of installation this can be calibrated in position with its own motor against a standard wattmeter, and a diagram prepared showing the horse-power corresponding to the indications of the ammeter. A current transformer would be required for the ammeter, but the complete apparatus can be installed for from $70 to $100. If the instrument requires the chart to be changed daily, the customer should arrange to do this and preserve the charts for the power company. If the power factor has to be measured, special readings would have to be taken at agreed times by the Power Company with their own portable instruments.

The above methods represent more or less accurate means of actual measurement of the peak. In many cases, especially in those of the smaller users, actual measurement of the peak are dispensed with on account of the expense of the instrument, and a figure is agreed upon that shall be considered to be the customer's peak load. This is usually based on the rated horse-power of motors installed or on the indicated horse-power of the engines replaced by motors.

A peak load charge based on the rated horse-power of motors connected is not usually a favorable arrangement to the power user. In the case of a single motor which is known to be at times fully loaded, it may be satisfactory, but as the number of motors is increased the margin between rated horse-power and peak load generally increases, and the arrangement becomes disadvantageous to the customer. The conditions vary greatly in every individual case, but the following list of actual results in a few cases will illustrate the point:—

Connected Horse-Power and Peak Load.

	Rated h.-p. of motors installed	Actual peak load in h.-p.	Ratio
Printing works	37	37	100%
Sawmill	179	140	2.2
Shipyard	360	276	23.3
Engine works	1,000	674	32.6
Engine works and foundry	1,576	900	42.8
Municipal motor supply	1,634	670	58.0
Engineering works	5,538	2,400	56.6

The Wisconsin State Commission collected data from companies in its area which showed that the average ratio of maximum demand to connected load in factors was 53 to 56 per cent.

The reason of course is the diversity factor, due to a number of motors employed on different operations, and it is obvious that payment for power on the basis of rated horse-power of motors is not likely to be a good bargain for the larger power users.

A maximum based on the horse-power of engines displaced may be even more disadvantageous to the customer, as owing to the cutting out of many sources of loss in the distribution of power when rearranging for electric drive, the total rated horse-power of motors installed is often much less than the I.H.P. of the engines replaced, and the actual peak still less than the rated horse-power of the motors.

Summing up on the matter of measurement of power taken by the horse-power year, actual measurement of the peak is more likely to be favorable to the customer than any estimate, and the measurement should wherever possible be made by continuous chart drawing wattmeters and power factor meters, such meters being calibrated after erection against standard instruments.

In regard to the second method of charge, i.e., a "service charge" per horse-power for the maximum power taken and the additional charge per kilowatt hour for the energy consumed.

This "service charge" which usually amounts to from $8 to $12 per horse-power per year, represents the proportion of the power company's expenses which are known as first charges, and includes interest on capital investment, depreciation, part of cost of staff, etc.; in fact the customer's proportion of the cost of standing by ready to serve whether power is taken or not. The "follow on" charge per kilowatt hour, which is usually very small, represents the balance of operating expenses and profit.

Under this system there is usually no clause as to power factor; this is still of equal importance to the power company, but the system is used more for the smaller consumers where the cost of instruments and their maintenance and supervision become a proportionately more important matter.

It is in these cases that the maximum is generally agreed upon on the basis of rated horse-power of motors connected or horse-power of engines displaced, and actual measurement is only made of the kilowatt hours used. The power company will naturally only agree to an estimate of peak load which they feel is safely on their side, and the customer will usually find it considerably to his advantage to insist upon his peak load being actually measured under working conditions. The meter used for measuring the kilowatt hours should of course be a certified instrument.

In regard to the third method of charge, i.e., a sliding scale per kilowatt hour, the price varying with the number of kilowatt hours used in a given time. This is generally used only for quite small customers and involves no complications or special measuring instruments. There are an almost infinite variety of such tariffs and many are far from equitable; "thrifty" users have not been slow to discover that in some cases by using a few extra kilowatt hours at the end of the month they can "get in" on the next lower scale and reduce their whole account.

SCIENTIFIC MANAGEMENT APPLIED TO RAILWAYS.

Wilson E. Symons, of Chicago, formerly superintendent of motive power and equipment of the Plant System, and later mechanical superintendent of the Gulf, Colorado and Santa Fe, and superintendent of machinery of the Kansas City Southern, presented a paper on the above subject at a joint meeting of the Franklin Institute and the American Society of Mechanical Engineers at Philadelphia, Pa., October 18, 1911, in which he presented statistics as to the mileage, equipment, capitalization, officers and employees, volume of business handled, and the income and expenses of the railways of the United States. Referring to scientific management and the proposed saving of one million dollars a day by its application to the railways he said: "Although it is claimed that this new plan or system is applicable to most all items of expense (material and labor) on a railway, the estimated probable economies will, in this treatment of the question, be confined to such branches of the work, or classes of employment, as in my judgment are susceptible of being placed on a comparative basis with large manufacturers of standard articles."

