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KAMINISTIQUIA RIVER BRIDGE, FORT WILLIAM

NEW ELECTRICALLY OPERATED STRAUSS TRUNNION BASCULE BRIDGE FOR THE CANADIAN PACIFIC RAILWAY—CLAIMED TO BE THE LARGEST DOUBLE DECK, DOUBLE TRACK BRIDGE IN USE

THE Canadian Pacific Railway Company are building extensive terminal yards and loading docks on Island No. 1 at Fort William, Ontario. In order to reach this island, it was necessary to build bridges across the Kaministiquia and McKellar Rivers, and, inasmuch as these are both navigable rivers, movable bridges were required, while on account of the rivers being so narrow, it became necessary to use bridges of a bascule type.

The Kaministiquia River, at the point where the railway crosses, has a clear width of channel of 125 feet, but as the railway crosses the river at an angle, a clear span of 180 feet is required. This leaves the channel perfectly clear when the lift is raised into the open position.

The bridge is a single-leaf, double-deck, Strauss trunnion bascule bridge, with the main trunnions at the point of intersection of the bottom chord and the end post of the truss (heel trunnion type), and embraces a 186-foot movable span, giving the required clear channel of 180 feet in the river, and a 40-foot stationary span or tower. The lower deck carries a double track railway and the upper deck two street car tracks in addition to a roadway and sidewalks on each side.

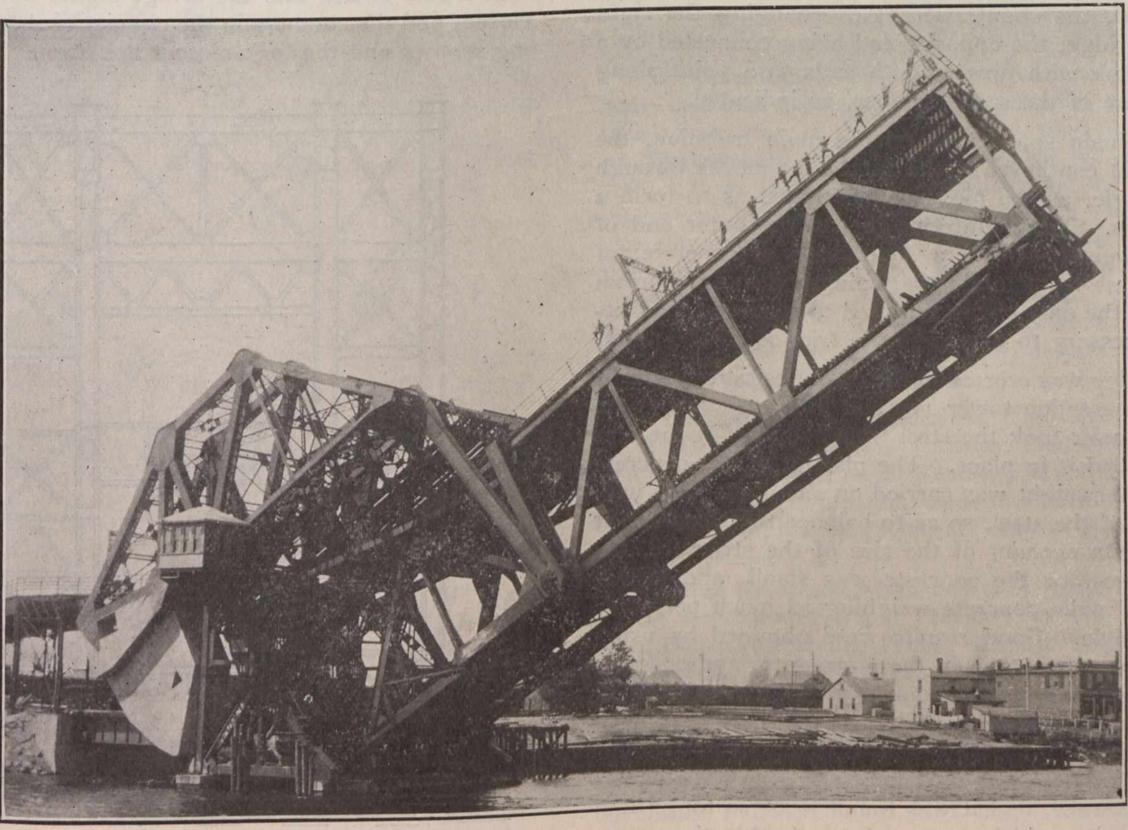


Fig. 1.—The Kaministiquia River Bridge, Fort William, Ont.

