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WATER SUPPLY AND POWER AT MEDICINE HAT

A UNIQUE MUNICIPAL DEVELOPMENT COMPRISING WATER SUPPLY AND FILTRATION AND GAS-GENERATED ELECTRICAL POWER IN ONE INSTALLATION.

THE city of Medicine Hat has entered upon an extensive scheme for the supply of water and also of light and power, to be increased in capacity from time to time as the growth of the city demands. The project was undertaken in 1912, and practically completed in the fall of 1913. The accompanying illustrations refer to some of its important features.

The scheme as adopted by the city included a new intake, a mechanical gravity filter plant, systems of low-lift and high-lift pumps, a service reservoir and new lines of water mains, and a power plant with gas-fired boilers to drive a set of turbo-generators for the production of power.

Prior to the installation the city was served by a pumping and filter plant on the bank of the South Saskatchewan River, which is the only source of its water supply, on a site in the business section of the city. Power was derived from a plant farther up the river, equipped with two 125-kw. alternating current generators with both gas and steam engine drive, the fuel being natural gas. The pumping outfit delivered to a 400,000-gallon standpipe, whose elevation proved insufficient to serve the higher parts of the rapidly extending city. When it was deemed necessary to improve the water supply service it was considered advisable also to add to the supply of power at the same time. The result is a combined power, pumping and filter plant, which has been erected on a site adjacent to the previously existing power plant. The locations of the old and new plants are shown in Fig. 2.

The South Saskatchewan River, from which the city derives its supply, is susceptible like most prairie rivers of the West, to great variation in flow and also to considerable turbidity. At Medicine Hat the river level varies over 30 feet, and in seasons of dry weather it is very shallow. Accordingly, the new intake was located in midstream and both intake and pipe line were arranged to avoid troubles from floating ice. The intake pier, the general design of which is shown in Fig. 7, is a low concrete structure with a gently sloping up-stream face carried below the river bed. The inlet is in the outer face parallel to the direction of the current, and covered by a removable screen, carried in grooves as shown.

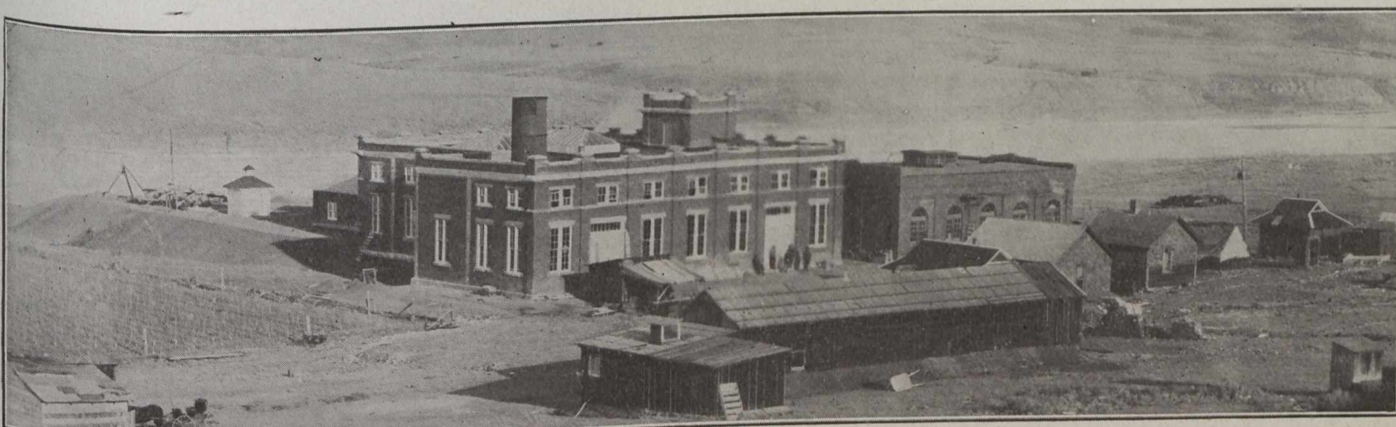


Fig. 1.—General View from Southwest of the Plant at Medicine Hat for the Supply of Water and Power.

This inlet serves a 30-inch cast-iron pipe entering the pier below the river bed and extending in a trench in the river bottom to the suction well on the bank. The cast-iron covered secondary inlet, shown in the intake in Fig. 7, is an emergency opening covered under ordinary conditions, but designed for easy removal by exterior ring handles when necessary. Provision is made for blowing off this cover by back pressure as well. It is for use only if the normal inlet is rendered unfit for service by ice or debris.

All the work in connection with the intake was done during the winter of 1912-13, when the ice on the river had a thickness of 2 feet or more. The excavation, which was sand, gravel and small boulders and very difficult to handle, was taken out with an orange-peel bucket operated from the ice and manipulated when necessary by a diver. The trench from the river bank to the intake location was excavated about 4 feet wide and about 1 foot below grade, surplus earth being hauled away on sleds.

Two-pile bents were driven at about 9 feet centres on each side of the trench, one pile on each side of the

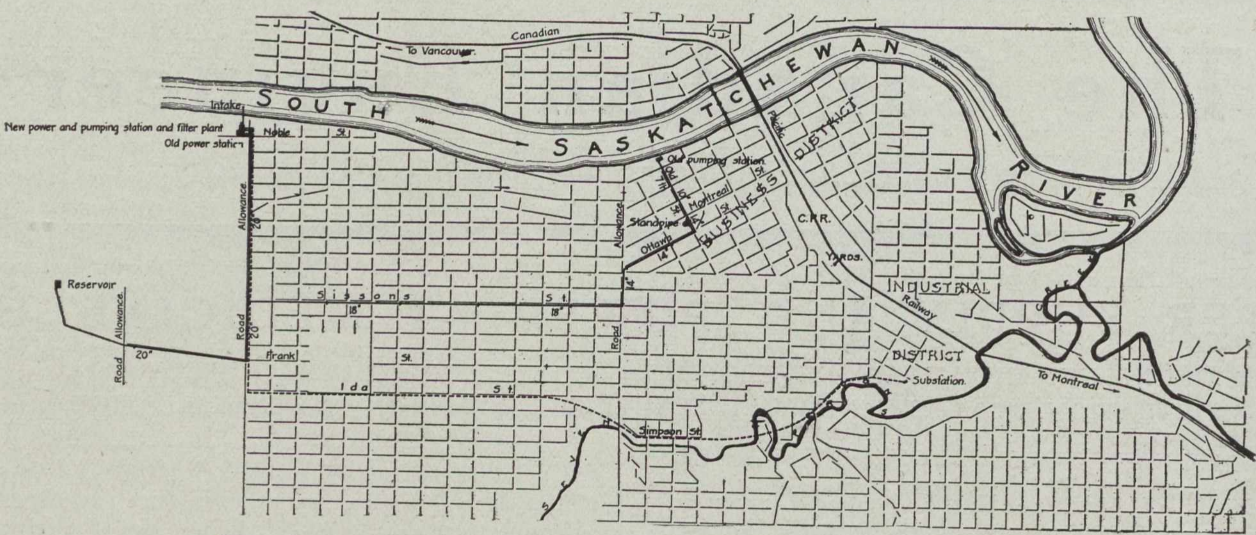


Fig. 2.—Locations of New and Old Power and Pumping Systems.

trench at each bent. These piles were capped with 8-inch x 10-inch timbers bored over the centre line of the pipe for 1-inch threaded rods about 4½ feet long.

Upon the completion of this preliminary work the intake pipe, which was 30 inches in diameter, was lined up on skids across the trench and the joints caulked with lead wool. The section of the pipe line thus treated was

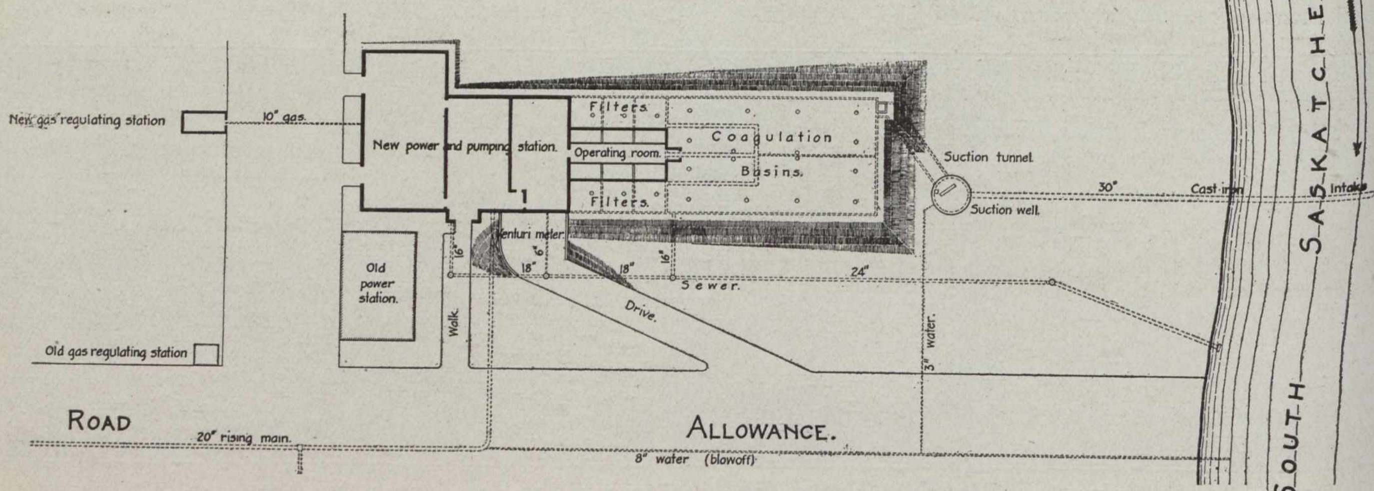


Fig. 3.—Arrangement of Power and Pumping Station and Filter Plant.

284 feet in length. Each threaded rod had a hook at the lower end and was provided with a nut having handles long enough for convenient turning.

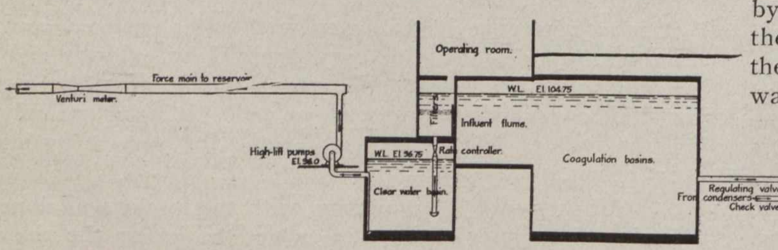
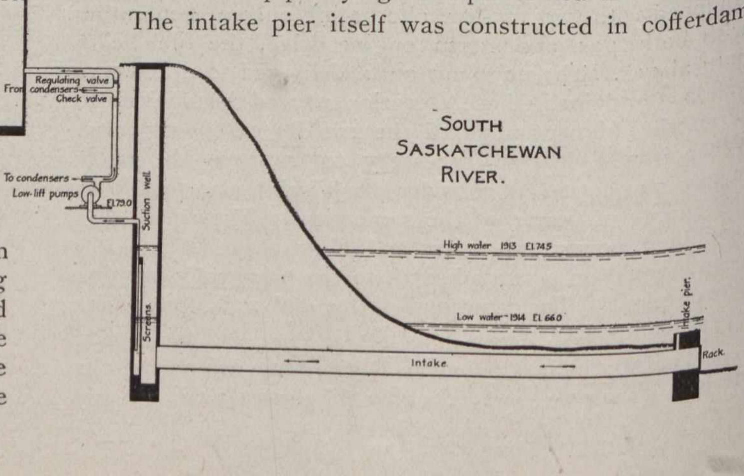


Fig. 4.—Diagrammatic Section of Waterworks Plant.

The actual pipe-laying was done by stationing a man at each bent with instructions to lower the pipe by giving the nut a certain number of turns at a pre-arranged signal. The pipe was slightly raised at first to provide for the removal of the skids, upon which it rested. Rope slings suspended the pipe from the hooks, and after the pipe had been lowered as far as possible by means of the threaded rods, these slings were temporarily secured to the bents whereupon the rods were raised to repeat the process, and provided with longer slings. By this means one period after another of the lowering process was accomplished. The pipe-laying arrangement is shown in Fig. 6.

When the pipe was down to grade it was inspected by diver and back-filled with material excavated from the trench. There was practically no settlement after the hooks and slings were finally cast off. From the water line the pipe-laying was performed in the drive.

The intake pier itself was constructed in cofferdam



and small cofferdams were also employed to make connection at both ends of the intake pipe after laying.

The suction well, the location of which on the river bank is illustrated in Fig. 3, is a reinforced concrete structure provided with a concrete roof with cast-iron

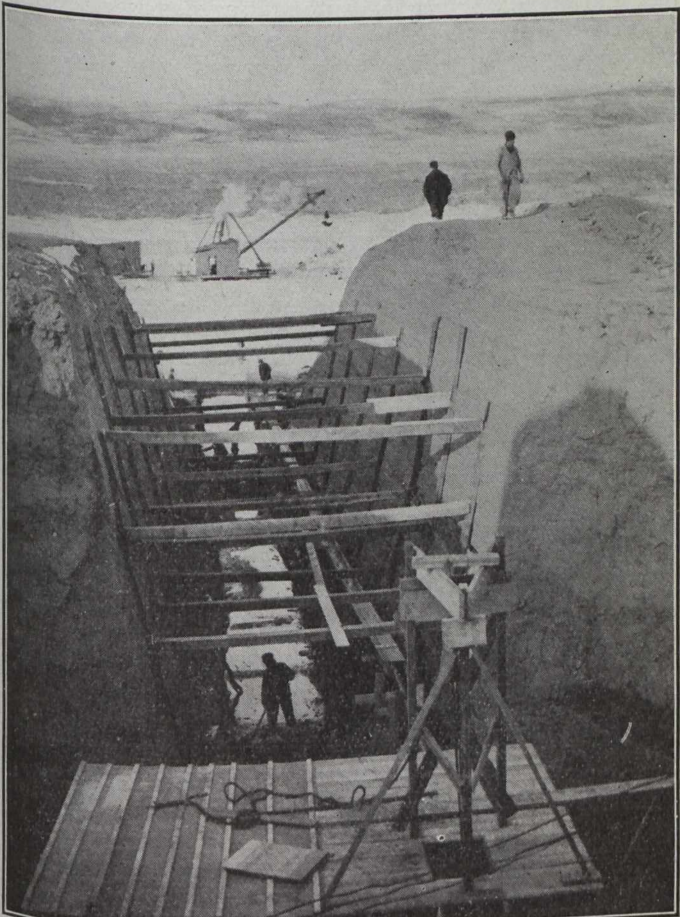


Fig. 5.—River Bank Excavation for the Intake Pipe.

covers for man-hole, screen and gate rod openings. The inlet from the intake pipe and the three low-lift pump suctions, the latter protected by duplicate copper screens, are arranged as shown in Fig. 8.

The low-lift pumps, whereby the raw water reaches the coagulation basins, as illustrated in Fig. 4, are three in number, each with a capacity of three million gallons per day. (There is a condenser connection also with the

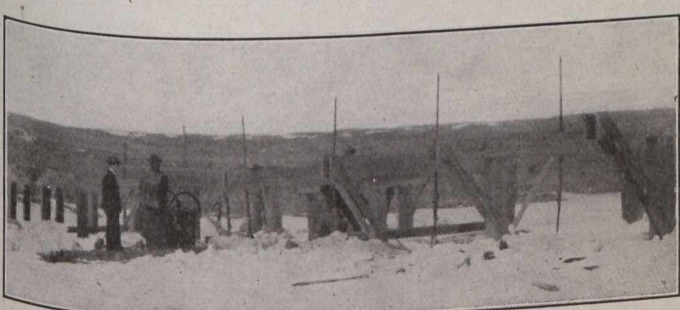


Fig. 6.—Novel Arrangement for Laying the Intake Pipe, Lowering Screws in Position.

power house as will be later described.) These pumps are located as illustrated to avoid occasional flooding which occurs along the river bank. They are in a pump pit, as shown in Fig. 10, within easy suction lift (about 17 feet) of the river at low water and safe from danger in time of flood. They are served by independent 16-inch cast-iron flanged sections, laid in a concrete tunnel constructed under the coagulation basins to the suction well, as illustrated in Figs. 9 and 10. These suctions have foot valves and the pumps are provided with ejectors for priming.

The coagulation basins consist of two units each with a preliminary and final basin. Regulating valves control the incoming supply of raw water.