Mr. Symons did not define just what he meant by the expression scientific management. That he considered it in a narrow sense is indicated by the fact that although the railways employed 1,502,823 persons in 1909, whose wages amounted to $988,323,694, Mr. Symons, by a process of elimination, concluded that the principles of scientific management were applicable to the machinists and other shop men only. This includes only 243,347, or 16 per cent. of the total number of employees.

After drawing attention to the fact that "repairs to the equipment are of such a character that they are not susceptible of predetermination as to methods of operation or cost and cannot, therefore, be reduced to writing, blue print or graph, but must be handled by experienced, practical men, who, usually, like the skilled surgeon, decide on the exact method or details of procedure while gathering instruments, tools and material to perform an operation," Mr. Symons concludes that it might be possible to make a saving of $78,242 per day. This, "on the assumption, however, that additional tools, shops, supervision, etc., be provided to enable the officers in charge to secure a greater output on the same expenditure, or the same output at a less expense and that the organization of the department should be on lines calculated to strengthen the hands of the line officers in charge who, in the last analysis, are always held responsible for results."

An analysis is made of the results that have been obtained on the Santa Fe and a comparison is made with other roads in the same territory, and also with the average results which are obtained throughout the United States, from which the conclusion is drawn that the Santa Fe, which is now and has for six years been under heavy expense maintaining the betterment plan, "has a maintenance of equipment cost of over five million dollars per year above an average for the United States and is far in excess of most of the other lines similarly situated."

Two examples are then cited of roads on which the efficiency of the mechanical department was very greatly increased by reorganizing it. Efficiency engineers were not used to bring this about, but unfortunately Mr. Symons does not go into the methods which were used, but simply presents a statement of the results which were accomplished.

The necessity of having additional supervision in the way of staff officers is emphasized and the following are laid down as the qualifications for an officer who is in charge of men or of any work involving contact with them:—

First. As a fundamental principle, a man who cannot handle himself cannot handle others, although it is a notorious fact that men who have little or no control of themselves actually believe that they have great ability to handle or control others.

Second. No man who is not well within self-control should ever be placed in charge of others. Disregard of these two cardinal principles in the selection of railway officers has driven more men into labor unions, and created more anarchists, than any other influence, and in addition has cost the railways untold millions of dollars that should have gone to employees and shareholders.

Third. No man should be placed in charge of men who is not personally familiar, from practical experience, with the work, or that of a correlative character, so as to enable him to intelligently direct others, and with a sufficiently liberal education to enable him to transact business with his colleagues, superiors, and the public, in a gentlemanly, business-like manner, and with capacity for increased responsibility.

A large part of the remainder of the paper is devoted to replying to an article in Hampton's for March, in which the statement was made that two million dollars a year were wasted on lubricating oil. Considerable attention was also given to refuting a statement in one of the popular magazines that the railways were run by "rule of thumb."

INDUSTRIAL ACCIDENTS.

Ninety-five fatal and one hundred and ninety-one serious injuries to work-people were reported to the Department of Labor during November. The record is considerably more favorable than that of the preceding month or that of the same month last year. In October there were 344 accidents, fatal and non-fatal, and in November, 1910, there were 407. The chief accident during the month was the foundering of the schooner Antigua off St. Martin's River in the Gulf of St. Lawrence, when the captain and eleven sailors were drowned. There were eleven killed in the railway service, eleven in the agricultural pursuits and twelve among unskilled laborers. The largest number of non-fatal accidents occurred in the metal trades, namely, forty-five, but the twenty-three non-fatal accidents reported in the railway service were of a more serious character.

Metallurgical Comment

T. R. LOUDON, B.A.Sc.

Correspondence and Discussion Invited

AXLES.

To determine what composition and heat treatment will produce a material for axles, shafts and similar parts which will give the best results in service has engaged the attention of the Carnegie Steel Company for some time. In a report embracing the results of these tests it is stated that the removal of axles from service is either for excessive wear of the journals or for fracture. Wear cannot be entirely prevented, and to reduce it to a practical minimum, a reasonably hard material is employed. Fracture may be either sharp, occurring at one time, or it may be detailed or progressive, extending over a considerable period of time. In the question of design, stresses are of the greatest importance in the consideration of fractures. If the stress is repeated a great number of times, each application being made before the material has been given time to recover from the preceding, it will eventually break, even though the stress is below the elastic limit. Axles are subjected to alternate transverse stresses and shocks imposed by the car, and the torsional stresses and shocks from the brakes and curves, and also from the gears in the case of motor axles.

On account of its great ductility, wrought iron or soft steel was formerly considered the most désirable material until it was demonstrated that breaking was due as a rule, not to a lack of ductility, but to the fact that the stresses too nearly approached the elastic limit. In the light of this knowledge axles have for some time been made of a fairly hard grade of steel, and for ordinary service standard forged axles, without any special heat treatment, have given good satisfaction. However, with increased loads and particularly with the very severe conditions imposed on motor axles, a better grade of material has been sought, which should have higher resistance to stresses and still be sufficiently ductile to insure freedom from brittleness. This has resulted in the evolution of the heat treated axle. With increased elasticity the increased life of material subjected to such stresses is much greater than the simple proportion of such increase in elasticity; an increase in the elastic limit will result in a greatly increased life.