The Kaministiquia River bridge is of the Strauss trunnion type, while that across the McKellar River is of the Scherzer rolling lift type. The bridge department of the Canada Foundry Company, Limited, have the contract for the fabrication and erection of both of these bridges, and the bridge across the Kaministiquia River is about completed.

The double-deck feature in bascule bridge construction is said to be out of the ordinary and it is reported that there is no other bridge of the bascule type containing a double deck that is quite as large, although there are a few single-deck bascule bridges under construction that are considerably larger than this one.

There are long approach viaducts on both sides of the river for the electric railway, to enable it to cross the bridge on the upper deck.

pinion, which moves along the rack on the lower face of the operating strut. This action lifts the span. As the bridge moves up, the motors move through the same angle, which in the highest position is 80 degrees.

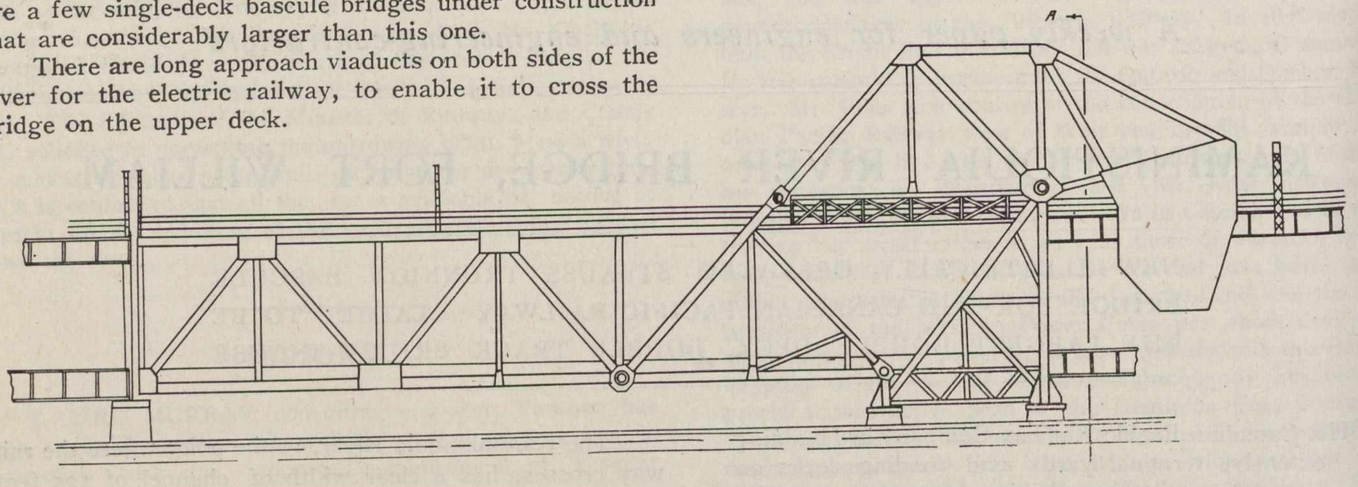


Fig. 2.—Kaministiquia River Bridge, showing General Elevation Diagram.

The construction of the bridge is rather out of the ordinary, as an inspection of the accompanying illustrations will show. The main span is pinioned on a main trunnion at the forward end of the triangular tower. It is for this reason that it is called a heel trunnion type. On the top of the tower a cantilever counterweight arm is trunnioned, the counterweight overhanging the right end of the bridge, the opposite end being connected by a connecting link with pins at both ends to a point along the lower part of the span member, as indicated.