The mechanical gravity filter plant consists of six units, each of one million gallons per day capacity. They are arranged in rows of three on either side of the operating room, as shown in Fig. 9. Each unit occupies 24 feet by 17½ feet floor space. Underneath the filters

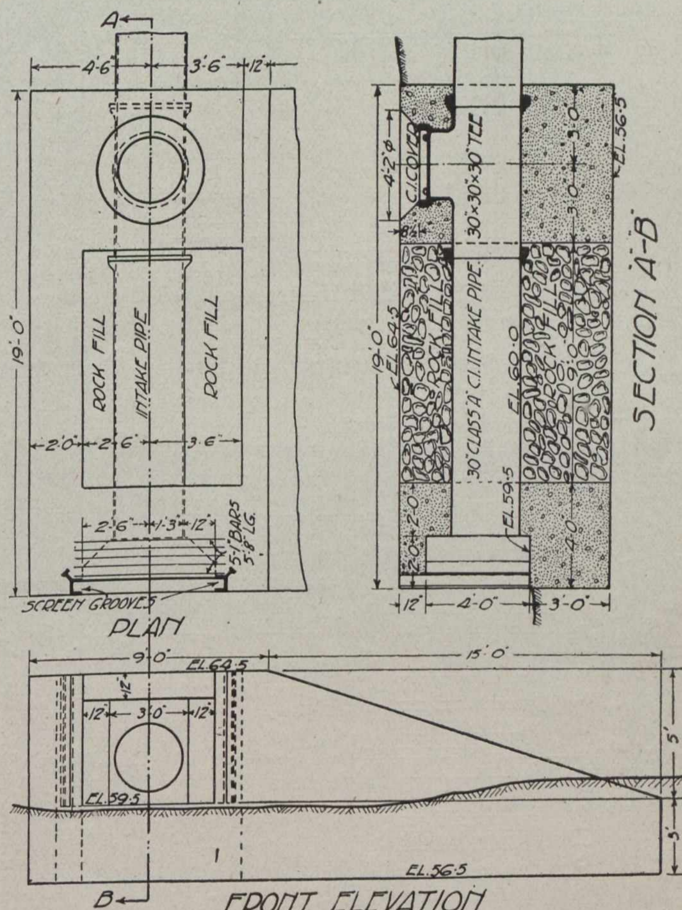


Fig. 7.—Details of Intake Crib.

and on the same level as the coagulation basins are the clear-water basins, with a capacity of 125,000 gallons. The arrangement is clearly indicated in Fig. 10. The filtration plant provides for a minimum of three hours' sedimentation.

The high-lift pumps, for raising the filtered water from the clear-water basins to the service reservoir, or for pumping directly into the distribution system, are also three in number, each with a capacity of 3,000,000 gallons per 24 hours. They are placed on the upper floor level of the station and their arrangement, together with the wash-water pump and blower for the filters is shown in Fig. 9. The service reservoir has a capacity also of 3,000,000 gallons, and its location is indicated in Fig. 2. From the plant to the reservoir is a length of about 9,500 feet of 20-inch main, with an 18-inch feeder 11,000 feet long on Sissons Street to connect with the old low-level system through a pressure-regulating valve. In all pipe lines Mannesmann lap-welded steel pipe was used and practically all of the joints are of the bell and spigot type, and leaded. Flanged pipe was used only for the first 125 feet of the line from the station, in which section there is a Simplex venturi meter with indicating and recording apparatus in the power plant.

The storage reservoir is of reinforced concrete, covered and rectangular in shape. It is 208 feet by 96 feet and about 21 feet in depth. Provision is made for future extension, one side wall having been designed as self-supporting, to serve as a dividing wall when extensions are made. A concrete gate house with a brick superstructure protects the necessary valves and connections. The reservoir has a beam and slab roof and buttressed walls, reinforced horizontally. In their design it was assumed that the earth pressures would be equivalent to that of a fluid weight of 15 lbs. per cubic foot when the reservoir was full and 33 lbs. per cubic foot when empty. Necessarily a heavier wall was adopted for the upper six or eight feet than this assumption required, to provide sufficient strength in case the earth backing were removed. An advantage of the type of wall adopted is that the main reinforcement serves also as temperature reinforcement and effectively distributes any vertical cracks.

When tested for leakage, the reservoir was found satisfactory. Under an 18-foot head a total leakage of ¾-inch developed in 96 hours. The walls were not faced and no special waterproofing was used. V-shaped horizontal construction joints were adopted and at each vertical construction joint was inserted a 16-gauge copper strip, 10 inches wide, with a corrugation at the centre. These joints were temporarily boxed out into

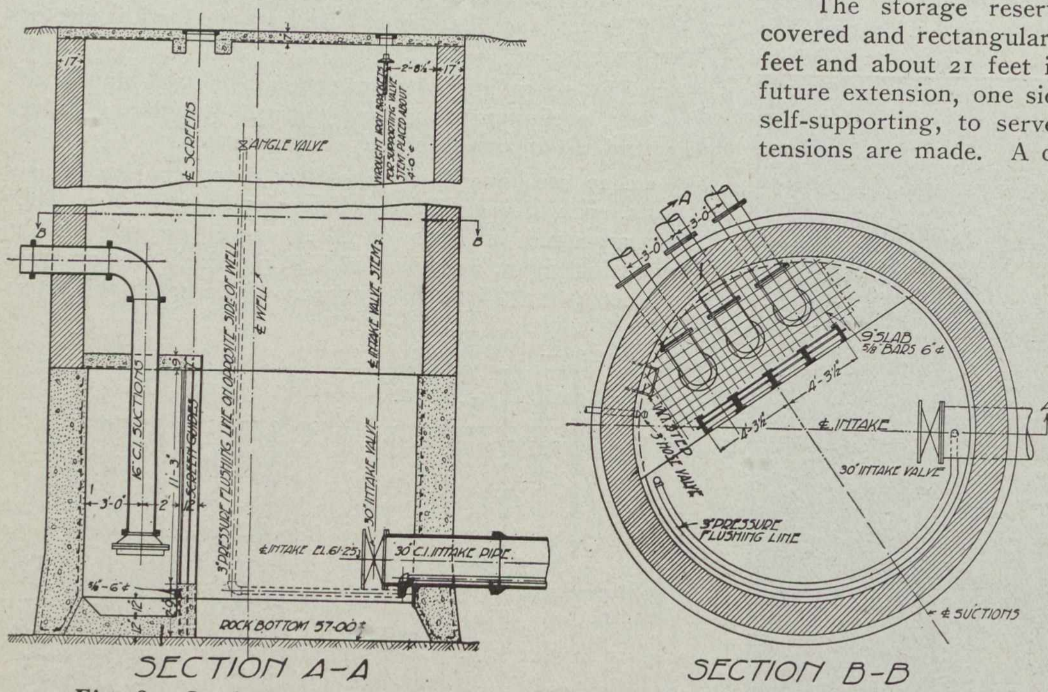


Fig. 8.—Sectional Diagrams of Suction Well, Showing Piping Arrangement.

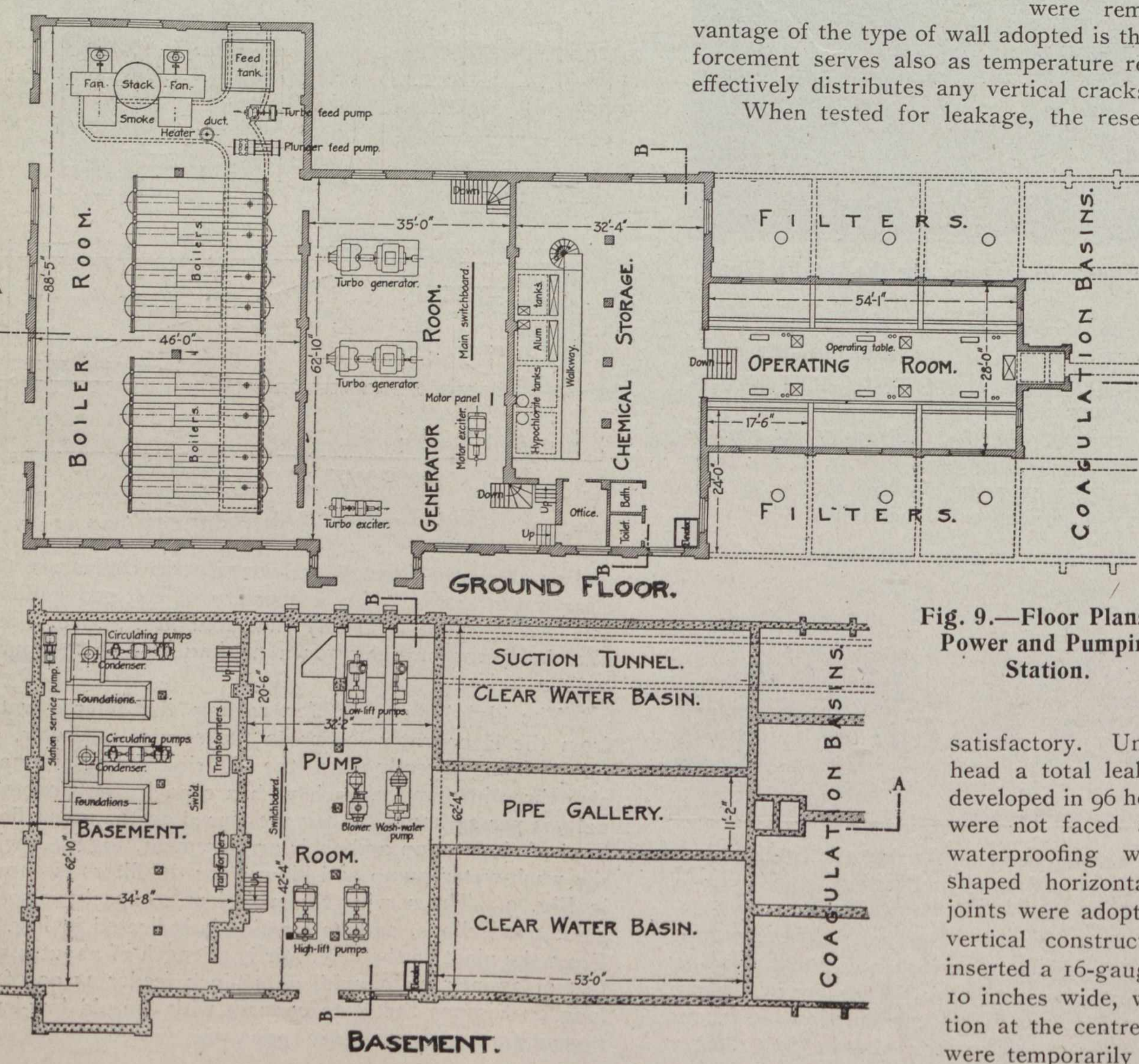
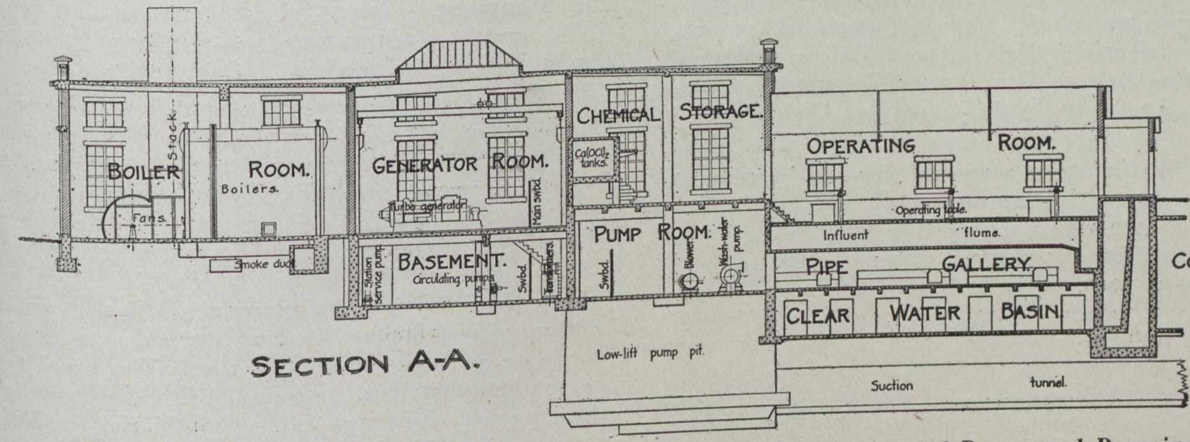


Fig. 9.—Floor Plans of Power and Pumping Station.

the backfill to permit inspection from the outside when the reservoir was put into service.

The structure is equipped with suitable connections for circulation and for cleaning out.



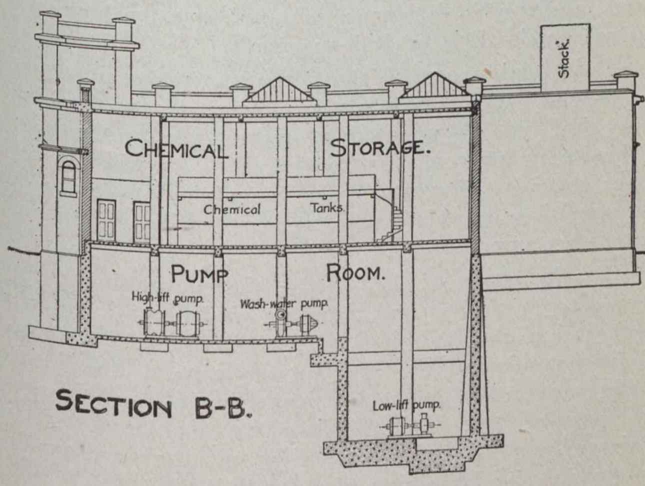


Fig. 10.—Sections of Power and Pumping Station.

The general features of the power development are illustrated in Figs. 9 and 10. The boiler room comprises four 400-h.p. water tube boilers set in two batteries. These are gas-fired and induced draught is provided by two steam-driven fans in the smoke duct, as illustrated, discharging immediately above the roof through an 8-foot steel stack. One multi-stage turbine-driven feed pump is employed, with a plunger feed pump in reserve. Both connect with a concrete feed water tank supplied by the discharge main or by service pump from the sedimentation basins.

The boiler and generator rooms are on the same level. The latter is equipped with two turbo-generator units each consisting of a 3,600 r.p.m. steam turbine direct connected to a 2,200-volt, 60-cycle, 3-phase, 750-kv.a. Siemens generator. The turbines were supplied by Fraser and Chalmers, of Montreal. Each unit is equipped with a Koerting ejector condenser, water for which is drawn from the discharge header of the low-lift pumps, and boosted by a small centrifugal pump driven by motor. The latter also drives a centrifugal return pump with submerged suction in the hot well, and whereby any desired amount of the water from the hot well is returned to the coagulation basins.

There is a motor-driven and also a steam turbine-driven exciter for the main unit. As shown in Fig. 9, the condenser, circulating pump, service pump and transformers are located on the lower floor level.

The building itself is of reinforced concrete with brick and tile curtain walls and a flat concrete roof. As noted in Fig. 10, the chemical storage and tanks are located above the pump room.

This unique system whereby Medicine Hat is provided with 6,000,000 gallons of water per day and 1,200 kw. of electrical energy with one boiler, one turbo-generator, one high-lift and one low-lift pump in reserve, has been developed according to the designs of Messrs. R. S. and W. S. Lea, consulting engineers of Montreal. It was carried out while Mr. A. K. Grimmer was city engineer. Messrs. Fyshe, Martin and Company, of Calgary, were

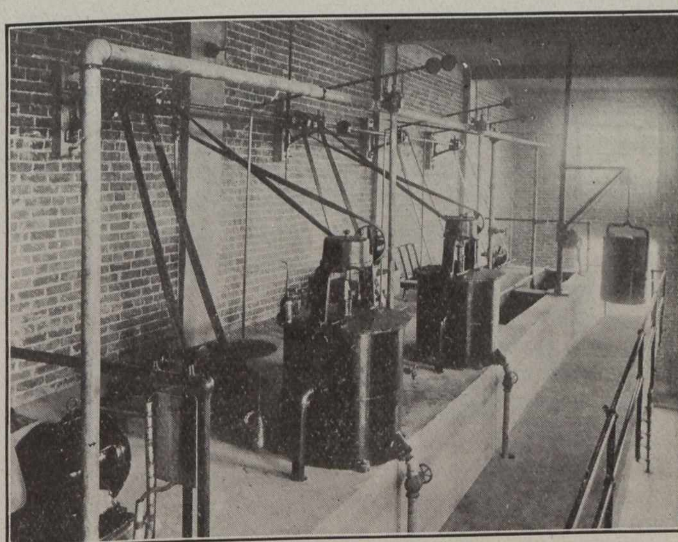


Fig. 11.—Solution Tanks and Operating Apparatus.