Heat treatment in every case should not be given until after the axle is cooled down after its final forging, as only in this way are the best results obtained. Heat treatment may consist either of annealing or toughening, and then "drawing back" or annealing at a lower temperature. Increasing the ratio between the elastic limit and the fiber stress, which greatly increases the life, may be done either by increasing the actual elastic limit by suitable treatment or composition, or by increasing the cross sectional area. The employment of heat treatment is held to be the most desirable as the ductility is also increased, insuring greater safety, and is the only practical solution of the difficulty where, on account of the design of the equipment, it is impossible to increase the section of the axle.

For the purpose of the tests 6-in. x 11-in. car or tender axles and 11½-in. x 14-in. driving axles were selected and the experiments consisted of drop tests for the full sized tender axles, and also of tensile tests, bending tests and torsional tests for both classes, the test pieces being taken parallel to the axis and on a radius half way between the centre and the outside. Three grades of basic open hearth steel—mild, medium and hard—were selected. To cover the respective range as completely as possible, axles were taken from three different heats for each grade, a total of nine heats or 120 axles. No driving axles were made from the mild grade.

The product of the heat treatment falls naturally into four different classes as follows: Carnegie standard forged, indicating the axle which has received no special heat treatment subsequent to forging, and is the most generally employed at the present time; Carnegie annealed and Carnegie toughened, indicating axles subjected to the two processes of annealing and toughening above mentioned; and Carnegie high test, in which the treatment is similar to that employed for the Carnegie toughened, except that the final "drawing back" or annealing temperature is slightly lower, the result being that the elasticity and tensile strength are considerably higher, while the ductility is not quite so great, but is still equal to that of the Carnegie standard forged or that of the annealed. This axle is particularly designed for very heavy service.

The results from these tests apparently indicate that it is unnecessary to bore out the centre of large axles in order to insure complete penetration of the effects of the heating and cooling operations, as no difference was discoverable between the large and small axles in these tests, indicating that with proper treatment the entire mass is affected.

In the tensile test the test pieces were the standard 2 x ½ in. specified by the American Society for Testing Materials. For the bending tests the specimens were both 6 ins. long, one lot ½ in. square and the other 1 x ½ in., the object being to determine whether they would show any marked difference. The bends were made by applying pressure until the specimen cracked on the outer edge or reached the bottom of the bending block. In the latter case it was removed and bent between the dies of the press until it failed by cracking on the outer edge or was closed flat. The difference in results between the use of the 1 x ½-in. and the ½-in. square specimens was very slight. In the torsion tests the specimens employed were about 12 ins. long over all, 1 in. square at the ends, the central portion was turned down to ¾-in. diameter for a distance of 8 ins. By means of a line drawn parallel to the axis, which followed the twisting of the piece in the machine, the number of twists could be determined. In the case of drop tests and fractures it was decided to break the various classes of axles to observe, by means of the fractures, the effect of the heat treatment. With the smaller axles this was done under the standard M.C.B. drop, a 1,640-lb. tup falling 43 ft., the axle supported on 36-in. centres. The deflection after the first blow was measured. The test was then continued up to 75 blows, after which the axle was nicked and broken. In case the axle failed before the seventy-fifth blow, the actual number was recorded. The driving axles were too large to be broken in this manner and were, therefore, nicked half way around to a depth of about 3/16 in. to ¼ in. and broken.

It was concluded as a result of these tests that any of the heat treatments employed is beneficial; that owing to the lower carbon, the mild grade is not affected by the heat treatment to the same extent as the others; that to insure material of the highest quality, the medium and the high grade should be heat treated; that the tensile tests do not seem to give as good an idea of the quality of the material as do the torsion tests.

TOOL STEEL.

At a meeting of the New York Railroad Club held on Friday evening, November 17, 1911, W. B. Sullivan, Carpenter Steel Company, Philadelphia, read an interesting paper on "Tool Steel." The author pointed out the necessity of accurate control of the temperature at which steels of different carbon content are forged and annealed in order to secure uniform and satisfactory results from the tools. Steel containing 0.90 per cent. carbon remains unchanged in structure until heated to about 1,360 deg. Fahr. As the the temperaure of the furnace is increased beyond this point the ferrite and pearlite suddenly begin to decompose. The reaction is completed at a temperature of about 1,460 deg. Fahr., which is called the critical point. The ferrite and pearlite change to martensite. By quenching at this point the martensitic condition of the grain structure will be preserved and the steel will be hard and brittle. If the steel be again heated to a still higher temperature the martensite in turn will be decomposed and the original ferrite and pearlite condition will be restored. If the steel is annealed at a temperature where martensite is formed it will contain a portion of the hardening element. By a judicious application of heat it is possible to obtain almost any desired combination of ferrite, pearlite and martensite. Tools when properly handled should be heated first to the proper temperature or critical point, and then quenched. Heating above this point tends to produce decarbonization. If a tool is heated too hot and then allowed to cool slowly before quenching it will have a grain structure developed by the higher temperature which is not corrected by allowing the tool to cool before quenching. Tools should not be allowed to soak too long even at the proper temperature, as this tends to produce decarbonization on the surface.