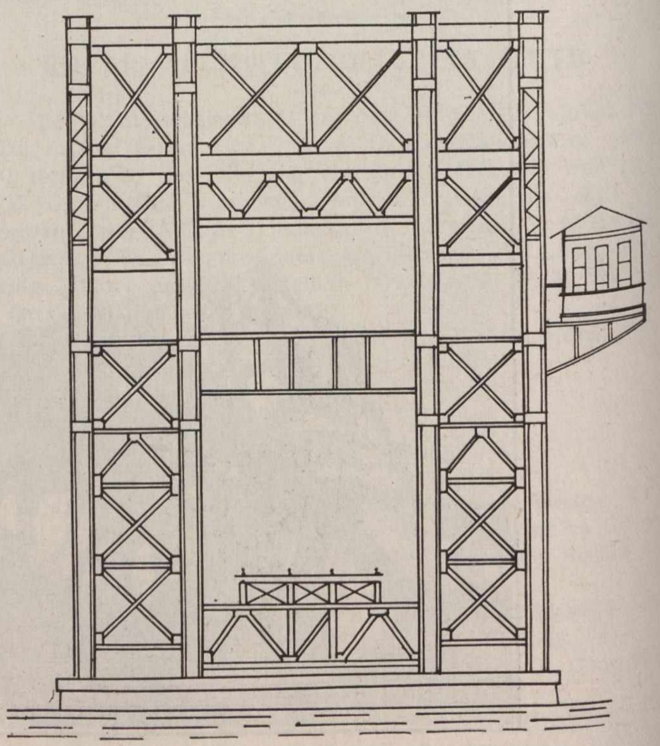
As the main span turns on the main trunnion, the counterweight cantilever at the same time moves through a similar angle, as the pins are so located as to form a parallelogram. The counterweight on the outer end of the counterweight arm is a solid mass of concrete, of such weight as to maintain the main span in equilibrium at all times, the only power required to raise the span being that necessary to overcome the friction of the parts.

The bridge was erected in the open position by means of a wooden erection tower 125 feet high. A derrick on top of this tower took the steel from the cars at the bottom and landed it in place. The placing of the concrete for the counterweight was carried on simultaneously with the erection of the steel, so as to balance the structure at all times. On account of the size of the structure, the available space for the concrete was small, and it was necessary to make concrete weighing as much per cubic foot as possible. Good results were obtained by using iron ore in place of stone in the aggregate, and concrete was obtained weighing about 175 lbs. per cubic foot. This concrete had such great tensile strength that most of the reinforcing ordinarily used in these counterweights was omitted. There was occasion to remove some of this concrete afterward, and it was found to be so tough that the only way it could be removed was by blasting.

Method of Operation.—The operation of the bridge is as follows: Pinned to the front of the triangular towers on each side are operating struts, on the lower end of which are long racks each engaging at the outer end with a pinion. This pinion is connected through gearing to an 85-h.p. motor fitted with solenoid brakes. These two motors are mounted on the towers as indicated in the illustration. The motors, when operating, revolve the

At the outer end of the span there are two lock motors of 5 h.p. each. These operate the locks through worm gearing. There is also a 3-h.p. motor geared to a crank disc to operate an emergency brake.

When the bridge is closed and ready for traffic, the lock signal switch and the bridge signal switch are both closed, and the contacts in the circuits of the main operating motors and the lock motors are open. To open, the



SECTION AA

Fig. 3.—Kaministiquia River Bridge—Section A-A (Fig. 2).

danger signal is first set. The action of so doing energizes the contactor points of the lock motor, causing them to close, when, by the closing of the lock motor circuit breaker by the operator, the locks are withdrawn. The lock moving out, automatically changes the light in the signal tower from white to red, indicating that the bridge is closed to traffic. Similar changes of light occur on the operator's panel.

Until the end locks are withdrawn, the contactors of the operating motors remain open. When withdrawn, these contactors are closed, so that the operator can, as soon as the light signals that the time is proper, energize the main motors through the controllers. The first notch of the controller merely releases the solenoid brake. This position can be used at any time when it is desired to coast. The starting of the span on its upward movement opens the lock motor contactors, so that the latter cannot