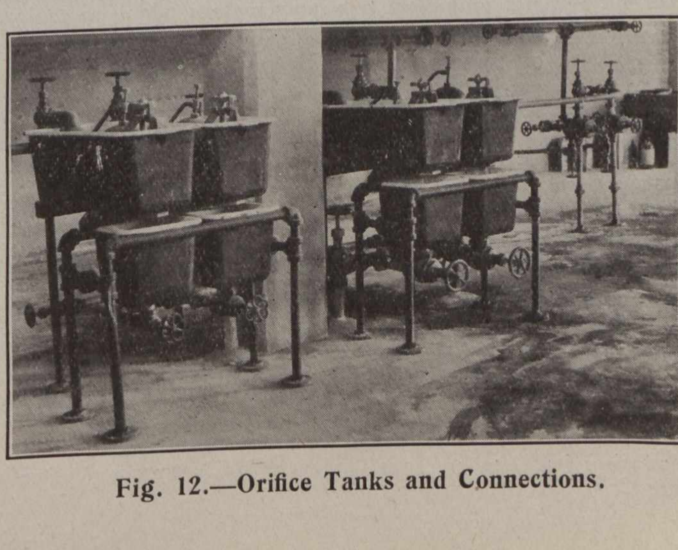


Fig. 12.—Orifice Tanks and Connections.

the contractors for the power plant, intake, suction wells, etc. The New York Continental Jewell Company supplied the filters which were installed and equipped after the company's own design. The reservoir was constructed by Messrs. Hotson, Leader and Goode, of Medicine Hat. Messrs. Fraser and Chalmers supplied the turbo-generator units, Drysdale high-lift pumps, piping and auxiliaries. Babcock and Wilcox furnished the boilers, the Gwynne Gas Burner Company the gas burners, and the Green Fuel Economizer Company the fans.

The city has before it a report prepared by request in 1913 by the consulting engineers, covering a development with ultimate capacities as follows: Filters, 30,000,000 gallons; high-lift pumps, 33,000,000 gallons and low-lift pumps, 55,000,000 gallons per day, in the pumping system; 16,000 h.p. boilers and 24,750 kv.a. turbo-generators in the power system.

THE INTERNATIONAL JOINT COMMISSION.*

At Washington, on January 11th, 1909, James (now Viscount) Bryce, on behalf of Great Britain, and Elihu Root, then Secretary of State of the United States, signed a Treaty that may fairly be said to mark the birth of a new epoch in the relations of the two great democracies of North America. In the preamble of the Treaty its objects are thus set forth: "To prevent disputes regarding the use of boundary waters and to settle all questions which are now pending between the United States and the Dominion of Canada involving the rights, obligations, or interests of either in relation to the other or to the inhabitants of the other, along their common frontier, and to make provision for the adjustment and settlement of all such questions as may hereafter arise."

Special clauses of this Treaty limit the diversion of water from the Niagara River above the Falls by either country to a specified quantity; and provide for the equal apportionment of the waters of the St. Mary and Milk Rivers, in the State of Montana and the Provinces of Alberta and Saskatchewan, between the two countries.

For the purpose of the Treaty boundary waters are defined as "the waters from main shore to main shore of the lakes and rivers and connecting waterways, or the portions thereof, along which the international boundary between the United States and the Dominion of Canada passes, including all bays, arms, and inlets thereof, but not including tributary waters which in their natural channels would flow into such lakes, rivers, and waterways, or waters flowing from such lakes, rivers and waterways, or the waters of rivers flowing across the boundary."

Boundary waters, as defined in the Treaty, therefore, include the St. Croix River and that portion of the St. John River between New Brunswick and Maine; the St. Lawrence from the point where the international boundary strikes the river to its outlet from Lake Ontario; Lake Ontario; the Niagara River; Lake Erie; the Detroit River, Lake St. Clair, and St. Clair River; Lake Huron; St. Mary River; Lake Superior; Rainy Lake, with the smaller lakes and rivers east of it through which the international boundary passes; Rainy River, and the Lake of the Woods. On the other hand, they do not include rivers flowing into these waters, such as the Seneca, Genesee, Sandusky, Grand, Thames, French, and Nipigon; or rivers flowing out of them, such as the Winnipeg, Lower St. Lawrence, and Lower St. John; or rivers flowing across the boundary, such as the Red, Souris, Columbia, and Kootenay.

It is agreed that the "navigation of all navigable boundary waters shall forever continue free and open for the purposes of commerce to the inhabitants and to the ships, vessels and boats of both countries equally." This right of navigation is also extended to the waters of Lake Michigan, and to all canals connecting boundary waters now existing, or which may hereafter be constructed. Tolls may be charged on such canals, but without discrimination against the subjects or citizens of either of the contracting parties. The equal right of navigation, therefore, extends both to the Canadian and the American canals at Sault Ste. Marie, the Welland canal, and the St. Lawrence canals above the boundary; but not to the Erie or Rideau canals.

It is further agreed that "the waters herein defined as boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other." As will be seen later, special action has since been taken to carry out the provisions of this clause, at least so far as boundary waters are concerned.

By the terms of the Treaty, the contracting parties agreed to "establish and maintain an International Joint Commission of the United States and Canada composed of six commissioners, three on the part of the United States, appointed by the President thereof, and three on the part of the United Kingdom, appointed by His Majesty on the recommendation of the Governor-in-Council of the Dominion of Canada."

Other clauses of the Treaty set forth the powers, provide the machinery, and the legal authority, by virtue of which the Commission is to carry out its important duties.

In passing upon the cases which come before it, the Commission is governed by certain rules or principles. It is first laid down that the contracting parties shall have, each on its own side of the boundary, equal and similar rights in the use of boundary waters. Then follows the order of precedence to be observed among the various uses of these waters. Uses for domestic and sanitary purposes are given the preference over all other uses; then uses for navigation, including canals for such purposes; finally, uses for power and for irrigation.

The importance of these principles adopted by the contracting parties for the guidance of their Commission can hardly be overestimated. It must be borne in mind that the boundary waters over which the Commission is given jurisdiction support a population of over 7,000,000 people, American and Canadian, and that this population is rapidly increasing. The governing principles recognize, so far as these people are concerned, the preëminence of domestic and sanitary uses, or, in other words, the supreme importance of safeguarding the public health. All other uses of boundary waters must be disregarded in so far as they conflict with or restrain uses for domestic and sanitary purposes.

Then comes navigation. The navigation interests of the Great Lakes are of enormous and rapidly in-

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creasing importance. It appears from official reports that approximately 95,000,000 tons of freight, valued at more than $800,000,000, and carried by over 26,000 vessels, pass up and down the Detroit River during the season of navigation, more than three times the freight through the Suez Canal in an entire year. Not only is an enormous capital tied up in navigation or transportation on the Great Lakes, but the communities, large and small, along these waters are to a considerable extent dependent thereon, and to a less degree communities farther afield, but connected by transportation lines with the lakes. The interests of navigation are the common interests of a very large population inhabiting the entire watershed of the Great Lakes. While secondary in importance to those of public health, they are, therefore, superior to the interests of power and irrigation. As a matter of fact, although bracketed together in the Treaty, power and irrigation do not bear at all the same mutual relation to navigation. Broadly speaking, power development along the international frontier belongs to the eastern half of the continent, and irrigation to the western half. Power may come in direct conflict with navigation; irrigation is unlikely to do so.

The relations of power to navigation and sanitation are recognized in an article of the Treaty relating to diversions for power purposes above Niagara Falls. The last paragraph of that article reads: "The prohibitions of this article shall not apply to the diversion of water for sanitary or domestic purposes, or for the service of canals for the purpose of navigation."

Uses for power, though of less vital or general significance to the Great Lakes communities than uses for sanitation or navigation, are, nevertheless, of very great importance. On the St. Mary River, the Niagara River, the Upper St. Lawrence, and elsewhere along the international boundary, millions of dollars have already been invested in power development, and the available power is far in excess of any attempts that have yet been made to utilize it for manufacturing and other purposes.

It will be seen that in placing in the hands of an international commission, half American and half Canadian, the settlement of questions involving the more or less conflicting interests of sanitation, navigation, power and irrigation, along a 2,000-mile frontier, the Governments of the United States and Great Britain have taken a long step forward. These questions, large and small, have been a fruitful source of irritation in the past to the people living along both sides of the boundary. A question, perhaps a trivial one, arises at some point on or near the international boundary. Some diversion is contemplated or has already been carried out, or some work constructed, on one side of boundary waters, affecting the interests of the inhabitants on the other. The local authorities have no powers or jurisdiction. The injured parties (let us assume they are Canadian) appeal to Ottawa. The case, cumbered with red tape, travels deliberately through several of the Dominion departments; rests, perhaps, for weeks in the file basket of one or other of the various officials; is referred back and forth between the federal authorities and their local officers; finally moves on to the Governor-General's Office, and is sent overseas to the Colonial Office in London, thence takes its dignified way to the Foreign Office, back across the Atlantic to the British Ambassador in Washington. The Ambassador takes the matter up with the Secretary of State of the United States, and the weary process of red tape is repeated in the departments of the Washington government. By this time the original question has probably been more or less lost sight of under its load of official commentary. Eventually the original complaint, or its official version, reaches the source of the trouble. The other side of the question is presented by the people on the United States side of the boundary, and the documents, growing like a snowball as they move, start on their long, roundabout, diplomatic journey back to the local complainants in Canada. It is no exaggeration to say that such a case may travel backward and forward, not merely for months, but for years, and in the end the parties interested may be as far from a settlement of the question at issue as they were in the beginning. It is true that in recent years it has been found possible to cut out, in some cases, the overseas part of the journey and deal directly, or less indirectly, with the United States Government through the Governor-General's Office and the British Embassy, but even so, the process has necessarily been exceedingly slow, cumbersome, and not always effective. Meanwhile, bitterness of feeling has been allowed to grow between two neighboring groups of people, separated only by an imaginary boundary, and with every reason in the world for a neighborly attitude toward one another.

That two such countries as the United States and Canada, with the same New World point of view, the same democratic and businesslike way of looking at things, should have submitted for so many years to the ponderous and circumlocutory traditions of diplomacy, is surprising enough. It must, at any rate, be matter for sincere congratulation to every thoughtful Canadian or American that, so far at least as the relations of these two countries are concerned, the shackles have been knocked off, and it is now possible for the citizens of the United States and Canada to settle their differences with as much ease, and perhaps a little more, as if the dispute were confined to one country.

As already mentioned, the so-called Waterways Treaty was signed January 11th, 1909, and ratifications exchanged at Washington May 5th, 1910. For various reasons all of the six Commissioners were not appointed until the end of 1911. In January of the following year the Commission held its organization meeting in Washington, and adopted rules of procedure.

Since the beginning of 1912 a number of important questions have been brought before the Commission for settlement. In every case but one the decision has been unanimous, and in that case the point at issue was not one affecting interests on either side, but simply whether or not a certain application for approval of a dam extending from shore to shore of an international stream came properly within the classes of cases with which the Commission was called upon to deal. The majority of the Commission decided that they had not jurisdiction; two of the Commissioners took the contrary view.

Of these various applications, one of the most important was for approval of a diversion dam on the St. Mary River at Sault Ste. Marie. In reality there were two applications, one from the Michigan Northern Power Company, on the United States side, and the other from the Algoma Steel Corporation, a Canadian Company. Each applied for authority to build works from its own side to the international boundary, the combined works making one structure across the river. At the hearings, legal and engineering representatives of various municipalities on both sides of Lake Superior, and of railway and other corporations, expressed anxiety lest the proposed works should have the effect of raising the level of Lake Superior and causing serious damage to wharves, buildings, and sewage systems in Duluth, Fort William, and other towns around the lake. After hearing the testimony of a number of expert engineers, including representatives of the United States and Canadian governments, the Commission approved of the proposed works upon certain conditions as to construction and maintenance, which, instead of being detrimental to the interests of navigation and of the several communities around Lake Superior, would, by maintaining the level of the lake between certain points, be very much to the public advantage. As part of their order of approval, the Commission made it a condition that the works, both during construction and thereafter, were to be under the direct control of an international board of engineers, one member of which was to be appointed by the Canadian and the other by the United States government. This board has since been appointed, Colonel M. M. Patrick, of the Corps of Engineers, representing the United States, and Mr. W. J. Stewart, Chief Hydrographer of the Department of Naval Service, representing Canada. In this way it was found possible to settle, in a very short time, and to the satisfaction of all the very important interests concerned, American and Canadian, public, navigation, and power, a question which might have dragged along for years under the old diplomatic procedure and been the cause of international irritation and material loss on both sides of the boundary.

Three matters have been referred to the Commission, under Article IX. of the Treaty, for investigation and report. One of these, relating to the construction of a dyke in the Detroit River, which, of course, is an international stream, has been disposed of. The enormous extent and value of the shipping using this waterway has already been suggested. It was found that certain dangerous currents swept across the Livingstone channel in the Detroit River, which were a menace to navigation. A dyke was proposed near the upper end of the channel to intercept these currents. At the hearings Canadian interests objected to the building of the dyke in the position first proposed on the grounds that it would have the effect of diverting Detroit sewage on to the Canadian shore, and would in other ways cause serious damage to communities in Canada. The Commission finally recommended to the two governments that the dyke should be built on the west side of the channel, where it would serve the same purpose, so far as the dangerous cross-currents were concerned, and at the same time would meet the objections raised against the dyke on the east side as originally proposed by the engineers.

The second question relates to the levels of the Lake of the Woods and tributary waters. The Commission was asked to report what levels, or range of levels, could be maintained in these international waters, which would be in the best interests of all concerned on both sides of the boundary—navigation, agriculture, fishing, lumbering, and power. To give an intelligent answer to the question it has been necessary to employ a staff of engineers for the last two years, as neither government had so far carried out anything more than fragmentary surveys in this district. These engineers are under the direction of two consulting engineers, one American (Mr. Adolph F. Meyer, of Minneapolis), and the other Canadian (Mr. Arthur V. White, of Toronto), who expect to submit their final report to the Commission this year.

To most people the Lake of the Woods country is a comparatively unknown region, and the popular impression probably is that it is of little or no importance. As a matter of fact, however, the hearings held by the Commission brought out the facts that the navigation, power, and other interests which will be affected by the Commission's decision have invested something over $100,000,000 in the Lake of the Woods district; that the resources of the region are enormous and only beginning to be developed; and that communities as far apart as Duluth and Winnipeg are more or less directly interested in the fixing of a level on the Lake of the Woods and its tributaries, which will give the maximum benefit to the people on both sides of the boundary.

The third question, and by far the most important, relates to the pollution of boundary waters. Such pollution is prohibited by the last paragraph of Article IV. With a view to the enforcement of this clause of the Treaty, the Governments of the United States and Canada sent to the Commission the following reference:—

1. To what extent and by what causes and in what localities have the boundary waters between the United States and Canada been polluted so as to be injurious to the public health and unfit for domestic or other uses?

2. In what way or manner, whether by the construction and operation of suitable drainage canals or plants at convenient points or otherwise, is it possible and advisable to remedy or prevent the pollution of these waters, and by what means or arrangement can the proper construction or operation of remedial or preventive works, or a system or method of rendering these waters sanitary and suitable for domestic and other uses, be best secured and maintained in order to secure the adequate protection and development of all interests involved on both sides of the boundary, and to fulfil the obligations undertaken in Article IV. of the waterways treaty of January 11th, 1909?

This reference is dated August 1st, 1912. On January 16th, 1914, the Commission sent the two Governments a progress report on the first branch of the investigation, as to the extent, causes and localities of pollution. This report embodies the result of exhaustive field investigations, by a corps of sanitary experts, under the general direction of Dr. Allan J. McLaughlin, of the Public Health Service of the United States, with the coöperation of Dr. J. W. S. McCullough, Chief Officer of Health of Ontario, and Mr. F. A. Dallyn, Provincial Sanitary Engineer of Ontario. Throughout the investigation the Commission has had the cordial coöperation of the United States Public Health Service, and of the Boards of Health of Ontario, Quebec, New York, and Michigan.

The investigation, which covered the examination of the waters of the Great Lakes and their connecting rivers, Rainy Lake, Rainy River, the Lake of the Woods, and the boundary portion of the St. John River in the east, wherever pollution might extend from one side to the other, discloses the gratifying fact that the great bulk of the Great Lakes water remains in its pristine purity, in spite of the fact that some seven million people have contracted the very bad habit of dumping all their sewage into these waters, and that the entire shipping of the Great Lakes, carrying in one season not less than 15,000,000 passengers, has followed the same evil practice. Serious pollution was disclosed at many points along boundary waters, and particularly in the Detroit and Niagara Rivers, where the cities of Detroit and Buffalo, with a number of smaller communities on both sides of the rivers, have been doing their best to make the water of these rivers unfit for human consumption.

Severe epidemics of typhoid fever in the lake cities have for years past warned these communities that, while they were spending hundreds of millions on their streets and buildings and in other ways adding to the comfort and convenience of their inhabitants, the most vital consideration of all, that of public health, was being grossly neglected. If the International Joint Commission should achieve nothing more than to awaken the cities of the Great Lakes to the vital importance of protecting their water supplies, it will have more than justified its existence.

Last year the Commission took up the second branch of the pollution investigation, and as an initial step held a conference in New York with a group of sanitary engineers, including men of international standing.