The hardness of a piece of steel properly treated is governed by the size, character of steel, temperature of bath and character of bath. In general, for small sections lower temperatures should be used than for large pieces. The degree of hardness depends on the rapidity with which the heat is extracted from the steel. A bath of high temperature will produce less hardness. A piece of steel quenched in water will be harder than one quenched in oil. Tests made by the Carpenter Steel Company showed that, compared with water on a basis of unity, No. 1 mineral oil had a tempering quality of 0.241; cottonseed oil, 0.161; fish oil, 0.149.

The author included an outline of the proper grades and tempers of carbon tool steel for various uses. Temper No. 1 contains 0.70 to 0.80 per cent. carbon; No. 2, 0.80 to 0.90 per cent. carbon; No. 3, 0.90 to 1 per cent. carbon; No. 4, 1 to 1.15 per cent. carbon; No. 5, 1.15 to 1.25 per cent. carbon. Grade A is the highest grade steel, selling for about 16 cents per pound. Grade B sells for 13 cents per pound, and Grade C for 10 cents per pound. Grade D is ordinary tool steel selling for about 7 cents per pound. The following outline shows the proper selection of temper and grade and the proper heat treatment:—

Temper No. 1	Grade	
Crowbars	D	Should not be heated over 1,800 deg. Fahr. for forging.
Pinchbars	D	Hardens at 1,485 deg. Fahr.
Pick Points	D	Temper drawn to suit character of work.
Wrenches	D	Should be annealed at 1,300-1,350.
Sledges	C	
Hammers	C	
Rivet Sets	B	

Temper No. 2.		
Smith Tools	C	Should not be heated over 1,800 deg. Fahr. for forging. Hardens at 1,480 deg. Fahr.
Track Tools	C	Temper drawn to suit character of work.
Boilermakers' Tools	C	Should be annealed at 1,300-1,350.

Temper No. 3.		
Cold Chisels	C	Should not be heated over 1,750 deg. Fahr. for forging.
Hot Chisels	C	Hardens at 1,465 deg. Fahr.
Rock Drills	C	Temper drawn to suit character of work.
Shear Blades	B	
Punching Tools	B	Should be annealed at 1,300-1,350.

Temper No. 4.		
Machine Drills	B	
Counter Bores	B	Should not be heated over 1,700 deg. Fahr. for forging.
Milling Cutters	B	Hardens at 1,460 deg. Fahr.
General Machine Shop Tools	B	Temper drawn to suit character of work.
Carbon Lathe Tools	A	
Taps	A	
Dies	A	Should be annealed at 1,300-1,350.
Reamers	A	

Temper No. 5.		
Brass Tools	A	Should not be heated over 1,700 deg. Fahr. for forging. Hardens at 1,455 deg. Fahr.
Finishing Tools	A	Temper drawn to suit character of work.
Small Machine Shop Tools	A	Should be annealed at 1,300-1,350.

MINOR MINERALS OF ONTARIO

Numerous mineral substances were produced in Ontario during 1910 and gave rise to many industries of local importance, employing in the aggregate much labor and capital. Most of them are non-metalliferous in character.

Calcium carbide, used in producing acetylene gas for lighting purposes, and made by the fusion of carbon and lime in the electric furnace, is turned out by two companies, the Willson Carbide Company at Merritton, and the Ottawa Carbide Company at Ottawa. Together, these companies produced and shipped 3,072 tons, valued at $184,323. They employed 56 men and paid out $37,630 in wages. The production in 1909 was 2,349 tons.

For a number of years the production of corundum has been carried on by the Manufacturers Corundum Company, formerly the Canada Corundum Company, at Craigmont, and the Ashland Emery and Corundum Company at Burgess Mines. The Ashland Company's mines and works were leased by the Manufacturers Company, 1st August, 1910, and consequently passed into the hands of that company, which is at the present time the sole producer of corundum. The quantity taken out and shipped from both mines in 1910 was 1,870 tons of grain corundum, valued at $171,944, or about 4.59 cents per pound. There were 201 men employed at the mines and works, receiving in wages the sum of $100,945.

The production of feldspar went up from 11,001 tons in 1909 to 16,374 tons in 1910, the latter quantity having a value of $47,518. The labor of 107 employees was required, the amount of wages paid being $32,901. The Kingston Feldspar and Mining Company, of Kingston, and the McDonald Feldspar Company, of Toronto, were the chief producers.