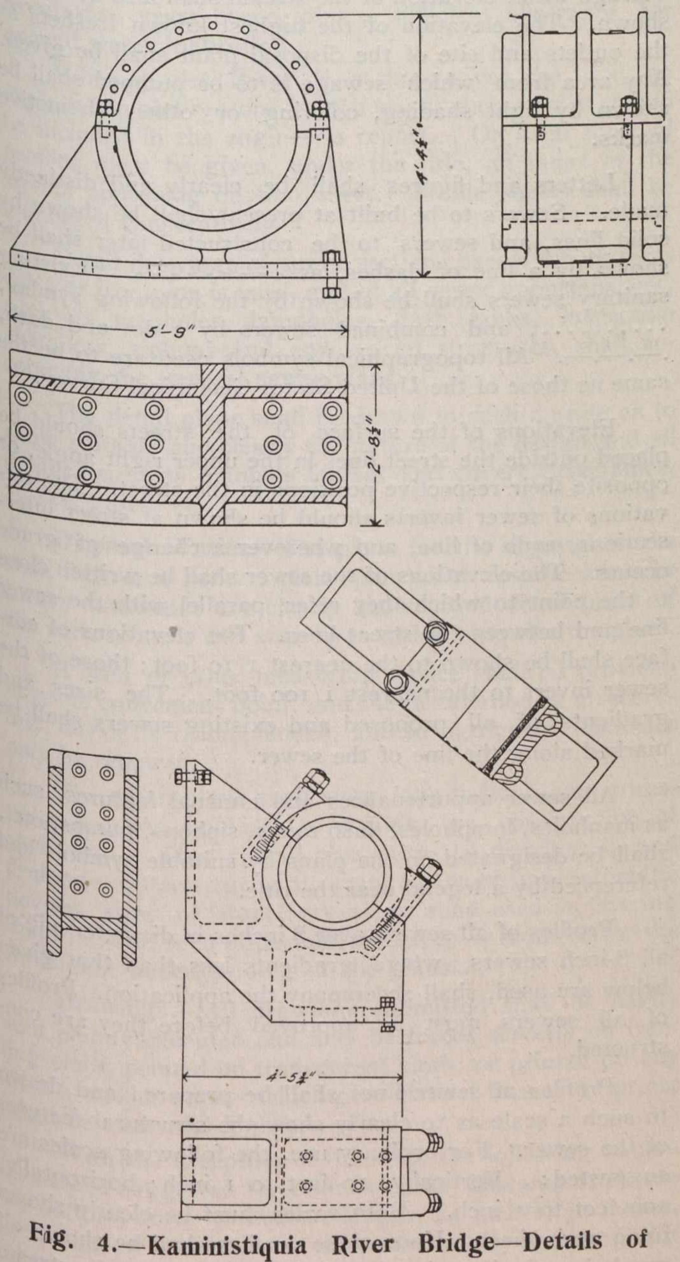


Fig. 4.—Kaministiquia River Bridge—Details of Trunnion Bearings.

operate by accident. The closing of the span is performed by reversing the operations outlined, and the signal lights show up in the same reverse order. Air buffers are provided to take up any shock when the span strikes the abutments. If the bridge is travelling too fast, these air buffers will cause the motors to overload and trip the oil switch, which will automatically put the brakes on. The operating machinery is all interlocked in such a way that every operation must be performed in sequence, and unless the bridge is actually moving up or down, it is held rigidly in position by a brake operated by an independent 5-h.p. motor.

The current for operating this bridge is obtained from the Kaministiquia Power Company and is 2,200 volts, 3-phase, 60-cycle A.C. current. It is stepped down to 550-volt for use on the bridge. The operator's house on top of one of the towers is fitted with a complete electrical control outfit, including switchboard and the necessary attachments.

The bridge is also equipped with a hand-operating mechanism for use in an emergency. It would take four hours to open the bridge with this mechanism.

The total weight of steel in the bridge, exclusive of the approaches, is about 2,500 tons. The counterweight weighs 2,400 tons. The bridge was designed by the Strauss Trunnion Bascule Bridge Company, of Chicago, under the direction of Mr. P. B. Motley, engineer of bridges for the Canadian Pacific Railway. It was fabricated in the Davenport works of the Canada Foundry Company, and all calculations in regard to counterweight were worked out in their engineering department, after the shop drawings were made. The entire electrical equipment was furnished and installed by the Canadian General Electric Company, Limited.

ELECTRIC RAILWAY CONVENTION IN ATLANTIC CITY.

The American Electric Railway Association, whose company members represent over 36,000 miles of track, more than 76 per cent. of the total in the United States, will hold its Thirty-second Annual Convention in Atlantic City, October 13th to 17th. The preliminary announcement of its programme indicates the growing attention which public service corporations are giving to the matter of relations with the public and employees. Technical matters, being left largely to the allied associations, composed of the technical men of the business, the parent association, in which are found the heads of the companies, devotes its attention largely to subjects of general interest to the industry.

Profit-sharing with Employees, The Relation of Carriers to the Development of the Territory They Serve, The Relief of City Congestion, Present Tendency of Public Service Laws and Regulations, Valuation, and Electric Railway Securities from the Investor's Viewpoint, are some of the subjects which will be discussed.