As a result of this conference, and the subsequent deliberations of the Commission, it was decided to adopt, tentatively at least, certain fundamental principles upon which the experts were in agreement. The most vital of these principles is that, while in certain cases where the ratio of water to volume of sewage is unusually large, the discharge of crude sewage into boundary waters may be without danger, "effective sanitary administration requires the adoption of the general policy that no untreated sewage from cities or towns shall be discharged into the boundary waters." The other principles relate more specifically to methods of sewage purification and water purification.

Engineering parties are now stationed at Buffalo and Detroit, under the direction of Mr. Earle B. Phelps, collecting data to guide the Commission in answering the second branch of the investigation, and in making its final report to the two governments.

The life of the Treaty, and, therefore, of the International Joint Commission, is five years from the date of the exchange of ratifications, and "thereafter until terminated by twelve months' written notice given by either high contracting party to the other." It, therefore, may be denounced by either side any time after May 5th of the present year, but it is safe to say that, in the light of what the Commission has already accomplished, directly and indirectly, in settling questions pending between the peoples of the United States and Canada, and preventing disputes regarding the use of boundary waters, and in view of its value to both countries in the peaceful and equitable disposition of the countless similar questions that must inevitably arise in the future, neither the Government of Canada nor that of the United States will be disposed to put an end to either the Treaty or the Commission, certainly not while the present happy relations exist between the two countries—and let us hope that those relations will be perpetual.

There are 2,800 miles of water mains in New York City's water supply system, exclusive of conduits and tunnels.

Work on the Vancouver terminals of the Canadian Northern Pacific is now under way. To date over 2,000,000 yds., out of a total of 3,250,000 to be reclaimed at the head of False Creek, have been filled in. Bids are being received on a reinforced concrete sea wall, which will be built to close the head of the creek from tide water. The specifications include the following quantities: foundation excavation (wet) 450 cu. yds., concrete, 4,950 cu. yds.; reinforcing steel, 305,000 lbs.; concrete piles, 15,900 1-ft.; creosoted fir piles, 12,200 1-ft.: asphalt, 2,820 sq. yds.; rock fill, 15,500 cu. yds.; square timber, No. 1 common, 19,500 f.b.m.; iron in timber including U-bolts, 5,500 lbs.; 255 spring coils.

ACTIVATED SLUDGE INSTALLATION AT MILWAUKEE.

At the recent convention of the American Society of Municipal Improvements, Mr. T. C. Hatton, chief engineer of the Milwaukee Sewerage Commission, described in detail the large plant under construction for the treatment of the city's sewage by the activated sludge process. Mention has already been made in these columns of the experimental work carried on there last March. The new plant, designed to treat 1,600,000 gallons of sewage daily, is a direct outcome of the results obtained. If the new installation proves satisfactory it is the intention of the commission to extend it to a capacity sufficient to treat the city's entire sewage.

The first experimental tanks were of the fill-and-draw type, but the new works are of the continuous flow type, with a 4-hour period of aeration and a 25% activated

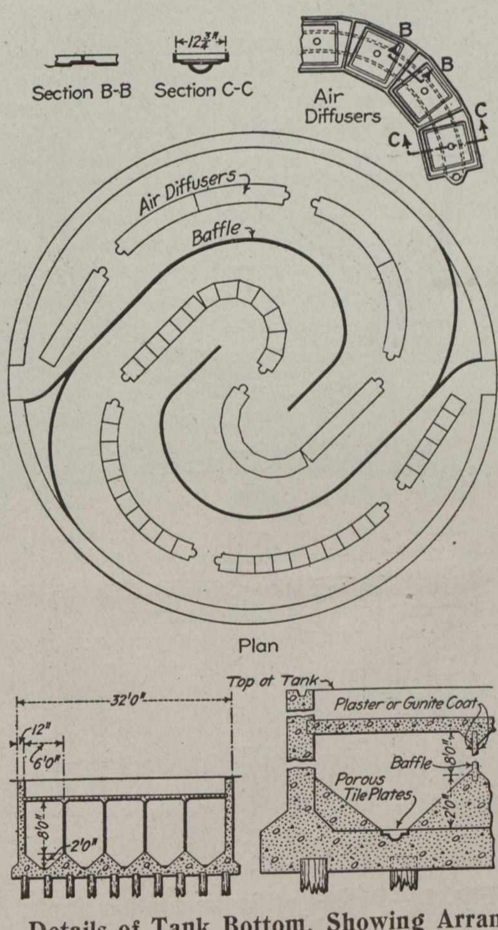

Fig. 1.—Details of Tank Bottom, Showing Arrangement of Baffles and Air Diffuser Plates

sludge content. There are 11 tanks, each 30 feet in diameter, and constructed of concrete.

In his paper Mr. Hatton states that the experiments with the fill-and-draw method gave good results when the sewage temperature was 50° F. or over; at smaller cost than any other process tried by the commission. Thereupon it was decided to try the continuous flow method. These experiments have been under way since early in July and were started with sludge from partly fresh and partly Imhoff tank sewage. The latter sludge, being anaerobic, had to be converted into aerobic sludge before activated sludge was produced. It was run into the new tank and fresh sewage added every 8 or 10 hours. The mixture was aerated by air at 5 lbs. pressure. After 6 or

8 hours the air was turned off, settlement permitted, the supernatant liquor removed, fresh sewage added and the aeration repeated. The process was continued until the tank contained about 30% of its capacity of good activated sludge, *i.e.*, for about 33 days. Then the seeded tank was started upon the continuous flow method.

Mr. Hatton reports remarkable results. With a rough screened sewage containing from 1,000,000 to 7,000,000 bacteria per c.c., 250 p.p.m. of suspended matter, 30 p.p.m. of organic nitrogen and 120 p.p.m. of oxygen consumed, an effluent was produced containing a 99 per cent. removal of suspended matter and bacteria, 12 to 14 p.p.m. of nitrates, stable after 5 days and clear as lake water, leaving a sludge containing 5.45% ammonia, 1.34% available phosphoric acid, 0.23% potash, worth $9 a ton, dry weight, as fertilizer. Only 1.77 cu.

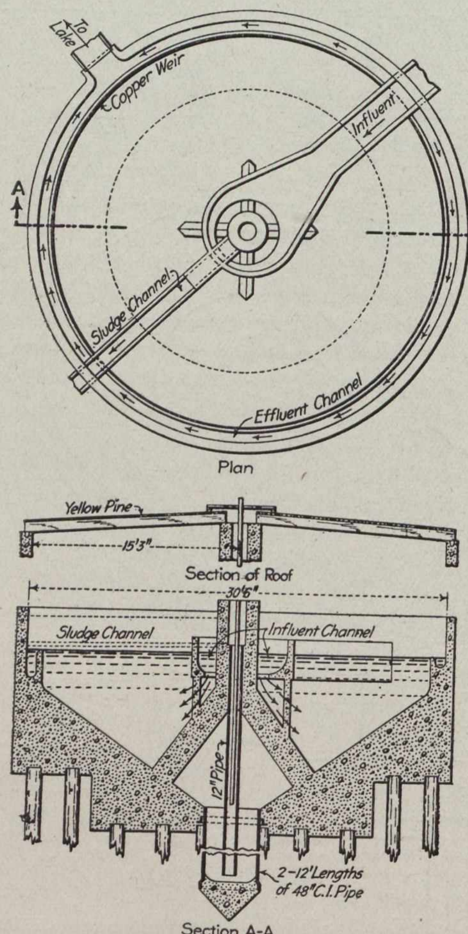

Fig. 2.—Details of Sedimentation Tank.

ft. of air was used per gallon of sewage treated, the process costing $4.43 per million gallons.

It is upon these excellent results that the commission based the decision to spend $65,000 on a large sized plant, the following description of which is abstracted from Mr. Hatton's paper.

The plant consists of eleven circular reinforced concrete tanks 30 ft. inside diameter by 13 ft. maximum depth, supported upon a pile foundation due to the instability of the soil. Tanks 1 to 6, inclusive, are the aerating tanks in which the sewage mixed with the activated sludge is aerated by means of air forced in under 5 lb. pressure. Tank 9 is the sedimentation tank, and tanks 10 and 11 are the activated sludge tanks. The drawings show details of the aerating tanks with their curved baffles, the manner of sloping the bottom of the running through channels so as to avoid the deposition of sludge, and the manner of placing the air diffusers. The sedimentation tank is the only tank to be roofed over. The roof is necessary to prevent ice forming about the edges of the circular weir, which would set up uneven currents. This tank has a radial flow, and is designed for a 25-minute sedimentation period at a 2,000,000-gallon rate.

The two sludge tanks are similar to the aerating tanks except that they are each made into two separate compartments by stop planks connecting the two ends of the baffle walls. Their pipes and diffusers are placed in the same number and manner as in the aerating tanks.

Wooden rectangular troughs are built part way around each tank to control the direction of the flow of liquor, and stop planks are arranged so that any one or series of tanks can be cut out. The sewage from 250,000 people, to which is added the sewage from the packing house district, passes out to the lake through a 20-ft. wide open channel alongside of the proposed plant.

In this channel a weir is constructed 20.35 ft. long, which maintains a depth of about 3 ft. of liquor for 40 ft. back of the weir. This is the grit chamber in which the heavier solids from the street washings are deposited, as the sewers connected with this large intercepting sewer are of the combined type. The weirs have been so arranged as to provide a flow through the plant to correspond with the fluctuations of flow through the main sewer, and the air applied to the sewage will be automatically regulated to correspond with this flow. Self-recording air meters will be installed to determine the volume and pressure of air used.

The sewage, after passing the plant weir, enters tank 1, where it comes into immediate contact with the air and the activated sludge, with which the tank has been originally seeded. It is designed to use 25 per cent. of this activated sludge at first and to increase or diminish it as the operation shows necessary to get the most economical results.

Passing through tank 1 the liquor, mixed with the sludge, enters tank 2, when it is again aerated and further mixed with the sludge contained in that tank, and so continues until it passes, with the sludge mixed with it, into the centre channel of tank 9. Here the sludge settles out to the bottom of the tank, the clear liquor passing over the circumferential weir to the lake.

The sludge settles to a deep well built in the bottom of the settling tank, and is discharged by gravity into sludge tanks 10 or 11, where it is aerated for such a period as may be necessary to maintain the nitrogen cycle. From these sludge tanks the sludge passes to an 18-in. cast-iron pipe sunk vertically in the ground with its base about 28 ft. below the height of the liquid in the sludge tank, and from this pipe it is pumped by air into the fresh liquor trough, entering tank 1 with the raw sewage and again passing through the process.

That portion of the activated sludge in excess of what is necessary to maintain the proper percentage in the aerating tanks is pumped out of the sludge tanks from time to time and dewatered and will be used as a fertilizer. The method of dewatering has not yet been decided upon, but will probably be by means of the sludge press or vacuum wheel. The deep chambers connected with the settling tank and sludge tanks are for the purpose of dewatering the sludge as much as possible by weight, and thus avoiding the pumping of unnecessary liquor through the process.

It has been found by the experiments conducted that the success of the continuous flow method depends upon maintaining good activated sludge at all times in the tanks treating the fresh liquor. By aerating the sludge to a higher degree than the whole body of the liquor, air is saved because only 25 per cent. of the entire mixture is thus given an additional aeration.

The plant can treat 1,600,000 gallons of sewage per day with a 4-hour period of aeration and with a 25 per cent. activated sludge content. From present indications it will be able to treat the sewage satisfactorily, when the temperature is 50° F. or over, at a much higher rate, but this is yet to be determined on the large scale. In order to overcome some of the effects of low temperature it is designed to pass the condensing water from the present sewage station adjacent to the new plant through coils of pipe hung to the inside perimeter of the two sludge tanks, inducing circulation by a circulating pump built in the condenser discharge line. This water is now discharged into the river at a temperature of about 100° F.

The power plant for producing the air necessary for operating the plant consists of two positive pressure rotary blowers each having a capacity of 2,400 cu. ft. of free air space per minute compressed to 6 lb. pressure and belt-driven from two alternating current variable speed motors each of 75 b.h.p. Only one unit will be required for operating the plant. Two are provided to avoid possible interruptions.

THE HOLDING POWER OF NAILS.

ONE of the rarest subjects dealt with in print is the holding power of nails in wood, and especially in hard woods. The nailing of soft woods, such as pine, is supposed to come to people like walking with all the proportions of length and thickness of nail for the size of wood to be put together. The nailing of hard woods is not so common, as hard woods are often framed or bolted together. As stated in the Indian Textile Journal, from which the following notes are taken, the subject seems to have had the minimum of study, for it is hard to discover the reasons that determine the size of nails or screws among woodworkers. A glance at the interior of any coasting boat will show that although every nail is clinched, a length of 3 inches is allowed for that purpose, while the spread of the head barely amounts to one inch. The waste of iron in nails alone cannot be less than from 20 to 25 per cent. Hard woods are more common in tropical than in temperate countries, and as they are frequently joined with nails, some system should be adopted to obtain the best results. It is useless to ask the carpenter to go into calculations about nails: he cannot do it, but he can make a simple experiment that will enable him to avoid splitting the wood.

A nail holds itself in place in two ways: by friction of its sides against the wood, and when clinched, by the resistance of the clinch which resembles a second but smaller head. The combined resistance of sides and clinch represent the total holding power of the nail. Square nails are usually tapered on two sides and parallel on the other two; the tapered sides should bear against the end grain of the wood, crushing it gradually as the nail enters; and when it is fully driven it bears uniformly against this end grain crushing it without splitting. All woods when soaked in water or when green may be nailed with less risk of splitting than when they are dry, but there are limits to the depth that a long nail may be driven into any wood before it begins to bend, that is to say, where the friction of the wood overcomes the driving power of the hammer. When a nail begins to bend it shows that a hole must be made beforehand; and the size of the hole is a matter of some importance. Its object is to reduce the friction so as to allow the nail to be driven without bending, but if made too large, the holding power of the nail will be reduced and clinching will be a very imperfect remedy. If many nails of one size have to be driven, as in boat building, it is advisable to experiment on a piece of wood of the necessary thickness in order to find out the right size of hole that will avoid splitting the wood, or bending the nail. When wire nails of a large size are used in drilled holes, the size of the hole should be such as will ensure a good fit; and if the nail is to be clinched it should be softened at the point by heating to redness. The wire nail is hard drawn to enable it to be driven without bending in soft woods, but it does not clinch well for this reason, and therefore needs softening.

The holding power of nails and screws may be ascertained by a simple experiment. The nail may be driven into an upright post leaving the head projecting just enough to be seized by a nail-puller. This instrument is then attached and weights added to the outer end until the nail begins to move. A bag loaded with stones will serve the purpose. The nail-puller consists of two levers formed by the extended handle and the projecting foot, and if the weight in the bag is multiplied into the length of the handle in inches and divided by the exact length of the foot measures from the nail to the point of contact of the foot with the post, the result will be the holding power in pounds of the nail.

Nails that have rusted after being driven have an increased holding power, but if rusted before use they tend to make a slightly larger hole than a smooth nail, because of their rougher surface. In cases where clinching would be liable to split the wood, nails may be cut and riveted over a small washer. This makes a strong and durable joint. There is also a way of clinching a nail within the wood that is at times useful. The point is filed away on one side to a wedge shape and then bent over the filed part until the point is level with the side of the nail. A hole is drilled to the size of the nail which is inserted with the filed surface parallel with the grain of the wood. When driven, the point takes the form of a hook and has a strong hold upon the wood. The point of this nail should be heated and softened so as to facilitate the turning of the point.

Nails driven in wood that is expressed to alternate wetting and drying are liable in time to work loose. The wetting swells the wood and increases its dimensions across the grain, and as the nail is inelastic it is moved, a space forming at the point equal to the amount of swelling of the wood. When the timber dries the nail does not return to its original place, and if tapered it tends to move outward each time that the wood is wet and dried. It is for this reason that wood structures bolted together and exposed to the weather require screwing up at intervals.

Screws offer an even more interesting subject for experiment, for it will be often found that if the hole for a screw is carelessly drilled it has less holding power than a nail. The holes for screws in hard wood should be very carefully made in two sizes: for the neck and the screw, respectively; and the point of the screw-driver should be of the shape of the notch in the screw and not a chisel point as is usually seen.

TYPES OF BITUMINOUS CONSTRUCTION AND THEIR LIMITATIONS.*

By Francis P. Smith, Ph.B., M.A.S.C.E., M.A.I.C.E.

THE selection of the most economical and suitable types of bituminous road construction to meet a given set of traffic, climatic, subsoil and drainage conditions involves a clear comprehension of the limitations of the various types in use and the conditions essential to their successful employment. Certain conditions should absolutely preclude the use of certain kinds of construction regardless of possible low first cost, and disregard or lack of knowledge of the vital principles underlying different forms of construction has often resulted in the waste of large sums of public and private money.