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

BOOK REVIEWS.

The Westinghouse Airbrake System. Published by Frederic J. Drake & Co., Chicago. 472 pages; 6x8¼ inches; price, $2.00.

This is a treatise containing detailed descriptions and explanations of all the various parts of the Westinghouse airbrakes. It is a compilation of the work of a number of airbrake experts. The book is very fully illustrated with many colored charts.

The New York Airbrake System. Published by Fred J. Drake & Co., Chicago; 374 pages; 6x8¼; price, $2.00. A similar book to the above one describing the New York airbrake system.

Deflections and Statically Indeterminate Stresses. By Clarence W. Hudson. Published by John Wiley & Sons, New York. Canadian agents, Renouf & Co., Montreal. Size 8x11¼ inches; 255 pages, with many cuts; price, $3.50 net.

Up until very recently very few text books in English have been published on the subject of statically indeterminate stresses. The publication of this book gives the underlying principles of the subject and shows their application to a number of problems to which they apply. The principle of the work of deformation has been freely used in many of the general demonstrations and in the solution of some of the special problems. Several methods of finding the distortions of elastic structure under loading are developed, and the importance of the subject, particularly in bridge erection, is shown. The method of writing equations for unknown stresses, forces and reactions in terms of certain elastic deformations due to unit loads, has led to new formulae for finding these quantities for certain structures. The author says that such formulas for unknown crown forces for both the solid webbed and braced arch are here published for the first time. Where methods have been used in the book which are not due to the author, credit for such work has been given.

Boiler Draught. By H. Keay Pratt. Published by Constable & Company, 10 Orange St., Leicester Square, W. C., London, England. Size, 5x7½ inches; 138 pages, including index; 29 illustrations; price, $1.25.

No new matter is included in this book, but the material has been presented in a very clear manner. The book was written with the object of placing some help in the hands of chief engineers and others to whom the efficient working of the steam plant is of interest and importance. The contents include chapters on Draught, Artificial, Forced and Induced; Calculations Relating to Air; Chimneys; Construction; The Application of Mechanical Draught for Land and Marine Installations, and the Chemistry of Combustion.

Practical Thermodynamics, a treatise on the theory and design of heat engines, refrigeration machinery, and other power plant apparatus, by Forrest E. Cordullo, M.E. Published by McGraw-Hill Publishing Co., 239 West 39th Street, New York. Pages, 411, illustrating, 223; price, $3.50 net.

An excellent book on the natural laws and principles of thermodynamics and their application to practical problems, the design and operation of thermodynamic apparatus. The opening chapters contain clear definitions of the terms used, and the units of measurement of heat, their determination and accuracy, the thermal properties of gases, vapors, and their characteristic equations, the thermodynamic processes and the properties of wet vapors and gaseous mixtures. The treatment of the fundamental physical principles is thorough and with a minimum of higher mathematics. Following the study of the fundamental principles are chapters on their practical application to the study and design of the steam, heat, gas and oil engines, and other thermodynamic machinery comprising the main parts of a steam power plant, as condensing apparatus, combustion of fuel, cooling system, chimneys, etc. The steam engine, its efficiency, steam cycle and losses is fully discussed with a chapter on its design and testing.

The theory and design of the steam turbine has been given some attention, but could be improved upon in view of the present practical application of this efficient prime mover.

The latter chapters deal with compressed air refrigeration, heating and ventilation machinery, with a chapter on the entropy diagrams. The material for the temperature entropy analysis of thermodynamic machines in this chapter has been arranged in the same order as the rest of the book. The book ends with a discussion on the kinetic theory of heat.

Problems illustrating principles have been given at the end of each chapter with accompanying answers. Their solution will materially assist students in comprehending the text. The book is a valuable addition to the text books on the subject. It is clearly written and logically arranged.

It is primarily a text book and will be found of value to the engineering student.—[F.A.G.]

Technical Dictionary in Six Languages. Volume V., Railway Construction and Operation, compiled by August Boshart, 870 pages and 1,900 illustrations. Vol. VI., Railway Rolling Stock, by August Boshart, 796 pages, 2,100 illustrations. Vol. VII., Hoisting and Conveying Machinery, by Paul Stülponagel, 651 pages, 1,500 illustrations, and Vol. VIII., Reinforced Concrete in Sub. and Superstructures, by Henirich Beeker, 415 pages, 900 illustrations. Edited by Alfred Schlomann; published by Constable & Co., London, and Copp-Clark Co., Toronto. Prices net Vol. V., $4.80; Vol. VI., $2.40; Vol. VII., ? ; Vol. VIII., ? .

Vol. V. covers the general terms of importance used in railway construction and operation. Also those used in the construction of plants for the delivery of power to electric railways.

Vol. VI., along with Vol. V., completes the technicalities dealing with railway construction, together with railway work-shop details.

Vol. VII. deals with hoisting and conveying machinery. The fundamental principles of these machines are first touched upon. Then the general working of the plant, which includes various combinations of plant and machinery. This will be found to be a valuable work to those interested in the building and operation of such machinery.