Among the speakers will be Frank Hedley, vice-president of the Interborough Rapid Transit Company, of New York; Paul Shoup, president, Pacific Electric Railway Company, Los Angeles; C. S. Sergeant, vice-president, Boston Elevated Railway Company; J. J. Burleigh, vice-president, Public Service Corporation of New Jersey; W. F. Ham, vice-president of the Washington (D.C.) Railway and Electric Company; C. L. S. Tingley, vice-president of the American Railways Company, Philadelphia; C. N. Duffy, vice-president, the Milwaukee Electric Railway and Light Company; Richard McCulloch, vice-president, United Railways Company, of St. Louis; C. W. Beall, of Harris, Forbes & Company, New York; A. D. B. Van Zandt, Detroit United Railway Company; David W. Ross, vice-president, Interborough Rapid Transit Company, New York; Frank Bergen, general counsel, Public Service Corporation, of New Jersey; C. M. Rosecrantz, general counsel, the Milwaukee Electric Railway and Light Company, and Assistant Surgeon-General W. C. Rucker, of the United States Bureau of Public Health.

NEW JERSEY REGULATIONS FOR THE DESIGN OF SEWERAGE SYSTEMS AND DISPOSAL WORKS.

At a recent meeting of the Board of Health of the State of New Jersey, a set of rules and regulations governing the submission of designs for waterworks or sewage works were adopted. These rules have been under consideration for about a year, and the necessity for them has increased daily. Plans are submitted at the present time in all sizes up to 6 feet by 10 feet, and on all kinds of paper from the wrapping kind up to tracing cloth. It is also an unfortunate circumstance that some few engineers who have worked along other lines will accept work designing municipal sewage disposal or water purification plants apparently without investigating the underlying principles as thoroughly as is desirable. It then becomes necessary for the authorities to gather detailed data regarding the project, which very often cannot be done as efficiently as would be best because of the small number of engineers which may be employed with the present annual appropriation.

The present rules are therefore intended to prevent loss of time incident to the collection of fundamental data, upon which the design is based, and also to make the plans and reports more uniform in character. Before taking final action they were submitted to several of the leading sanitary engineers, with the request that comments and criticisms be made, so that no unjust provisions should be included which would cause unnecessary hardship or expense upon the part of the engineers. Many helpful suggestions were made by these engineers.

The following is extracted from the adopted rules and regulations:—

Sewerage Systems and Sewage Disposal Works.—The plans for a complete sewerage and sewage disposal system shall include the following:

A general map of the municipality or sewerage district.

Profiles of all sewers proposed.

Details of construction of manholes, flush tanks, and special structures pertaining to the sewers.

General and detailed plans for disposal works.

A comprehensive report upon the proposed system by the designing or consulting engineer. This report to be typewritten upon letter-size paper, and the sheets firmly bound together.

A preliminary report, containing data and information sufficient for the complete understanding of the project may be submitted to the State Board of Health for their consideration, prior to the submission of detailed plans.

Map or General Plan.—The general plan referred to shall be drawn to a scale not greater than 100 nor less than 300 feet to 1 inch, and shall show the entire area of the municipality or district. If the municipality is greater than two miles in length the map may be divided into sections, conforming in size to those mentioned under "Drainage." The sheets shall be bound together and a small index map supplied, showing by number the area covered by the various sheets. A general plan shall accompany each application, in the case of a new sewer system or any extension or modification of any existing sewer system unless such general plan has already been submitted.

The map shall show all existing or proposed streets, the surface elevations at all street intersections, and contour lines at intervals of not more than 10 feet.

If it is intended to defer the construction of sewers in some of the streets, the plan shall show that sewerage facilities are provided for all such sections of the municipality or sewerage district. The plans shall also clearly show the location of all existing sewers, either "separate" or "combined," the location of the disposal works, and the location of existing and proposed sewer outlets or overflows. The true or magnetic meridian, the town or borough lines, title, date, scale, direction of flow and average water elevation of the stream shall also be clearly shown. The elevation of the highest known freshets at the outlets and site of the disposal plant shall be given. Any area from which sewage is to be pumped shall be shown by light shading, coloring or other distinctive marks.