Whatever type of construction is decided upon, it must always be borne in mind that a bituminous wearing surface is flexible and will only give good service when it is properly supported by an adequate foundation. Soft spots or weak places in the foundation will cause a settlement of the overlying wearing surface which will result in rapid deterioration. Water will collect in such low spots and rapidly destroy the bond between the bituminous binder and the mineral aggregate. The wheels of each vehicle passing over such depressions will strike a heavy blow as they drop down into them and cause displacement of the wearing surface, resulting in the formation of a ridge which still further adds to the vibration of the springs and causes successive blows to be dealt to the pavement until the spring vibration becomes normal again. This, of course, results in the formation of waves. In most heavy commercial vehicles the springs are comparatively short and stiff. The vibrations are, therefore, quick and tend to strike very heavy blows, resulting in wave formation at right angles to the line of traffic having their crests from 3 to 4 feet apart. This is plainly noticeable on roads having a bituminous wearing surface and it is still more evident on waterbound macadam roads. The poorer and less rigid the foundation the more pronounced the waves. This is quite distinct from the shearing or shoving action exerted by vehicles rounding curves at a moderately high rate of speed. The motor bus is perhaps more directly responsible for this type of wave formation than any other modern type of vehicle. In England, more especially in the neighborhood of London and other large cities, it is easy to pick out those roads which carry motor bus traffic, as they invariably show the kind of wave formation above described. On waterbound macadam roads it is no uncommon thing to find considerable stretches in which the difference in level between the wave crests and troughs amounts to 4 inches and over. This wave formation is noticeable in rock and sheet asphalt pavements laid on 9 inches of concrete as well as on country roads covered with sheet asphalt, tarred slag, bituminous concrete or bituminous macadam. Generally speaking, the wave formation in sheet or rock asphalt pavements laid on concrete foundations, while noticeable, is not excessive, whereas in bituminous surfaces on inferior macadam foundations it is one of the primary causes of disintegration. The consistency of the bituminous binder used in these English roads is on the average somewhat harder than that used in the United States and there are no long hot periods to soften them up, such as are frequent in the latter country. In their very moist climate it has been found that a harder bitumen adheres more tenaciously to the mineral aggregate and is less affected by water action. It is fair to assume, therefore, that their road surfaces are at least no more plastic than ours and personal examination showed that in the majority of them the bonding qualities of the bitumen had not been weakened by water action and that the grading of the mineral aggregate was normal. The writer believes that much of this could be avoided by having longer and more flexible springs on vehicles of this type, thus greatly lessening the road shock.

Slow-moving, heavily loaded vehicles are much more prone to cause displacement and wave formation than are the lighter type of vehicles moving at a speed of from 15 to 25 miles per hour. This was clearly shown by a 60-ft. street in one of our eastern cities which was paved with a bituminous concrete mixture containing more stone than the average Topeka mixture. The foundation was 5 inches of concrete and the average grade about 3 per cent. A trolley line in the centre of the street sharply divided the moving traffic. The traffic uphill was composed largely of slow-moving, loaded, 3 to 4-ton, horse-drawn vehicles and a few motor trucks, whereas on the down grade it was confined to light delivery wagons and empty trucks, but the number of vehicles on each side was about equal. The pavement on the uphill side very soon developed wave formation to such an extent as to require a large amount of resurfacing, whereas that on the downhill side gave satisfactory service for a long period with practically no wave formation. Both sides were laid with the same mixture and at the same time. The concrete in many places was defective and at these points the wave formation was most marked.

In the writer's opinion, wherever the traffic calls for a bituminous surface, a concrete foundation is justified and is economically sound. There is always movement in a macadam foundation, as evidenced by the rounded edges of the stone of which it is composed. This is noticeable wherever a macadam road is dug up or scarified. If the larger particles of stone are screened out from the mass and examined, their edges will be found to have become rounded by attrition. Where the traffic is very light, as on country roads which are not main arteries from or between large cities, and in some residential streets, old macadam roads have proved to be suitable foundations for bituminous surface mixtures. Far more failures than successes have resulted from their use, however, and great caution should be observed with respect to employing them. Many roads are classified as macadam roads which contain no base course of large stone and are in reality old dirt roads on which comparatively fine stone has been dumped and consolidated by traffic, no provision having been made for their proper drainage. Unless constructed on a sandy soil, such roads inevitably become quagmires in spring when the frost comes out of the ground and are totally unfit for use as a foundation. New York State has many miles of penetration roads constructed on such foundations which have utterly failed, sometimes within six months after they were laid. Before using any macadam road as a foundation its history should be investigated and more particularly its behavior in the spring of the year. The character and depth of the stone should be determined by putting down a sufficient number of test-holes and proper under and side-drainage must be provided. In most instances it will be found necessary to rebuild the road in many places. Assuming it to have been a properly constructed and drained macadam road and hence suitable for a light traffic

*Read before the American Society of Municipal Improvements at its annual meeting at Dayton, O., October, 1915.

foundation (and the number of these is very few), it will be necessary to re-grade it and probably to reduce its crown before placing any bituminous surface upon it. In a few cases this can be done by filling up the depressions and building up the shoulders. Wherever possible, this method should be employed, as traffic will compact a road far better than is possible with a roller, and a road surface which has been scarified and then rolled will never be as hard and firm as if it had been compacted by years of traffic. Where new stone is added in depressions or on the shoulders, the road bed on which it is laid should be clean and slightly loosened to insure proper binding of the new stone. The size of the added stone should be the same as that which would be employed in building up the corresponding portions of a new waterbound macadam road and should be thoroughly rolled with a road roller weighing not less than ten tons until it is well compacted and vehicles passing over it do not cause displacement. Water and screenings should be used during rolling to effect this. Unless this work is thoroughly and conscientiously done, the foundation will not be of uniform strength throughout and settlements will probably occur at those places where the new stone has been put in.

If it is necessary to scarify the road surface, this should be done with care not to go deeper than necessary, and the surface of the road should be built up with new material and rolled until the greatest possible compaction is obtained, exactly as if building a new waterbound macadam road. If it is then possible to turn traffic upon it for a few months before laying the bituminous surface, so much the better, as any weak spots will be developed and still greater compaction will be secured. To do all this thoroughly and as it ought to be done (including drainage) will often cost almost as much as putting down 5 inches of concrete. With the concrete, a permanent and satisfactory foundation is assured which may be resurfaced when necessary at the minimum expense. In England a number of fairly heavy traffic roads have been successfully surfaced with sheet asphalt or bituminous concrete using the old macadam as a foundation, but as a rule their macadam roads have been in existence for a long time and have been properly constructed and, owing to their moist climate, have been thoroughly drained. They, therefore, start with a much better foundation on the average than we can hope to obtain. Their winters are mild and frost rarely penetrates to any considerable depth in the earth, hence they are free from heaving and the unstable conditions produced by our spring thaws.

Where the subsoil drainage and climatic conditions are especially favorable, a foundation of 4 to 6 inches of broken stone properly consolidated by rolling may be used for light traffic roads. Except under extremely favorable conditions, the proper construction and drainage of a base of this kind will cost more than would 4 to 5 inches of concrete.

The question of foundation having been settled, the kind of wearing surface must next be determined. The various types of bituminous construction under consideration may be classified as follows: Coarse aggregates—Penetration method, cold mixture, hot mixture; fine aggregates—Topeka, sheet asphalt.

As between coarse and fine aggregates, the heavier the traffic (more especially that carried on iron tires), the finer should the mineral aggregate be. Large particles of stone will be fractured sooner or later by the passage of heavy loads over them. Wherever such a fracture occurs we have two faces which are not cemented together by bituminous cement. This permits grinding away and the entrance of water, two extremely destructive agencies. As illustrative of this, in certain sheet asphalt pavements laid by the writer in heavily travelled sections of Glasgow, Scotland, it was found to be necessary to exclude grains of sand coarser than those passing a 20-mesh sieve, as even 10-mesh grains would crack and permit the water to enter and destroy the pavement. In a test made last winter in the presence of the writer of a bituminous road surface at the National Physical Laboratory at Teddington, England, in which a road continually flooded with water was tested to destruction by passage of heavily loaded iron-tired wheels over it, it was found that disintegration commenced at those points where large sized grains occurred on the surface. Large sized aggregates give a rougher road surface, and hence better foothold for horses, than do smaller sized aggregates, and automobiles are less liable to skid upon them in wet weather. For light and moderate traffic there is, therefore, much to be said in favor of large sized aggregates. As between penetration methods and mixing methods, the latter are undoubtedly far superior. In the case of Portland cement concrete, except in special forms of construction, grouting is seldom resorted to except where mixing is impossible and in this case we have a fluid cement which readily penetrates the interstices without chilling or becoming solid for a very considerable period of time. When grouting broken stone with a hot bituminous cement its tendency is to chill as soon as it strikes the colder stone. Its distribution is, therefore, very uneven and whenever the interstices are small practically no penetration takes place. Work of this character should never be done except in the hottest weather, and yet we see many of these roads constructed in the late fall. It is really the most difficult kind of bituminous work to execute properly and yet, because of the cheapness of the plant required, many contracts are let to small contractors who have never done such work before. A few years ago suitable portable mixing machinery was not available for work of this kind except in the vicinity of railroads and hence some type of bituminous construction had to be developed which was cheap and could be put down without the use of heavy and non-portable plants. These conditions no longer exist and the writer believes that for this and other reasons the penetration method of construction will gradually disappear. When, because of failure or increase in traffic, it becomes necessary to reconstruct a penetration road laid on a broken-stone foundation, practically all of the road must be removed and this is an expensive piece of work. This is not true of a bituminous road laid on a concrete foundation. The foundation can still be utilized and in most cases resurfacing is all that is necessary.

As between hot and cold mixtures the hot mixtures can be better graded and more thoroughly compressed by rolling, and are, therefore, somewhat better suited for fairly heavy traffic. For light traffic, the cold mixture will in many instances give equally good results and will often be very much cheaper and will, therefore, always have a wide field of usefulness. Cold mixtures would appear to be ideal for use by road patrols in the upkeep of bituminous road surfaces constructed of large aggregates, and are much superior to hasty mixtures of stone and bituminous binder often imperfectly made on the spot with inadequate appliances by more or less inexperienced workmen.

The so-called Topeka mixture is intermediate between the sheet asphalt and the coarse aggregate mixtures. As ordinarily made, it consists of a standard sheet asphalt mixture to which has been added from 15 to 25 per cent. of stone passing a ¼-inch screen and retained on a 10-mesh screen, and 10 per cent. or less of stone passing a ½-inch screen and retained on a ¼-inch screen. When well made and laid, however, its surface is practically no rougher than sheet asphalt. Owing to the somewhat lower percentage of bitumen which it contains and the fact that it is usually laid without a binder course, it is somewhat cheaper than sheet asphalt. It is, however, a more difficult pavement to lay satisfactorily. Theoretically the coarse stone particles which it contains should make it a more stable pavement and one less liable to shoving and wave formation. As a matter of fact, however, a slight excess of bitumen renders it much more unstable than even an inferior sheet asphalt pavement and liable to extreme displacement under traffic. This is probably due to the fact that it does not contain sufficient stone to permit the larger particles to be closely keyed together. When the mixture becomes plastic through heat these large particles are therefore relatively free to move, the only restraint to such movement coming from the relatively fine sheet asphalt mixture in which they are embedded. Owing to their size, a pressure tending to displace them acts with a greater total force than it would exert on, for example, a sand grain 1/10 of an inch in diameter, in addition to which in many cases there is a distinct leverage action. Too little bitumen will make a Topeka mixture open and water absorbent and a variation of one-half of 1 per cent. of bitumen above or below its proper content is about the limit of safety. Double this variation in a sheet asphalt pavement will not seriously affect it. For medium and light traffic the writer believes that a not too dense sheet asphalt mixture, laid the same thickness under the same conditions as the Topeka will give at least as satisfactory service and will be much safer to lay in the long run. The Topeka mixture appears to him to be a hybrid possessing vices and weaknesses peculiarly its own and not as good as either of the types which it is intended in part to supplant.

For very heavily travelled city streets sheet asphalt on concrete foundation is undoubtedly the best type of bituminous pavement. When sheet asphalt is laid on very light traffic streets a somewhat coarser sand should be used than for heavy traffic streets. As the number of particles decrease, the surface area to be covered with bitumen also decreases. In this way, without increasing the percentage of bitumen in the mixture, a thicker coating of bitumen is obtained on each grain of sand and the pavement will not crack as readily under minimum traffic as will a standard heavy traffic mixture. All sheet asphalt pavements are improved and their life prolonged by the passage over them of sufficient traffic to exercise a constant kneading action and equalize the internal stresses set up by contraction and expansion.

A comparative table showing the average composition of the various bituminous surface mixture discussed herein is given below.

	Coarse Aggregate. Bituminous Concrete. Hot mixture.	Coarse Aggregate. Bituminous Concrete. Cold mixture.	Fine Aggregate. Topeka.	Fine Aggregate. Sheet Asphalt. Light traffic.	Fine Aggregate. Sheet Asphalt. Heavy traffic.
Bitumen..........	7.0%	6.5%	8.5%	10.5%	11.0%
Passing 200 mesh	5.0%	4.5%	8.5%	10.5%	14.0%
" 100 "	4.0%	1.5%	6.0%	10.0%	14.0%
" 80 "	2.0%	1.5%	6.0%	10.0%	13.0%
" 50 "	5.0%	1.5%	6.0%	14.0%	19.0%
" 40 "	4.0%	1.5%	10.0%	14.0%	11.0%
" 30 "	4.0%	1.5%	10.0%	13.0%	10.0%
" 20 "	3.0%	3.0%	9.0%	10.0%	5.0%
" 10 "	5.0%	5.5%	6.0%	8.0%	3.0%
" 8 "	3.0%	5.0%	6.0%	.....	.....
" 4 "	7.0%	8.0%	14.0%	.....	.....
" 2 "	20.0%	40.0%	10.0%	.....	.....
" ¾" "	14.0%	11.0%	.....	.....	.....
" 1" "	12.0%	9.0%	.....	.....	.....
" 1½" "	5.0%	....	.....	.....	.....
	100.0%	100.0%	100.0%	100.0%	100.0%

Summarizing the foregoing brief discussion of the various principles and considerations involved in the different types of bituminous construction, we have the following:—

Foundation.—*Old Macadam*: Suitable for light traffic under favorable climatic and drainage conditions but only when properly constructed and drained. Thickness and character of stone layer and method of construction should be determined by test holes before adopting it. Road must be carefully shaped and graded, preferably by the building-up process, before laying any bituminous top upon it. Inferior to concrete.

Broken Stone: Suitable for light traffic but only under favorable climatic and drainage conditions. Inferior to well constructed old macadam and to concrete.

Concrete: Four to six inches thick, depending upon traffic and character of subsoil. This is much the best type of foundation and is the least expensive to resurface.

Coarse Aggregate.—*Penetration Method*: Suitable for light traffic only; gives a rough surface; best results cannot be obtained except with skilled labor. Should only be carried on in hot weather and stone should be at a uniform temperature not below 60° F. when binder is applied. No plant required, melting kettles being all that is necessary. Extreme care needed to prevent rich spots and bleeding. Stone must be carefully spread and fine material rigidly excluded from lower course, otherwise penetration of bituminous binder will not be satisfactory and uniform. Bituminous binder must not be overheated and must be at proper temperature and uniformly applied.

Cold Mixtures: Suitable for light traffic only; gives a rough surface. Stone must be clean and carefully graded. Bituminous cement must be of proper consistency, otherwise mixture will not be workable. Should not be laid at a lower temperature than 40° F. Work should preferably be done in warm weather. Can be manufactured at the quarry from which the rock is obtained and shipped ready to lay to the work. Rolling should be continued until maximum possible compression is obtained. Especially suitable for repair work done by patrol gangs on coarse aggregate surfaces.

Hot Mixtures: Suitable for light and medium traffic only; gives a rough surface. Stone must be clean and carefully graded to secure best results. Can be laid at any time of year. Heating and mixing plant must be within hauling distance of the work. Rolling should be continued until maximum compression is obtained.

Fine Aggregates. — *Topeka Mixture*: Suitable for light and medium traffic. Gives a comparatively smooth surface. Heating and mixing plant must be within hauling distance of the work. Great care must be exercised to keep bitumen contents within proper limits. Stone and sand should be weighed separately into mixer to secure uniform mixture. Can be laid at any time of year. Rolling should be continued until maximum compression possible is obtained. Unless very carefully manufactured is more liable to shoving and displacement under traffic than is sheet asphalt.

Sheet Asphalt: Suitable for light, medium and heavy traffic but should not be laid on as steep grades as is permissible with coarse aggregates. Gives a smooth surface and can be laid at any time of year. Heating and mixing plant must be within hauling distance of the work. Rolling should be continued until maximum compression possible is obtained.

PROGRESS ON THE ALBERTA AND GREAT WATERWAYS RAILWAY.

On the Alberta and Great Waterways Railway the end of steel is now about Mile 140, or 25 miles northeast of Lac la Biche. The remaining distance to Fort McMurray is 150 miles and of this distance less than 5 miles remain ungraded.