Tests of a Suction Gas Producer. By C. M. Garland and A. P. Kratz, is issued as Bulletin No. 50 of the Engineering Experiment Station of the University of Illinois.

This bulletin gives the results of twenty-five tests made on a small suction gas producer, for the purpose of obtaining data on the efficiency, reliability, and operation of suction producers of small size, using anthracite as a fuel. The theory of gas producers is discussed at some length. The conclusion is reached that a producer of the above type is a practical piece of apparatus for a class of work not requiring close regulation; also that the percentage of CO_2 in the gas can vary within wide limits without affecting the efficiency of operation. A very complete set of forms for reporting tests has been drawn up, and the formulas for calculating the trials have been deduced.

Copies of Bulletin No. 50 may be obtained gratis upon application to W. F. M. Goss, Director of the Engineering Experiment Station, University of Illinois, Urbana, Illinois.

Hydraulics, by Hughes and Stafford. Published by The Macmillan Company, New York. Size, 6x9; pages, 500; illustrated; price, $3.75.

The joint authors of the work are Hector J. Hughes, Assistant Professor of Civil Engineering, Harvard University, and Arthur T. Stafford, Consulting Hydraulic Engineer. The book is intended as a text-book for technical schools and colleges on certain parts of the broad subject of hydraulics.

The engineer, however, will find this book a distinct addition to his library, as he is frequently confronted with problems requiring the solving of hydraulic formulas intricate and complicated. In this work the authors have succeeded in presenting, in direct and simple manner, the recognized methods of solving hydraulic problems; have pointed out practical difficulties and how to meet them; have presented coefficients and formulas as are in good use; provided tables and diagrams and outlined the present practice in dealing with hydraulic problems.

Eighteen chapters and nineteen tables represent the subdivisions of this work.

Fluid pressure, equilibrium of floating solids, flow of water and methods of measurement, the pitol tube, the Venturi meter, orifices, nozzles, weirs, flow of water in pipes and open channels, and water-wheels and certrifugal pumps are a few of the subjects treated.

In addition to a table of contents, there is an index of some 700 words, covering fully the questions treated of in the work.

This is one of the best works on hydraulics. One could not require anything better.—[E.A.J.]

Rock Drilling, Open Cut Excavation and Submarine Rock Removal, by Richard T. Dana and W. L. Saunders. Published by John Wiley & Sons, New York; Renouf & Co., Montreal, Canadian agents. Size, 6x9; pages, 319; illustrations, 127; price, $4.00.

The rock drill, perhaps more than any other instrument, except the engineer's transit, is the tool that accompanies the vanguard of civilization, and its contribution to the general economy of construction, its effect upon the cost of rock work, and its influence on standard engineering methods, have been enormous. In principle it is unique as a machine, and in practice it offers a class of problems which have long deserved special study and a special treatise.

To establish the fundamental facts for determining this "best" way for any given conditions, and to place these facts at the disposal of engineers and contractors, the Ingersoll-Rand Company instituted an investigation into the economics of drilling work, the results of which are presented in this book in the hope that it will mark a step forward in the effort to place the study of rock drilling upon a scientific basis. While much still remains to be done, the present work contains the cream of the available information on the subject, most of which has never before appeared in print.

Sixteen chapters are devoted to discussing the various phases of this work, including chapters on Blasting and Explosions; Drilling on Land, and Subaqueous Drilling.

The efficiency of the various types of drills it dealt with, the numerous types described, cost of operation, is given along with methods to be adopted in drilling.

A complete index makes the book convenient to use.

Those requiring any information on the subject of drilling will find it a practical work.—[E.A.J.]

Proceedings of the 3rd National Conference on Town Planning. Published by the secretary, F. Shurtleff, 19 Congress Street, Boston, Mass. Size, 6x9; pages, 300; cloth.

The Third National Conference on Town Planning was held at Philadelphia, Pa., May 15-17, 1911.

The secretary of the conference has issued in book form the addresses and discussions there delivered, and this volume will be found to be a splendid contribution to the literature on this interesting subject.

One very noticeable feature of this conference was the fact that much more than half the time was taken up with discussions by men informed on their subject.

The Table of Contents includes papers on the following subjects:—

The Location of Public Buildings in Parks.
Buildings in Relation to Street and Site.
Water Terminal Problems.
Street Widths and Their Subdivision.
Standard Street Widths.

This publication will be of value to the city engineer and the surveyor, as well as the man who gives his time to town planning exclusively.—[E.A.J.]

Report of the American Society for Testing Materials, 1911. Published by Edgar Marburg, Secretary of the Society University of Pennsylvania, Philadelphia, Pa. Size, 6x9; pages, 400; cloth.

The specifications published by this society have long been accepted as the standard. The specifications included in this volume cover 39 subjects. To outsiders the society disposes of a set for 25 cents, to members 15 cents.