Letters and figures shall be clearly and distinctly made. Sewers to be built at present shall be shown by solid lines, and sewers to be constructed later shall be shown by a line of dashes, as - - - - - - - - -. Existing sanitary sewers shall be shown by the following symbol, ..., and combined sewers by a dot and dash, .—.—.—. All topographical symbols used are to be the same as those of the United States Geological Survey.

Elevations of the surface of the streets should be placed outside the street lines in the upper right angle, or opposite their respective positions in the street. The elevations of sewer inverts should be shown at street intersections, ends of line, and wherever a change of grade occurs. The elevations of the sewer shall be written close to the point to which they refer, parallel with the sewer line and between the street lines. The elevations of surface shall be shown to the nearest 1/10 foot; those of the sewer invert to the nearest 1/100 foot. The sizes and gradients of all proposed and existing sewers shall be marked along the line of the sewer.

All sewer appurtenances and unusual features, such as manholes, lampholes, flush tanks, siphons, pumps, etc., shall be designated on the plans by suitable symbols and referenced by a legend near the title.

Profiles of all sewers over 8 inches in diameter and of all 8-inch sewers, where gradients less than that given below are used, shall accompany the application. Profiles of all sewers must be approved before they are constructed.

Profiles of sewer lines shall be prepared and drawn to such a scale as to clearly show the structural features of the sewer. For ordinary use, the following scales are suggested: Vertically, 10 feet to 1 inch; horizontally, 100 feet to 1 inch. Both scales must be clearly shown upon each sheet. Upon these profiles shall be shown all manholes, flush tanks, lampholes, siphons, and stream crossings, with elevations of stream bed and normal water. Figures showing the sizes and gradients of sewers, surface elevations, sewer inverts, etc., should be shown with the same frequency as required for the map.

Grades, Etc.—The following gradients for sewers flowing half full are suggested as minimum grades for ordinary use, as with careful construction a theoretical velocity of approximately two feet per second can be obtained:—

Size of pipe.	Fall in feet per 100 feet of sewer.
8 inches	0.40 feet
10 inches	0.29 feet
12 inches	0.22 feet
15 inches	0.16 feet
18 inches	0.12 feet
20 inches	0.10 feet
24 inches	0.08 feet

The sewers should have a capacity when flowing half full sufficient to carry twice the future average flow twenty-five years hence, plus a sufficient allowance for ground water infiltration.

When grades lower than those given are used, an explanation and reasons for the use of such grades should be included in the engineer's report. On each sheet of profiles must be given, under the title, an index of the streets appearing on that sheet. Profile sheets shall be numbered consecutively.

Detail drawings of sewer sections except where terra cotta or iron pipe is used, and of all sewer appurtenances, such as manholes, lampholes, flush tanks, inspection chambers, siphons and any special structures, shall accompany the general sewer plans.

The detail plans shall be drawn to such a scale as to show suitably and clearly the nature of the design and all details, such as manhole frames and covers, iron pipes, valves, gates, etc.

Disposal Works.—The plans for the disposal works shall include a general plan upon which reserve areas or future extensions are clearly shown, and detail plans of the various units and structures which comprise the plant.

A weir or other measuring device shall be provided at some convenient point, and the installation of a recording device is recommended, and in particular instances may be required.

The detail plans shall show longitudinal and transverse sections sufficient to explain the construction of each unit. They should also show the distributing and drainage systems, general arrangement of any automatic devices, sizes of stone, gravel, or sand used as filtering material, and such other information as is required for the intelligent understanding of the plans.

Drawings.—All drawings submitted shall be neatly and plainly executed and may be traced directly on tracing cloth, printed on transparent cloth, or printed on any of the various papers which give distinct lines. All prints shall be clear and legible.

With the exception of the map, the following dimensions are suggested for ordinary use: Distance from top to bottom, 20 or 30 inches; length, 24 inches, 32 inches, 40 inches or 48 inches, or thereabouts. By this section it is intended to prevent the use of long profiles and unnecessarily large maps, which are difficult to file or to use.

Each drawing shall have legibly printed thereon the name of the town or persons for whom the drawing is made, the name of the engineer in charge, the date, the scale, and such references in the title as are necessary for the complete understanding of each drawing.

A report, written by the designing or consulting engineer, should accompany all plans for complete sewerage systems, and shall give all data upon which the design is based, such as:

Information Concerning Sewer Systems.—(a) The nature and extent of the area which it is proposed to include within the present system of sewerage, and of the area which it is planned shall ultimately drain into this system.