The grade from the end of steel runs in a northeasterly direction to the west end of Christina Lake, and thence in a general northerly direction, crossing the Christina River, passing west of Sharp Point and Cowpar Lakes and east of Gregoire Lake, until it reaches the confluence of the Clearwater and Christina Rivers. The banks of the Clearwater are about 200 feet high, and the valley from two to three miles wide. The road gradually descends the bank of the Clearwater on a one per cent. grade, until finally it reaches McMurray.

Grading along the bank of the Clearwater is rather heavy. Part of the bank consists of clay, and in other parts cuts have to be made through beds of tar sands, which oppear to be of extraordinary extent in the vicinity. About 600 men are employed on construction work at the present time.

Between the present end of steel and McMurray, Mr. Ralph Douglas, assistant provincial railway engineer, reports long stretches of good land, particularly along the Christina River and tributary creeks, and the percentage of muskeg is not by any means so large as anticipated. The country is of a rolling character.

It is expected that the grading will be completed in about a month and that steel-laying will be resumed about that time. The road to Lac la Biche is ballasted, and in very good shape. The remainder of the road from Lac la Biche to the present end of steel will be ballasted during the next few weeks. The grade on the balance of the route, the engineers report, has been particularly well done, and a great deal of drainage work has been undertaken that will be of enormous benefit to the country.

The Victoria Falls of the Zambesi in South-Central Africa, according to the "Engineering News," are capable of furnishing 35,000,000 h.p. of electrical energy and probably not over from 25,000,000 to 30,000,000 h.p. is employed in the world to-day from the direct or indirect use of oil or coal. There are three other great cataracts which so completely surpass all the rest on the score of power available that they are entitled to be grouped with the stupendous African phenomenon which the natives call "The Smoking Waters." This quartet of great cataracts—Victoria, Niagara, La Guayra and Iguassu—aggregating something in excess of 60,000,000 h.p., represent between them from 5 to 7 per cent. of the power of all the rivers of the world.

ENGINEERS AND WAR.—IV.

By R. O. Wynne-Roberts,
Consulting Engineer, Toronto.

It is appropriate in the concluding observations on this subject to refer to the training of military engineers and the experience they often gain apart from war operation. As has already been pointed out, the professional military engineer constitutes only a small proportion of the engineers of all classes who are engaged in multitudinous ways to fit the army and the navy for active warfare. Reference has already been made to the training of the naval engineers, and there again those who design and build ships, machinery and equipment for the Royal Navy far outnumber the engineers who go to sea. The Royal Engineer officer must be proficient in mathematics, geometry, mechanics, natural philosophy, fortifications, languages, chemistry, drawing, surveying, etc., while the men are taught crafts, musketry, field work, signalling, use of plants, water supply, pontooning, sapping and mining. As they are not continually engaged in drilling, they have superior opportunities for acquiring knowledge, under a great variety of conditions, in all parts of the world, often engaged in minor military movements. They, therefore, in times of peace are able to study what would be the requirements in time of war.

The United States engineer officers hail from the engineering educational institutions of that country. As the United States have for a long period enjoyed peace, the principal campaigns since the Civil War were those at Cuba and Philippines, so that the military engineers have not been engaged in active service to put to test the quality of their training. Reference will be made to their work in peace times, and they have a good record in this respect.

The Royal Military College of Canada, Kingston, Ont., is a federal institution, and takes on the functions of the Woolwich, Sandhurst and Chatham military colleges in England. This college was established in 1876, when Lord Dufferin was Governor-General. Kingston was a naval station at the commencement of the last century, and ships were to be built there for the purpose of patrolling the Great Lakes. In 1812 money which was sent out by the Imperial Government for the purpose of building a man-of-war was devoted to building a barracks, and this incident gave occasion for the name it bears to-day—the Stone Frigate. As there were buildings available they were converted into schools and dormitories for the Royal Military College.

The training given at this college is not only for cadets, but also for officers of the permanent force. It does not necessarily follow that cadets trained at this college must follow a military career. "The original idea was not to found a purely military college, but to have an institution at which the young Canadian would receive an education which, while fitting him to take a commission in the military forces of the country, would give him a practical training in civil engineering, surveying and physics." The first two years' study are similar to those at Woolwich, but in the last year, apart from a few attendances given to military history, tactics and military engineering, the work is entirely civil engineering, physics and surveying. In addition to these, the students are taught a variety of subjects, such as the management of horses, riding, physical exercises, sport, etc.

There are seven commissions in the Imperial service offered annually, one of which is in the Royal Engineers. Commissions in the Canadian Permanent Force are, of course, open to the graduates of this College. During the North-West Rebellion in 1885 there were 33 ex-cadets employed, in the South African war there were 82, and in the present war over 450 ex-cadets are serving. Up to 1913 the graduates of the R.M.C. had adopted quite a variety of careers. About 20 per cent. had entered the Imperial Army and 11 per cent. the Canadian Permanent Force, 1 per cent. were in the Royal N.W.M.P., and the remaining 53 per cent. were engaged in law, medicine, farming, accountancy, architecture, surveying, government service, etc. "It may be of interest to know," writes the Commandant of the R.M.C., "that over 50 per cent. of the graduates of the College since it was started in 1876 are now serving in the field in France or elsewhere."

Many of the graduates have attained high positions in the army and in public life. Sir Percy Girouard, Major R. W. Leonard, Mr. F. P. Jones and General W. T. Bridges, of the Australian army, are a few of them.

After dealing with the R.M.C. it will be well to refer to the Canadian Army Hydrological Corps and Advisors on Sanitation. This corps consists of volunteers, who now occupy positions prominent in Canadian affairs, Lieut.-Col. Nasmith being the principal officer. The function of this corps is to supervise the water supply and sanitary works. It holds a quasi-official status, but hitherto its services have not been utilized as fully as might be desired, and it is to be hoped that this unfortunate condition will soon be remedied. The Hydrological Corps is very similar to the London (Eng.) Sanitary Companies, which have been well utilized by Lord Kitchener. The London companies consist of men whose ordinary vocations are associated with various branches of sanitary work, and who are themselves capable of performing duties of different kinds whenever called upon, thus relieving the Royal Engineers as much as possible. The writer some months ago offered to organize a similar corps in Canada, which would in no way interfere with the functions of the Hydrological Corps, but the authorities at Ottawa did not see their way to accept the offer. Canada has also the Corps of Railway Engineers under Col. Ramsay, the engineers under Major Janin, formerly City Engineer of Montreal, and the Pioneer Corps that are now being recruited.

The science and art of war now involves practically every branch of the engineering profession, and, as Morrison stated in his "Golden Epoch," war is now more than ever essentially an engineer's war. The military engineer has to understand and direct the technique of equipments of all kinds—guns, explosives, aeroplanes, transports, instruments, etc., in regard to quality and strength of materials and standard of workmanship. It may be contended that in general the precision required in connection with military machinery and equipment is probably greater than obtains in civil engineering. Furthermore, the testing of materials, as, for example, those made at Watertown, N.Y., furnishes a mass of data that is useful in engineering generally. The testing to destruction of concrete and brick columns affords information of value to those engaged in general constructional work. Capt. Daley, of the United States Engineers, made an apposite remark when he stated that vital, irreparable mistakes of the future can only be avoided by careful preparation now. It is, therefore, of importance to the military engineer that all sources of information should be drawn upon in times of peace so that he may be ready for active service at any moment.

Capt. Downey, United States Engineers, stated that strategy selects, tactics occupy, and fortifications strengthen the position. Strategy is the province of higher commanders, but tactics and fortifications are work for the subordinate officers, and, as there have been great changes in methods of warfare, strategy and tactics are revised and adapted to the powerful weapons employed, the improved facilities for transport, the employment of air-scouts; yet the broad principles of attack and defense and the work required to make them as valuable as possible remain practically the same.

The condition of sea warfare has changed enormously; there was very little in common between the naval fights at Trafalgar and at Falkland excepting the valor of the men engaged in those battles.

The size of the armies now employed is vastly different to those of Napoleon's day, and the rifles of to-day fire further than did Napoleon's guns. Under these conditions it will be seen how important are the duties of the engineer.

The function of military engineers in warfare "comprehends all the preparations for the attack and defence of posts and positions, construction or improvement of military roads and communications, pontoon and bridging of all kinds, mining and destruction of bridges, and, when necessary, the repair and adaptation of buildings for the purpose of hospitals, stores, etc., the construction of temporary wharves and piers, surveying and reconnoitring, provision of field telegraphs, etc." The above was written in 1862, and, as far as it goes, it is applicable to-day, though it does not include all his duties. The engineer must be a fighter as well as a specialist. He must go ahead of the column, collecting notes with storming parties. Often he must go alone seeking information, and, when the infantry rests, he must reconnoitre, attend to the water supply and to the passage of guns. He must be in advance, opening roads, building bridges, and at the rear destroying them. He always leads the forlorn hope, making defences, constructing entanglements, blocking roads, laying mines, establishing means of communication, setting up and operating searchlights and clearing obstacles. Some of the most successful of wars were won by engineers. Abyssinia and Soudan are British examples. An American writer states that in the Mexican war of 1846-7, the most successful ever waged by the United States army, the young engineer officers played a part in it that must ever be a source of inspiration and profitable study to their successors in that branch of the service. In the present war, after seventeen failures and the loss of many lives, the British engineers succeeded in throwing a bridge across the Marne at Vareddes, threatening Von Kluck. The result of "delay in throwing a pontoon bridge caused the loss of 10,000 men of the Federal army at the passage of the Rappahannock and the battle of Fredericksburg in 1862." In the Crimean War the engineers lost 550 officers and men out of a total of 1,650 of all ranks. During the Indian Mutiny it was necessary to destroy the gate at Cashmere, and the engineers performed the task in face of a terrific hail of bullets from the enemy, costing the life of many an officer.

The engineer must be prompt of decision. "Fortunately for the engineers," wrote a contributor to the "Quarterly Review" of 1863, "it is their privilege to be allowed to think. They are not like the architects, first forced to enquire whether or not a thing was done in the fifth century before or in the thirteenth century after Christ before they are allowed to act." The writer, of course, does not venture to express any opinion on this interesting and delicate point, but in war and in preparing for it precedents have no value, and decision borne of experience is essential. Curiously, many things, which had to all appearances become obsolete, are now in use again. It would seem as if old equipments are being resurrected. The Assyrian catapults, the sixteenth century armor and the grenades are revived, and perhaps the cross-bow may be once more used to silently throw bombs.

Surveying has always been a primordial necessity in war. The advance on Kabul, in Afghanistan, was made by the aid of transit observations in two valleys—the Khyber and the Kuram—where intercommunication was generally impossible. Plane table surveys are made by Indian natives, who pace the distances with such accuracy that in a march of 15 to 20 miles the error is less than a quarter of a mile. One of the first acts of Italian commanders when they secured Tripoli was to send engineers to survey for harbors and construct them, also for water supply, sewerage, buildings and other requirements of a port. Reference has already been made to the great work of road construction by the Italians in the Alps, for which surveys had to be made in the face of deadly opposition.

Sir W. Abney was a Royal Engineer, and to him is due much of the credit of having advanced the art of dry-plate photography.

Military engineers are engaged in times of peace on various works. Jamaica was a valuable station for the navy, for in 1696 Chief Engineer Christian Lilly was sent to attend to its fortifications. Capt. Henry Brabant was sent to New York, and a train of engineers were sent to Newfoundland to erect strong defences against the impending attack of the French.

It is interesting to observe the value set on engineers. Col. Romer was captured by the French on his return voyage from New York, but was released on parole. England wanted to use his services, and agreed to release twenty men or the Marquis de Levy for the abrogation of the Colonel's parole.

The Royal Engineers designed and built the Rideau Canal in 1827-31. They were sent to the Arctic regions in 1847 in search of Sir John Franklin. They supervised the relief work in Ireland during the 1846 famine. The first great exhibition of 1851 was largely the work of Royal Engineers. Lord Taunton declared that "whenever the government was in a difficulty in finding an officer of high capacity in civil administration the right man was sure to be obtained among the officers of the Royal Engineers."

The Scotch rebellion of 1745 was the cause of the government's authorizing the ordinance survey of Great Britain by Royal Engineers. This survey took several decades to complete, but to-day every part of the British Isles has been surveyed and mapped. The maps can be purchased at small price, and every minute detail is recorded thereon. The elevation of the roads and streets is shown, and contour maps are published showing the topography. The Redistribution Committee ordered no less than 453,000 of these maps in connection with the parliamentary redistribution scheme.

The great Indian survey was commenced about 1800 by Major Lambton. In this connection it may be stated that the British Government presented the Chinese Emperor with a huge theodolite, measuring 36 inches across the vernier plate, and made in a superb manner by one of the best instrument makers. But that potentate did not appreciate such a gift and returned it. So the case found its way to India, and was found most useful in the primary triangulation of that empire. The eleven base lines were measured and checked in a most scientific way by several Colley's compensation bars, each 10 feet long, with microscopes at each end of the base lines.

The International boundary line was surveyed by Royal Engineers and United States Engineers. The published description of the experience of these men makes most entertaining reading.

Palestine has been a favorite field for surveys by Royal Engineers. Capt. Wilson, and after him Capt. Cordron and Lieut. Kitchener (now Lord Kitchener), were engaged on this work. In carrying out the surveys of the district of Ghor they suffered greatly from the scorching heat of the loose, basaltic soil, from malaria and ulcers. Major Kitchener, in 1883, surveyed around Mount Sinai. Another party surveyed the country and built the telegraph line across Persia in 1857 in face of treachery, murders and stern opposition. This line was required to give means for more expeditious communication with India at the time of the Indian Mutiny. The Persian Shah and his advisers were not quite favorable, but, while they discussed the pros and cons, the engineers proceeded with this work of necessity. This exploit was characterized at the time as "sheer, cool impudence" on the part of the engineers. Explorations have often been undertaken by members of this corps. Capt. Gill explored Persia in 1870 and China in 1876, travelling mostly alone, confronting unknown dangers, traversing hostile countries, and yet arriving at his destination no worse for his experience. Gordon was also an explorer.

The United States Engineers are employed on surveys and pioneer road construction to develop new territories. The construction of roads and bridges by them in Alaska with temperatures ranging from 90 degrees F. to 70 degrees below freezing point are typical examples of works undertaken by them. Flood protection work, river-training, irrigation schemes, etc., as well as the great works of the Panama Canal are some of their peaceful battles.

Lieut.-Col. Maunsell, the Director-General of the Engineer Service in Canada, was good enough to supply the writer with a few notes with respect to Canadian engineers. There are two main branches, namely, the Royal Canadian Engineers and the Canadian Engineers. The former are permanent and the latter are non-permanent. The R.C.E. in peace times are distributed as follows:—

1st (Fortress)	Company,	R.C.E.	Halifax.
2nd (Field)	"	"	Quebec.
3rd (Fortress)	"	"	Esquimalt, B.C.

Their duties are running defence lights, work in connection with defence of their fortress, construction of fortifications and works.

The supernumerary staff is composed of warrant and non-commissioned officers of the R.C.E. for duties as machinists, draughtsmen, clerks and surveyors. The officers of the corps are allotted, not only to the several companies, but to the divisional areas as commanding Royal Canadian Engineers and division officers to carry out engineer services during peace and war. These officers' station duties continue in war, and every officer ordered overseas must be replaced by another officer.

The R.C.E. officers are appointed from graduates of the Royal Military College, who, when appointed, get two years' instruction on all technical subjects at the School of Military Engineering, Chatham, England.

A special instructional Cadre, R.C.E., is appointed for instruction in all branches of military engineering, telegraphy and engineer services.

The Canadian Engineers comprise:—

(a) Four field troops—Hamilton, Winnipeg, Regina and Calgary.

(b) Eight field companies—Woodstock, N.B., Toronto, Ottawa, Montreal, Kingston, North Vancouver, London, Toronto.

(c) Eight telegraph detachments, with same headquarters as field companies.

(d) One wireless detachment—Hamilton.

(e) One fortress company—Halifax.

A field troop is a mounted unit to accompany a cavalry brigade. A field company accompanies an infantry brigade—three per division. A telegraph detachment forms a portion of a signal company. One signal company is allotted to a division, and contains three cable detachments as well as brigade signallers. A wireless detachment forms part of a signal troop to accompany a cavalry brigade. A fortress company is detailed to a fortress for defence lights and fortification works. All the above-mentioned non-permanent troops and those now preparing for war are trained by the R.C.E.

An engineer training depot has been established in England, and also one in Canada, for training the engineers with the Canadian Expeditionary Force. The officers and men of the C.E.F. engineer units are selected from the various R.C.E. and C.E. units as required and sent to the Canadian Engineer Training Depot for their first training prior to their going to the Training Depot in England.

The establishment and proportion of engineer units have been increased in this war.