The society has now a membership of 1,382.

Inspection of the Materials and Workmanship Employed in Construction. By Austin T. Byrne. Published by John Wiley & Sons, New York; Canadian agents, Renouf Publishing Co., Montreal. Third edition revised and enlarged, 4½x7¼ inches; 609 pages, including index; price, $3.00.

This well-known book, which is a reference book for the use of inspectors, superitendents, and others engaged in the construction of public and private works has now reached the third edition. It contains a collection of memoranda pertaining to the duties of inspectors, the quality and defects of materials, the requisites for good construction, the methods of slighting work, and much other valuable data. There are in all eighty-four tables contained in the volume, which will be found exceedingly useful.

Vol. VIII. deals with the terms and phrases in reinforced concrete, both in sub and superstructures. It is a valuable addition to the work and will be of use to engineers desirous of studying foreign articles and manuals on the subject.

The terms and phrases defined in these books are given in six languages—English, French, German, Italian, Spanish and Russian. The term or phrase is defined or illustrated by means of clear cuts of drawings which illustrate the object or the operation referred to. These cuts or illustrations are placed in the centre part of the sheets forming the leaves of the book, on each side of which in vertical columns is placed the terms and phrases in the six languages, these on each side explaining the cut or operation to be described. The cuts are excellent and leave no doubt as to the meaning of the phrase or term. For terms and operations, which are readily understood, the illustrations or drawings have been omitted.

The subject dealt with in each of the books is divided into sections in order of importance, taking up the elementary principles and terms, which are followed by elements of machines, and material, complete machines and operation of plant, use of materials, etc., concluding with terms and phrases on various combinations of plant machinery, and their operation. The arrangement ensures a comprehensive survey of the subject covering a large field, and very little has been omitted. A large number of collaborations were used in its compilation and the checking of technical terms in all languages, many of which are high authorities on the respective subjects and eminent engineers. The technical terms have been carefully checked by these leading experts and may be regarded as accurate and comprehensive.

The work has been carefully indexed alphabetically, terms and works in all languages, being placed in one index, with the exception of the Russian, which is indexed separately at the end of the volume.

This most excellent work is elaborate, and is the most comprehensive translating technical dictionary on the market, and covers a field attempted by none. The careful checking by the large number of experts tends to eliminate errors and omissions so prominent in dictionaries of this character. This book can be employed with confidence, and will be found to be a valuable dictionary to those engaged in translation.

The books are indispensable to the engineer and technical translator.—F. A. G.

The Design of the Static Transformer, by H. M. Hobart, M. Inst. of C.E. Published by Constable & Company of London; p.p., 174; illustrated, 101; tables, 17. Price net, $2.

The book deals with the practical design and construction of the transformer, and supplies a much-needed manual filling the gap between theory and manufacture. It will be of material assistance to the student in showing him how to proceed with the commercial design of the transformer and use his theory.

The introductory chapter is historical of the development of the transformer and reminiscent of the author's experience in its early design. For further study of the transformer a bibliography of a large number of papers and articles is given after the introduction. The fundamental principles of practical design are taken up in the first few chapters, fully illustrated by cuts and curves, followed by chapters on the constructional details, with a study of the core losses, annual efficiency, no load current, power factor, efficiency, frequency, regulation and heating, and their influence on the design. To illustrate and explain the principles of design, calculations have been made for a small capacity transformer, each step in the design being fully described, special characteristics and variations in design, the adaptability and value of material, are fully discussed. The various data curves and rules introduced to aid in carrying on the design where it is necessary to make assumptions are based upon the author's experience. The reader is supposed to be familiar with the underlying theory of the transformer. The treatise may be regarded as an introductory to the practical design of the transformer.—F. A. G.

PUBLICATIONS RECEIVED.

The Eleventh Annual Report Canadian Association for the Prevention of Tuberculosis. This report includes transactions of the annual meeting held in London, Ont., May 17-18, 1911. Secretary Geo. D. Porter, Esq., Ottawa.

Directions for Laying Vitrified Brick Street Pavements. No. 1, specification endorsed and recommended by the National Paving Brick Manufacturing Association. Copies of this specification may be secured from Will P. Blair, Secretary, 824 B. of L. E. Bldg., Cleveland, O.

Victorian Institute of Engineers. Proceedings for 1910. Published by the Institute, Melbourne, Australia.

The Prevention of Sap Stain in Lumber. Circular No. 192. Forest Service, U.S. Department of Agriculture, Washington.

Interstate Commerce Commission. Bulletin of revenues and expenses of steam roads in the United States for the month of July, 1911. Prepared by the Division of Statistics, Washington.

Reinforced Concrete Patents. Their scope or monopoly value and the consequences of infringement. Legal questions to the owner, engineer, architect and builder. Copies may be secured on payment of fifty cents to the author, Charles Day Williamson, McLachlen Bldg., 700 10th Street, Washington.