(b) The population to be served, both present and estimated for twenty-five years hence.

(c) The estimated per capita daily flow of sewage to be cared for.

(d) The total and per capita water consumption of the town at the present time.

(e) The allowance made for leakage into the sewers.

(f) The estimated daily flow of sewage, including leakage.

(g) The character of the sewage (whether domestic or including manufacturing wastes, and in case of the latter, the nature and approximate quantity of the same stated in specific terms).

(h) Method of flushing or periodically cleaning the sewers.

(i) That portion of the sewers to be built at the present time.

(j) The minimum grades of sewers for each size used.

(k) If there are sections which cannot drain into this system, the extent of such sections and the probable future disposition of the sewage from these sections.

(l) Distance of sewer outlet from shore and depth of water at mean tide at outlet, if outfall discharges into ocean or large stream.

A list of bench marks or fixed elevations should be included in this report.

Information Concerning Disposal Plant.—With regard to the disposal plant, the engineer's report shall cover the following subjects:—

(a) The method of disposal to be adopted and a description of the units of the system.

(b) The rate of working of each unit.

(c) If disinfection is to be used, the name of the disinfecting substance, the quantity per million gallons of sewage and the method of application.

(d) The nature of the body of water into which the effluent discharges, with particular reference to the run-off during dry weather.

(e) The disposal of sludge.

(f) All conditions peculiarly characteristic of the locality and which in any way affect the design of the system.

(g) Special devices used in connection with the disposal system.

(h) Special methods of maintenance or operation of the system.

(i) The results expected from the purification system.

(j) Explain any provisions for reserve units in pumping plants, pipe lines, filters, etc.

Specifications and Estimate of Cost.—Specifications for the construction of the system of sewers and sewage disposal works and an estimate of the cost of the same shall accompany all plans for new or original systems. With plans for extensions of existing systems, specifications may be omitted, provided that these extensions are to be constructed in accordance with specifications filed previously with original plans.

If the plans are solely for the extensions of an existing system, then only such information as is necessary for the comprehension of the plans will be required. This information must in general conform to the above requirements for a complete system.

Systems on Separate Plan.—Under ordinary circumstances the board will approve such plans only when designed upon the separate plan, in which all rain water from roofs, streets and other areas and all ground water, other than unavoidable leakage, is to be excluded.

No by-passes which may allow raw or partly purified sewage to be discharged from the sewers or disposal works shall be included in the plans, except by special permission of the board.

Water Supply and Water Purification Systems.—The plans for a complete water supply and water purification system shall consist of the following parts:

A general plan of the municipality or district, showing the proposed system.

Detailed drawings showing construction of any special structures in the distribution system.

General and detailed plans for the water purification works.

A comprehensive report upon the proposed system by the designing or consulting engineer. This report to be typewritten upon letter-size paper, and the sheets firmly bound together. A preliminary report, containing data and information sufficient for the complete understanding of the project may be submitted to the State Board of Health for their consideration, prior to the submission of detailed plans.

General Plan.—The general map referred to in paragraph 2 shall be drawn to a scale not greater than 100 nor less than 300 feet to 1 inch, and covering the entire area of the municipality or district to be supplied with water, and shall accompany each application in the case of a new water system, or any extension or modification of any water supply or water purification system, unless such a general plan of the entire area has been previously submitted.

If the municipality is greater than two miles in length, the map may be divided into sections, conforming in size to those mentioned under "Specifications." The sheets shall be bound together and a small index map supplied, showing by number the area covered by the various sheets.

This map shall show all existing or proposed streets, the surface elevations of all street intersections, and the elevations of the principal parts of the water system, such as water at the intake, in the reservoir or standpipe, etc. The map should show that water supply facilities can be provided for all sections of the municipality or district, even though the construction of pipe lines in some of the streets is to be indefinitely deferred. The location of intakes, valves, hydrants, reservoirs, pumps, standpipes and purification plant, and any special structures, shall be shown and referenced in a legend near the title. The size of pipes shall be written between the street lines and along the pipe. The map shall also show the true or magnetic meridian, title, scale, date, the municipal or district boundaries, the mean, low and high water elevations of water at the intake. If the site of the pumping plant is subject to flooding, the elevation of the highest known flood water must be given.

Letters and figures shall be clearly and distinctly made. Pipe lines to be built at present shall be shown by solid lines and those to be later constructed shown by broken lines. All topographical symbols used are to be the same as those used by the United States Geological Survey.