The chief duty of Canadian Engineers is the cooperation with the other armies in the construction of field defences. The infantry supply the working parties, the engineers the supervision and technical labor. The proportion of engineers is in the neighborhood of 50 sappers to 1,000 infantrymen. The engineers also carry out the technical portion of communication in the field-telegraphs, telephones and wireless, which are of such importance. All engineers are fighting troops, and carry their rifles with them at all times.

While engineers have always been engaged on important duties in connection with war from the early times to the present, it is only comparatively recently that they became a recognized profession. Their efforts were sporadic, and the value of their work depended upon the cleverness of the individual more than upon the advanced state of the science of engineering. Royal Engineers were previously known as sappers and miners, which names still survive, but bear a somewhat different meaning. It was at the long siege of Gibraltar that the first formal organization of engineers took place, and since then they have constituted a most important and integral part of every campaign. As one writer stated, they "are not unprogressive as anthropoids, little raised above them in intellectual developments, living and laboring only to supply their immediate material wants and dying only to be forgotten," but they occupy a prominent place in history by virtue of the fact that forces of nature are subjected to human skill, mechanical power is substituted for animal force, labor of the mind has become more active and more productive as the pressure of daily toil is lightened by the dynamic application of heat.

Engineers are successful as commanders, for General Eliot held Gibraltar against the combined forces of France and Spain. Lord Napier was in command of the Abyssinian expedition; General Gordon in China and Egypt; General Lee, of the United States Confederate Army. Vauban, Marshal Niel, Vaillant, Caraignoc, Graham, Warren, Prendergast, Joffre and Kitchener are a few typical examples of engineers who have won immortal fame. The motto of the Royal Engineers is "Ubique" (ubiquitous), and on their banner is inscribed, "*Quo fas et gloria ducunt*" (Whither duty and glory lead).

TELEPHONE EXTENSIONS IN SASKATCHEWAN.

In the annual report for the year ended April 30, 1915, of the Saskatchewan Department of Telephones, the completed construction work for the year is stated to be: New toll offices, 16; new exchanges, 3; pole miles (long distance), 234.6; wire miles (long distance), 550.

The most important section added to the system was that from Gull Lake westward to the boundary to join up with the Alberta system. This connection permits of communication between points from Regina west as far as Calgary and with all other points south of the main line of the Canadian Pacific Railway. The field was further widened by arrangement for connection with systems across the international boundary so that now points as far as Chicago may be reached.

Exchange construction for the year included only that of plants in three small towns and the installation of a new automatic system in Prince Albert which latter work necessitated a great deal of outside reconstruction. The year's work was made up largely of the rearrangement of equipment which had grown through successive yearly additions into a system comprised of some 15,000 wire miles of long distance and of exchange plant to serve some twenty odd thousand subscribers.

Somewhere between four and five thousand miles of rural systems were constructed during the year, making altogether over 12,500 pole miles of system owned and operated by nearly 500 farmer companies and serving some 13,000 farmer subscribers.

Mr. W. Warren is chief engineer of the telephone department of the province.

COBALT ORE SHIPMENTS.

The following are the shipments of ore, in pounds, from Cobalt Station for the week ended October 15th, 1915:—

Buffalo Mines, 62,410; Penn Canadian Mines, 63,662; McKinley-Darragh Savage Mines, 81,066; Dominion Reduction Company, 88,000; La Rose Mines, 87,127; Mining Corporation of Canada (Cobalt Lake Mine), 86,115; Nipissing Mining Company, 77,387; Right-of-Way Mines, 77,831; Peterson Lake Silver Mine, 65,958. Total 689,556 pounds, or 344.7 tons.

The total shipments since January 1st, 1915, are now 24,803,343 pounds, or 12,401.6 tons.

Editorial

A COMMISSION ON NATIONAL RESOURCES.

The Dominion Government has recently appointed a new Commission, assigning to it a huge task. It is to be a sort of general purpose Commission to take stock of Canada's national resources, to investigate a large number of problems and to report upon their economical and expeditious solution. Among the problems consigned to it are those of increased production, co-operative systems, unemployment, and transportation by rail and water. Their work will consequently be of no small interest to the engineer. In fact, many a Canadian engineer has devoted much time and study to these very problems and has attained a worthy reputation for himself and his colleagues as the advance guard of scientific economy and national development.

The Commission is made up of ten prominent men, under the chairmanship of Senator Lougheed. Men have been chosen that will undertake the task with vim and will devote a great deal of energy to its fulfilment. It is really unfair to these men that they should start their work with a handicap. Having to do with a considerable amount of engineering economics, how much more efficiently might they be expected to persevere in their researches if assisted by the skilful knowledge and training of a capable engineer as one of their number.

The usefulness of an engineer on such a commission was probably never considered. At any rate it is difficult to imagine an advertent government disregarding his qualifications in a case like this, if it is ordained that the Commission shall really be a useful one. It is but another case of the engineer missing by an inch or a mile the recognition which he deserves and which is badly needed for the exercise of that influence so necessary for proper control in the administration of engineering affairs.

THE CANADIAN SOCIETY OF CIVIL ENGINEERS AND THE CIVIC OFFICIALS OF MONTREAL.

From the attitude of Controller Cote and his civic colleagues in Montreal, one is at once led to the conclusion that the advice offered by the Council of the Canadian Society of Civil Engineers regarding the proposed extensions to the waterworks and lighting plant has not been received in the spirit in which it was given. Assuredly the men who form the Council of the Society have no axes to grind in the matter or no interest therein other than that of the ratepayers, and their own desire to preserve the good name of the engineering profession.

Recent events relating to the controversy, if such it may be called, were reviewed in *The Canadian Engineer* for October 14th, 1915, the reference concluding with a letter from the Secretary, Prof. C. H. McLeod, to the civic officials, in which letter the Council reiterated its desire to see the whole project reported upon by a board of independent engineers before further expenditure is incurred.

The letter apparently caused the civic officials to adopt a new tactical procedure, for the Board of Commissioners invited the Society to send a delegation to confer with the former regarding the subject of their correspondence. It evidently dawned upon them that the Society might entertain objections to certain details of the proposed improvements, and the object of the meeting would be, according to Controller Cote, to find out what these objections were. The Council of the Society replied, however, that as a body it could not, under any circumstances, undertake to approve or to criticize in detail any public engineering work, and that in this case its full duty had been performed when it had urged that the expenditure of large sums of public money upon the enlargement of the aqueduct and the construction of a 10,000-h.p. hydro-electric plant should cease until the project, as now outlined, had been studied and reported upon by a board of qualified, independent engineers. "It has been conclusively established," stated the Secretary in his letter, "by statements recently placed in the hands of the Society by all of the engineers, not civic employees, who were named in Mr. Cote's letter of August 2nd to Mr. Jamieson, that no one of them has ever studied and reported on the second enlargement of the aqueduct and the construction of a large hydro-electric plant, but that on the contrary all investigations by them have been of earlier projects or of isolated portions of the works now in progress.

"In view of the large expenditures which have been made and the proposed expenditure of still larger amounts of public money on a work which has received no engineering support aside from that of its originator and his staff, and realizing that the project is viewed with distrust by many local engineers, who have some knowledge of it but have no access to all the data necessary to the forming of a mature and comprehensive judgment regarding it, the Council of the Society has thought it its duty to recommend that independent, competent engineers be engaged to report on the proposed enlarged development."

At a council meeting on October 19th, Mr. Cote had the letter "filed as a record." Thus, to all intents and purposes a most important voluntary recommendation from a body of men chosen by virtue of merit and ability to represent the engineering profession of Canada and to safeguard its interests, has been ignored.

To quote from the editorial page of the Montreal Herald and Daily Telegraph for October 16th, the Society "has on its Council some of the most eminent engineers in Ontario and Quebec—men who have accomplished much in the development of this country. They courteously say to the authorities of the city of Montreal: 'We are not satisfied that the enormous expenditure proposed for power in connection with the city waterworks is wise. Will you not have it thoroughly investigated before going ahead?' This is a reasonable request, made by men who know what they are talking about. The Board of Control should heed this request. The scheme is too big for us to be able to afford to have it go ahead and be a failure. If it is necessary to spend $10,000 to make sure we are right, let's spend it. Public confidence in the scheme has been much shaken by the action of the engineer's Council. The way to restore public confidence is to have the best experts available report on it. If the scheme is right it will stand this; if it is not right, we can save millions. But now is the time."

LETTER TO THE EDITOR.

"A Light and Useful Roof Truss."

Sir,—The writer is inclined to disagree with the statement in the closing paragraph of the article on page 477 of the issue of October 14th, 1915, of *The Canadian Engineer* that "No apology is necessary for introducing" to him his old friend (or enemy), the "light and useful roof truss." He is inclined to be rather grouchy about it just at this time, because he is at present wrestling with the problem of how to keep an 80-ft. roof truss of this identical type from falling down. It is not that the type is at fault, for some of the claims made for it are sound; but the 45 ft. 9 in. truss described in the article is so far below the common standard of engineering practice in this country that it should not be so unreservedly presented without some explanations.

In the first place, it is "designed" for a total load of 12,000 lbs., or 24 lbs. per sq. ft. of roof. Of this, about 9 lbs. is the dead weight of truss and roof, leaving 15 lbs. per sq. ft. for snow and wind load. Now, last January we had, in southern Ontario, a combination of snow and rain and wind that loaded our roofs not far from the 30 lbs. per sq. ft., which is the usual minimum live load used in designing in this latitude. Many roofs went down under it. In Toronto 40 lbs. per sq. ft. is the minimum allowed, and for localities further north much heavier loads should be provided for. So it should be noted that this truss ought to be at least 60 per cent. stronger for use in Canada.

However, assuming a total load of 24 lbs. per sq. ft. and a depth of 5 ft. 6 in. at the centre (this dimension is not given, but the drawing scales that), the direct compression in the top chord is found to be 1,630 lbs. per sq. in. Toronto and Hamilton building by-laws allow a maximum of 1,100 lbs. per sq. in. for long-leaf yellow pine in direct compression. With such loads as we had last winter the direct stress would be 2,600 lbs. per sq. in. On the other hand, the bottom chord seems to have an excess of material for assuming the whole section can be counted on; the unit stress is only 415 lbs. per sq. in. In the same way, the stress in the purlins would be about 2,850 lbs. per sq. in.

The statement that "there are no secondary stresses in the fibre of either strung or bow" is incorrect. The bending of the top chord, or "bow," to its curve produces a fibre stress of over 300 lbs. per sq. in. in it. This is 30 per cent. of the allowable working stress, and it must be added to the direct stress. To hold this curved piece in place puts an initial stress in all other members of the truss.

Again, a snow load on one side of the truss only would produce shearing stresses at the centre, to be taken care of by the diagonal web members. These diagonals do not intersect on the centre line of the chords, and consequently must produce secondary stresses. When the truss deflects under its load all kinds of secondary stresses will be set up. The larger the truss, the worse these conditions become.

The placing of a monitor on the truss, which can be "done with such ease," will alter the line of stress so that it will no longer be a parabola, and more unknown stresses are developed. On the whole, the stresses in this type of truss are very indefinite, and instead of increasing the unit stresses as recommended they should be considerably reduced.

Considering Claim 2 made for this type of roof, viz., "small superficial area of the roof in relation to the area covered by it." This is due entirely to the shallow depth of the truss in relation to its span. The same result may be obtained with almost any type of truss at the expense of extra section in the chord members. For a large truss it would be very uneconomical to make the depth only one-eighth of the span like this small one.

The same argument applies to Claim 3, "the eliminating wind pressure as a factor in the stress calculation." But the wind pressure on small roofs is never calculated anyway, it being considered that the 30 lbs. per sq. ft. live load includes wind pressure. However, when the trusses rest on columns and it really becomes necessary to provide for wind pressure by using knee braces to make the truss and column act as a bent, this type of truss is a most unsatisfactory one.

There are other details of construction that are open to criticism. The use of double strips to form the purlins only adds to the cost and invites dry rot along the surface of contact.

Special care and expense is required to make a good roof when the sheeting is curved. Each strip of sheeting —in this case ship-lap—must end on a purlin and be especially well secured, for there is a strong tendency for the ends to spring up and cut holes in the roof covering. The smaller the span the more important this becomes.

Regarding the carpenter as a truss builder. In timber structures such as trusses where the full strength of the material is supposed to be developed, the ordinary methods of the average carpenter are useless. In a dwelling house a workman would consider a couple of 5-inch nails quite enough to secure a 2″ x 4″ scantling in place. In a truss it would require eight or ten nails to develop its working value in tension, but no ordinary carpenter would think of putting that many nails into it unless he were made to do it.

In the design of a small truss of 45-ft. span many fine points may be disregarded. In a 120-ft. truss, such as is recommended, when the stresses would be at least ten times as great, the members would have to be built up with many thicknesses and splices and the difficulties are so multiplied as to make such a truss, if properly constructed, very expensive. In small trusses, "skinned" as this one is, there is doubtless an apparent economy in first cost, but if a structural steel designer were allowed to use such light loads and relative high stresses in his work and ignore the effects of rust and defective material as the designer of this truss ignores dry rot and other undesirable properties of timber, the apparent economy would disappear.

Timber trusses have their place and use in construction, but their utility, durability and ultimate economy depends entirely upon the amount of care taken in their design and construction.

E. H. DARLING, M.E.*

Hamilton, Ont., October 19th, 1915.

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*Of McPhie, Kelly and Darling, Architects and Engineers, Hamilton, Ont.

The Engineer's Library

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer, 62 Church Street, Toronto.

CONTENTS.

BOOK REVIEWS.

Manual of Surveying for Field and Office. By Raymond E. Davis, C.E., instructor in Civil Engineering, University of Illinois. Published by McGraw-Hill Book Co., New York. First edition, 1915. 395 pages; illustrated; 4½ x 7 ins.; flexible leather binding. Price, $2.50.

Of the several handbooks on surveying that have appeared this year, civil engineers and surveyors will find the manual under consideration one worthy of investigation. The practice of surveying, from both field and office standpoint, is dealt with concisely and in a manner that makes it a very serviceable volume for the engineering student as well as the man in the field. The proper use of surveying instruments, the best procedure in making surveys, and the proper methods of computing and mapping are dealt with in a manner suggesting the particular aim in view to be instruction, not only to civil engineering students, but to students in other courses requiring a working knowledge of surveying.

The first chapter prepares the user for the practice of surveying developed in succeeding chapters. It covers the field note book, field problems, surveying instruments, office computations and maps. The succeeding chapters are under the following headings: Elementary field problems; compass and transit problems; level problems; use of the plane-table and sextant; field astronomy; topographic surveying and office problems. Some 122 pages of the work comprise the usual tables necessary to the surveyor.

The subject-matter is well arranged, in that each problem is complete in itself as far as possible. There is little information necessary to an inexperienced surveyor that has not been included in the text-book. A good deal of emphasis is placed on the precision of measurements, methods of checking, and systematic compilation of notes. The latitude, longitude and azimuth problems require little or previous knowledge of astronomy. Plane-table methods for large scale work have been given more attention than they are usually accorded. The index is very complete, facilitating ready reference.

The author gives credit to a number of prominent authorities for assistance rendered in the compilation of the work.

Valves and Valve Gears. By F. D. Furman, M.E., Stevens Institute of Technology. Published by John Wiley and Sons, New York; Canadian selling agents, Renouf Publishing Co., Montreal. First edition, 1915. (Reviewed by Robt. W. Angus, B.A.Sc., Professor of Mechanical Engineering, University of Toronto.)

Vol. 1.—Steam Engines and Steam Turbines. 254 pages; 357 illustrations; 6x9 ins.; cloth. Price, $2.50 net.

Vol. 2.—Gasoline, Gas and Oil Engines. 190 pages; 170 illustrations; 6 x 9 ins.; cloth. Price, $2.00 net.

This work is devoted to a branch of mechanical design sometimes treated by itself, but more commonly in general books on engines. The first volume deals with valves for steam engines and steam turbines, and begins with a general description of the parts of an engine and a discussion of the different features of a valve, such as lead, lap, etc.

This is followed by a discussion of the Leuner and other valve diagrams and the applications of these to valve design, adjustment and analysis. The next two chapters deal with valve forms and the various mechanisms used for operating the valves, including shaft and other governors. About two-thirds of this volume is taken up in discussing valves used in various engines, in many cases drafting-board problems being suggested for solution.

The second volume treats of gasoline, gas and oil engine valves, and the general treatment is fairly complete. After giving a description of the action of the internal combustion engine, the details, such as carburettors, igniters and ignition systems, number and disposition of cylinders, valve gears, cams, etc., are described and considered briefly. Many actual forms of valve mechanisms are then fully considered and analyses made in most cases. Amongst the machines treated in this way are the Franklin, Knight, Gnome and other aeroplane engines, Diesel and several forms of gas and oil engines.