Gypsum Deposits of the Maritime Provinces. A report by William F. Jennison, The Mines Branch, Dept. of Mines, Canada.

Water Powers of Canada. A report by the Commission of Conservation, Canada.

Experimental Farms. Appendixed to the Report of the Minister of Agriculture for the year ending March 31st, 1911.

Department of Mines and Fisheries. 44th Annual Report.

Report of the Minister of Agriculture for the year ending March 31st, 1911.

Report of the Secretary of State for the year ending March 31st, 1911.

Report of the Minister of Public Works for the year ending March 31st, 1911.

National Association of Cement Users. Proceedings of the seventh annual convention held at New York, December 12th to 20th, 1910, containing summary of the proceedings with the different papers given before the association.

Composition and Strength of Mortar. The report on the results of the experimental investigation conducted for the Science Standing Committee of the Royal Institute of British Architects, by W. J. Dibdin, F.I.C. Published by the Royal Institute of British Architects, No. 9, Conduit Street, Regent St., London. Price, five shillings.

CATALOGUES RECEIVED.

Cement Sidewalk Tools. 1912 catalogue and price list sent out by T. Slack & Co., manufacturers, Toronto.

Mathematical and Drawing Instruments. New circular forwarded by Keuffel & Esser Co., New York.

Ballbearings. A circular issued by the Hoffman Manufacturing Co., Chelmsford, Essex, England, dealing with the use of ballbearings on woodworking machinery.

Circular 1198, describing alternating-current water-wheel generators, has been issued by the Westinghouse Electric and Manufacturing Company, of East Pittsburg, Penna. The publication illustrates and describes the different types of generators, both vertical and horizontal, for water-wheel drive, manufactured by that company.

Messrs. Chambers and Simpson, of 103 Bay Street, Toronto, have some copies of the 1912 diary issued by the Campbell Gas Co., Ltd., at Halifax, England, which firm Messrs. Chambers & Simpson represent in Ontario.

This diary is a most useful souvenir, containing a lot of very valuable information, and is handsomely bound in morocco. Altogether the diary is very fine and will be appreciated by everyone who is fortunate enough to be favored with a copy.

COMING MEETINGS.

THE AMERICAN INSTITUTE OF CONSULTING ENGINEERS.—January 16th, 1912, Annual Meeting, Aldine Club, Fifth Avenue and 23rd Street, New York City, at 8 p.m. Secretary, Eugene W. Stern, 103 Park Ave., New York.

CANADIAN FORESTRY ASSOCIATION.—February 7th and 8th, 1912. Forestry Convention Meetings held in the Railway Committee Room, Parliament Buildings, Ottawa. Secretary, Mr. James Lawler, Canadian Bldg., Ottawa.

CANADIAN LUMBERMEN'S ASSOCIATION.—February 6, 7 and 8, 1912. Annual Meeting to be held at the same time and place as the Canadian Forestry Association.

THE CANADIAN SOCIETY OF CIVIL ENGINEERS.—Jan. 24, 25, 26, 1912, General meeting, 413 Dorchester St. West, Montreal. Prof. C. H. McLeod, Secretary.

THE CANADIAN FORESTRY ASSOCIATION.—February 6, 7 and 8, 1912 Annual Meeting, Ottawa. James Lawler, Secretary.

ENGINEERING SOCIETIES.

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

QUEBEC BRANCH—
Chairman, P. E. Parent; Secretary, S. S. Oliver. Meetings held twice a month at Room 40, City Hall.

TORONTO BRANCH—
96 King Street West, Toronto. Chairman, H. E. T. Haultain, Acting Secretary; E. A. James, 57 Adelaide Street East, Toronto. Meets last Thursday of the month at Engineers' Club.

MANITOBA BRANCH—
Secretary E. Brydone Jack. Meets every first and third Fridays of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—
Chairman, Geo. H. Webster; Secretary, H. K. Dutcher, 319 Pender Street West, Vancouver. Meets in Engineering Department, University.

OTTAWA BRANCH—
Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N. T. Ry., Cory Bldg.

MUNICIPAL ASSOCIATIONS.

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

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

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

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

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

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secretary, Mr. Heal, Moose Jaw

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.

BUILDERS, CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary Treasurer, J. H. Lauer, Montreal, Que.

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

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; 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, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Thomas Southworth, Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

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

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

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

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

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, T. A. Starkey, M.B., D.P.H., Montreal. Secretary, F. C. Douglas, M.D., D.P.H., 51 Park Avenue, Montreal.

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

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

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

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

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, W. B. McPherson; Corresponding Secretary, A. McQueen.

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

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Killaly Gamble; 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 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 PROVINCIAL GOOD ROADS ASSOCIATION.—President, W. H. Pugsley, Richmond Hill, Ont.; Secretary, J. E. Farewell, Whitby.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. Whitson; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

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.

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

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

SOCIETY OF CHEMICAL INDUSTRY.—Dr. A. McGill, Ottawa, President; Alfred Burton, Toronto, Secretary.

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

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

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