Properties of Steam and Ammonia. By G. A. Goodenough, M.E., Professor of Thermodynamics, University of Illinois. Published by John Wiley and Sons, New York; Canadian selling agents, Renouf Publishing Co., Montreal. First edition, 1915. 108 pages; illustrated; 7 x 10 ins.; cloth. Price, $1.25 net.

In this book of steam and ammonia tables Professor Goodenough has aimed at accuracy and convenience in application, and, with these ends in view, has consulted the works of the most recent experimenters who have been working along this line. The tables of saturated steam are similarly arranged to those of other compilers, while the properties of superheated vapors have been differently arranged; but whether this results in a greater facility for use or not, one cannot say without much experience in their use.

The tables for ammonia are arranged in similar manner to those for steam, and are most useful because of their completeness.

One table, which is of very great value, and the contents of which have rarely appeared in print, gives the properties of mixtures of air and saturated water vapor in such form as to be readily available for computations on drying and humidifying. This table alone makes the book of much value.

A set of examples shows the applications of the tables.

Handbook of Mathematics for Engineers (with Tables). By L. A. Waterbury, C.E., Professor of Civil Engineering, University of Arizona. Published by John Wiley and Sons, New York City; Canadian selling agents, Renouf Publishing Co., Montreal. Second edition, 1915. 213 pages; 80 figures; size, 3 x 5½ ins.; bound in leather. Price, $1.50 net.

This is a rewritten and enlarged edition of a very useful vest-pocket handbook for engineers. It has few equals as a reference book that the engineer can have with him on the job. The branches of mathematics, algebra, trigonometry, analytical geometry, differential and integral calculus are followed by sections on theoretical mechanics, dynamics, mechanics of materials (including special sections on beams, struts and columns, and reinforced concrete), and hydraulics (including sections on weirs, orifices and jets, flow in pipes, flow in channels, hydraulic grade line). The tables comprising the balance of the book include 5-place logarithms, log. sines, cosines, tangents and cotangents, the natural trigonometrical functions, and conversion factors.

The user of the first edition of this handbook will find revisions and alterations in plenty and the errors of the first work corrected. Much new material has been added, including the extensive section on hydraulics, the conversion factors, and a generous treatment of the subject of reinforced concrete.

As may be inferred, it is not a textbook, but a very serviceable, concise, complete and authoritative reference book.

McGraw Waterworks Directory. Published by McGraw Publishing Co., Inc., New York. First edition. 615 pages; no illustrations; 6 x 9 ins.; cloth. Price, $15; duty charged by Canadian customs, $1.50.

This directory lists 313 cities and towns in Canada and 4,872 in the United States, giving the essential facts about the ownership and management of the waterworks in each town or city, the source of supply, purification, pumping equipment, distributing system and rates.

The book is arranged alphabetically by states and provinces, with the towns in alphabetical order under each state or province. The description of each waterworks is given under the town which it supplies, while a statistical summary gives the number of plants in each state or province that are municipally or privately owned, the number of towns that are supplied from other towns, the number using electrical equipment, the number of combined light and waterworks plants and the number of plants using water power. Of the 313 plants listed for Canada and Newfoundland, 256 are municipally owned, 48 privately owned and 4 mixed ownership. Five towns are supplied with water from other towns, 24 use electrical equipment, 75 plants are combined light and waterworks, and 31 plants use water power.

In the preface of the directory it is stated that "much information has been obtained from the Canadian Conservation Commission's report on Waterworks of Canada, by Leo. G. Denis"; and, while it is true that the information given in the latter book is used extensively in the McGraw directory, and has probably been the basis for the information given regarding Canada, nevertheless it should be stated that the information given in the McGraw directory is considerably more recent and far more complete than the information given in the first edition of Mr. Denis' book. In other words, the data regarding Canada in the McGraw directory is by no means merely a copy of the report issued by the Commission of Conservation of Canada in 1912.

PUBLICATIONS RECEIVED.

Ontario Railway and Municipal Board.—Ninth Annual report, for 1914, recording the sessions of the Board with judgments or opinions.

Electro-Plating With Cobalt.—Part III. of the report or researches by H. T. Kalmus, C. H. Harper and W. L. Savell. 69 pp.; illustrated; 6 x 9 ins.

Queen Victoria Niagara Falls Park.—Report of the Commissioners for 1914, including reports of superintendent, chief gardener and assistant engineer.

Public Works in Ontario.—Report of the Minister for 1914, including reports of deputy minister, chief engineer, architect, superintendent colonization roads, etc.

Chemistry of Gas Manufacture.—A bibliography compiled by the U.S. Bureau of Mines. Selected from a large list of references to the chemical behavior of hydrocarbons.

Saskatchewan Railways and Telephones.—Two provincial reports for the year ended April 30th, 1915, issued by the Minister of Railways and the Minister of Telephones, respectively.

Lime Kilns, Stone Quarries, Brick Plants and Cement Mills in Canada.—Circulars issued by the Mines Branch, Department of Mines, Ottawa, giving lists of manufacturers, location of plants, etc.

Safety in Stone Quarrying.—A 48-page bulletin of the U.S. Bureau of Mines prepared by Oliver Bowles, relating to sources of danger, safety in quarry equipment and methods, safety devices, statistics, etc.

Geology of Vancouver Island.—Bulletin 36, Geological Survey, Department of Mines, Canada. 143 pp. besides illustrations and maps relating to the geology of the Victoria and Saanich map areas. Prepared by C. H. Clapp.

Inflammability of Mixtures of Gasoline Vapor and Air.—Technical Paper 115, U.S. Bureau of Mines, relating to methods for determining the contents of gasoline vapor in air and the range of complete combustion for mixtures.

Influence of Temperature on Strength of Concrete.—A 24-page illustrated bulletin prepared by Prof. A. B. McDaniel of the University of Illinois, describing experiments performed at the Engineering Experimental Station.

Coking of Coal at Low Temperatures.—Bulletin 79, Engineering Experiment Station, University of Illinois. 39 pp.; 6 x 9 ins.; illustrated. The bulletin gives special reference to the properties and composition of the products.

Wabana Iron Ore of Newfoundland.—Memoir 78, Geological Survey, Bureau of Mines, Ottawa. 163 pp.; illustrated; 6 x 9 ins. A detailed study of the petrology and chemistry of the Wabana iron ore, prepared by Mr. A. O. Hayes.

Yukon-Alaska International Boundary.—Memoir 67, Geological Survey, U.S. Bureau of Mines. Prepared by D. D. Cairns. Special reference given to boundary between Porcupine and Yukon Rivers. 161 pp.; illustrated by maps and diagrams.

Cost of Pumping Water.—A collection of graphical charts with accompanying explanatory text to facilitate computation of the over-all economy of different types of steam pumping units. Issued by the DeLaval Steam Turbine Co., Trenton, N.J.

U.S. Mining Statutes Annotated.—A U.S. Bureau of Mines publication of 1,772 pages, devoted to sections and statutes relating to metalliferous and coal mining and to miscellaneous mining subjects. Issued as Bulletin 94 and prepared by J. W. Thompson.

Geology, Central British Columbia.—A geological reconnaissance between Golden and Kamloops, B.C., along the Canadian Pacific Railway. Prepared by R. A. Daly and issued as memoir 68, Geological Survey, Department of Mines. 260 pp.; numerous maps and diagrams.

Highway Improvement in Ontario, 1914.—Report by W. A. McLean, Commissioner of Highways. The publication also contains a number of complete papers prepared by the assistant engineers of the Ontario Office of Public Roads, which appeared in abstract form in *The Canadian Engineer* issues of March 4th, 11th, 18th, 25th, and April 1st, 1915.

American Society for Testing Materials.—Year book for 1915, containing the standards and tentative standards adopted at the recent meeting. These standards relate to ferrous and non-ferrous metals, lime and clay products, miscellaneous materials, etc. The book also contains technical information applicable to certain standards, standards applicable to locomotives and data relative to committees and publications.

CATALOGUES RECEIVED.

Distant Train Control.—A 28-page illustrated bulletin (No. 131) of the General Railway Signal Co., Rochester, N.Y., describing the G.R.S. low-voltage or "distant control" switch machine.

Drawing and Blue Print Files.—A 16-page illustrated catalogue of the Yawman and Erbe Manufacturing Co., Rochester, N.Y., describing their mammoth vertical drawing file built of wood and steel.

Coal Gas Plant.—A handsomely compiled booklet issued by the Stone and Webster Engineering Corporation, illustrating the coal gas plant constructed by them for the Falls River Gas Works Company.

The Riensch-Wurl Screen.—A 24-page bulletin illustrating and describing this type of apparatus and its method of clarifying sewage and trade wastes. Issued by the Sanitation Corporation, New York City.

Sewage Spraying Nozzle.—A 4-page leaflet issued by the Snow and Petrelli Manufacturing Co., New Haven, Conn., describing a new nozzle of the circular orifice type with an absence of all internal clogging features.

Water Turbines and Pelton Wheels.—A 16-page illustrated catalogue issued by Pitman, César and Company, London, Eng., descriptive of the types of water wheels, turbines, oil-pressure governors, pumps and hydraulic accessories which they manufacture.

COAST TO COAST

Hope, B.C.—The Hope Mountain section of the Kettle Valley Railway will be completed next month.

Quebec, Que.—It is understood that the Quebec and Saguenay Railway may shortly be taken over by the Federal Government.

Levis, Que.—A new coal discharging apparatus, costing about $9,000, has been installed on the Carrier Laine wharves, and is now in operation.

Halifax, N.S.—The corner-stone for the new terminals was laid last week by Hon. Frank Cochrane, Minister of Railways and Canals.

New Westminster, B.C.—The second unit of the north arm jetty, which is being constructed by the Marsh-Hutton-Powers Company, is about half completed, and the contractors expect to finish it about February.

Owen Sound, Ont.—The Hydro-Electric Power Commission is installing the equipment for the new transformer station, and it is expected that power from the Eugenia Falls development will be turned on early in December.

Vancouver, B.C.—Mr. F. W. Peters, general superintendent of the British Columbia division of the C.P.R., has announced that the Kettle Valley Railway has leased from the former line its Nicola Valley branch, in order to facilitate the operation of the completed portions of the Kettle Valley line.

Quebec, Que.—The new road between Quebec and Montreal, the construction of which began in June, 1914, will be completed next month. It is a macadam roadway 16 ft. wide with 4-ft. shoulders on either side. It involves the construction of a bridge across the Jacques Cartier River at Donnaconna. Mr. J. Dumont is engineer in charge of the work for the government, and Mr. E. Massicotte is the general contractor.

Hamilton, Ont.—Mr. A. F. Macallum, city engineer, has been requested to prepare plans of all sewers emptying into the bay in the vicinity of Catherine and Wentworth Streets, with suggestions as to how they may be diverted to prevent any further untreated sewage from reaching this section of the bay. When this has been done, the Hamilton Harbor Commission will commence the work of improving the bay shore.

Calgary, Alta.—The Milk River irrigation project, which is being developed by the Dominion Government with Mr. F. H. Peters, Commissioner of Irrigation, in charge, will embrace nearly 2½ million acres. It will be a canal proposition throughout, involving several large dams and other structures. The sources of water will be the Milk, St. Mary's and Belly Rivers. The engineers of the Irrigation Department are at present working on the scheme.

Edmonton, Alta.—The city council has retained Mr. W. E. Skinner, consulting engineer, 204 Sterling Bank Building, Winnipeg, to advise them regarding the terms of the proposed agreement between the council and the Edmonton Hydro-Electric Power Company for the supply by the latter of electric power within the city. This agreement will be submitted subsequently to a vote of the burgesses. Mr. Skinner will also be requested to make a valuation of the existing municipal power plant, and to report on the actual cost to the city of the current generated there.

Toronto, Ont.—There is little to report concerning the harbor development delay. Messrs. Roger Miller, John Sweeney and E. P. P. Shewen, who formed a commission appointed by the Dominion Government to investigate the work done by the Canadian Stewart Co. and the sub-contractors on the ship channel and turning basin at the foot of Cherry Street, have handed in their report, which has not been made public as yet, but which is receiving consideration at Ottawa from the parties involved. The Commission was appointed last July on the requisition of Mr. E. L. Cousins, harbor engineer.

Vancouver, B.C.—Construction work is now well advanced on the new government elevator, and it will be ready for service by January 1st. The foundations and basement of the storage bins and working house have been finished, the trackage completed, and work is now proceeding on the upper sections. As the foundations are below water level at the dock site, the structure is surrounded by a basin lined with pitch and felt, and every precaution is being taken to prevent danger of moisture. Messrs. Barnett-McQueen & Company are the contractors. The dock itself is rapidly approaching completion, and, according to the builders, Messrs. Henry McFee and McDonald, it will be finished next month.

Montreal, Que.—A new binding surface is being applied on over 30 miles of the King Edward Highway. The work is being done by the Government Department of Roads. The material used is fluxphalte, and is being applied by two Kinnear pressure outfits. The road surface is first thoroughly swept of dust and loose stones and the heated fluxphalte is then forced into the interstices and covered over with a thin dressing of finely screened gravel. The road is then ready for service. The cost of this improvement is about $800 per mile. The section of the King Edward Highway between Laprairie and Victoria Bridge will probably be reconstructed next year and the same treatment then applied.

Fort McMurray, Alta.—The opening up of the new north-west is making progress along other than railway and agricultural lines. The Dominion Government has been petitioned to establish wireless stations at Fort McMurray, at Fort Chipewyan, Fort Smith, Fort Vermilion and Smith's Landing, to connect these points with the present government telegraph line operating south from Fort McMurray. Improvement of navigation of the Athabasca River between Forts McMurray and Chipewyan by removing sand bars, installing buoys, and maintaining suitable wharfage at various points, is agitated, and the improvement of harbors and river entrances also appear to be urgently needed. The entrance of the Alberta and Great Waterways Railway is expected to greatly increase the freightage of the northern towns.

EDMONTON BRANCH, CAN. SOC. C.E.

The first annual meeting of the Edmonton Branch Canadian Society of Civil Engineers took place at the Cecil Hotel on October 18th last. About twenty members were present. After an informal dinner, the retiring chairman, Professor W. Muir Edwards, introduced the newly elected chairman, Mr. A. T. Fraser, District Engineer, Canadian Northern Railway, to the members. The secretary's and auditor's reports were then read which showed that the Branch had been active during the past year, and that the Branch's financial condition was satisfactory. As a feature of the new season's programme, it was decided to devote the meetings largely to informal discussions on important engineering problems of the day, especially as they occur in Western Canada.

PERSONAL.

H. V. ARMSTRONG, B.A.Sc., for several years town engineer of Estevan, Sask., has resigned.

A. F. MACALLUM, city engineer of Hamilton, Ont., has been elected president of the American Society of Municipal Improvements.

Lieut. EDWIN A. BAKER, of the Sixth Field Company, Canadian Engineers, and a graduate of Queen's University, Kingston, has been reported wounded, according to a recent casualty list from the front.

WM. H. BOUGHNER, formerly assistant engineer on the staff of the city of St. Thomas, Ont., has been appointed assistant engineer at Fort William on the staff of the Dominion Department of Public Works. Mr. Boughner is a graduate of Queen's University, Kingston.

GEO. E. GRAHAM, formerly superintendent of District 2 of the British Columbia division of the Canadian Pacific Railway, and for the past two years general manager of the Coquitlam Terminal Company, has been appointed general manager of the Dominion Atlantic Railway, a subsidiary line of the C.P.R., operating in the maritime provinces and eastern states. Mr. Graham was formerly with the C.P.R. as superintendent of terminals and elevators at Fort William, Ont.

J. A. TILSTON, B.A.Sc., a member of the Canadian Overseas Railway Construction Corps, writes that the corps has recently been enjoying a short furlough in England after some extensive operations in Belgium where, near Dixmude, it was engaged in track building, and elsewhere on foundations for big guns. It is expected that the corps will shortly proceed to the east, either to the Persian Gulf or to Russia to carry on similar work. The corps has been very fortunate, having had only two casualties while in Belgium.

OBITUARY.

The death occurred at Warwick, N.Y., recently of Mr. Thomas P. Fowler, formerly president of the Ontario and Western Railway.

The remains have been found near Timmins, Ont., of Mr. T. F. Cheyney, a mining engineer widely known in the Timiskaming district of Ontario, who disappeared last August. The deceased was a resident of Cleveland, Ohio, up to several years ago.

Word was received in Ottawa recently of the death of Lieut. T. C. Campbell, of the Royal Engineers, who died on a hospital ship from wounds sustained in Gallipoli. The deceased was formerly a member of the engineering staff of the city of Ottawa. He was born in India, and educated in Ireland, graduating there from an engineering school. On coming to Canada he was employed first on the Mount Royal Tunnel preliminary survey, and afterwards residing in Ottawa.

COMING MEETINGS.

NATIONAL MUNICIPAL LEAGUE.—Annual convention to be held at Dayton, Ohio, November 17th to 19th. Secretary, Clinton Rogers Woodruff, 705 North American Building, Philadelphia, Pa.