The elevations of the street intersections shall be placed outside the street lines in the upper right-hand angle or opposite their respective positions in the street.

Detail drawings of all special appurtenances, such as blow-offs, siphons, intakes, conduits, reservoirs, collecting galleries, filters, etc., shall be submitted.

Profiles of long conduits or pipe lines may be plotted to a convenient scale and shown on sheets of the sizes mentioned below.

Purification Works.—The plans for the purification works shall consist of a general plan upon which reserve areas or future extensions must be shown, and also the general layout of the various units of the process, together with the piping system.

The detail drawings shall include longitudinal and transverse sections sufficient to show the construction of each unit and part of the plant. They shall also show the distributing, drainage and cleansing systems, general arrangement of any automatic devices, sizes and depth of stone, gravel or sand used for filtering material, and such other information as is required for the intelligent understanding of the plans.

All drawings submitted shall be neatly and plainly executed and may be traced directly on tracing cloth, printed on transparent cloth or printed on any of the various papers which give distinct lines.

The following dimensions are suggested for ordinary use, with the exception of the general map: Distance from top to bottom, 20 or 30 inches; length, 24 inches, 32 inches, 40 inches or 48 inches or thereabouts. By this section it is intended to prevent the use of unnecessarily long or large maps, which are difficult to file or to use.

Each drawing shall have legibly printed thereon the name of the municipality or persons for whom the drawings are made, the name of the engineer in charge, the date, the scale, and such references in the title as are necessary for the complete understanding of each drawing.

Engineer's Report.—A report, written by the designing or consulting engineer, shall be presented with all plans for complete systems, and shall give all data upon which the design is based or which is required for the complete understanding of the plans.

When a purification or treatment plant is to be constructed, a measuring device shall be provided at some convenient point, and the installation of a recording device is recommended, and in particular instances may be required.

If no purification process is provided, the nature and extent of the watershed, with special reference to its sanitary condition, shall be fully and explicitly discussed, together with proposed methods and regulations for the prevention of accidental or other pollutions.

A small scale map of the watershed, showing the roads and the number and character of buildings, shall be included in the report. Other features which should be discussed in the report are: Storage capacity, average depth, general nature and area of the storage reservoir, liability of odors or tastes in supply, and removal of color, iron, or hardness.

If the water supply is to be taken from wells, describe the number, depth, size and construction of the same;

method of pumping, capacity of pumps, kind of strainer used, nature of ground through which wells will be driven, and probable flow of the wells. If collecting galleries are to be used, describe their construction.

Information Concerning Purification Plant.—The following information is required respecting the purification plant: The method of purification and a description of the units of the system; the rate of operation of each of the systems; the rate of operation of each unit of the plant; if any chemicals are used, the nature and quantity of each with a description of the appliances for adding the same to the water; a description of all conditions peculiarly characteristic of the water or locality which in any manner affect the design or operation of the system; a description of all special appliances used, any special methods of maintenance or operation of the plant, and the extent of purification expected or guaranteed.

If for purposes of fire protection it is necessary to provide by-passes, by which partly treated or raw water can be turned into the mains, they shall have valves upon them of such a character that they may be properly sealed by the State Board of Health.

The report should further include a description of the nature and extent of the area to which it is proposed to supply water, or which will ultimately be supplied from the system, the quantity of water to be supplied daily, and the population to be served, the portion of the system to be constructed at present and the minimum depth of pipe below the surface of the ground. A description of any provision for future units of pumping plants, filters, etc., should be given.

Should there be areas in the municipality or district which, on account of topography or for other reasons cannot be supplied with water, a definite statement to this effect must be made and the probable future supply of this omitted territory should be discussed.

Specifications.—Specifications and an estimate of the cost for the construction of water supply and water purification systems shall accompany all plans for new or original systems. With plans for extensions of existing systems or plants, specifications may be omitted, provided that these extensions are to be constructed in accordance with specifications filed with the original plan.

Extensions of Present Systems.—If the plans are solely for the extension of the existing system, only such information as is necessary for the comprehension of the plans will be required. This information shall, in general, conform to the above requirements for a complete system.

The application for approval of plans shall be made by the proper municipal authorities, persons for whom the work is to be done, or their properly authorized agents, upon blank forms, which will be supplied by the board.

The above regulations were prepared by C. G. Wigley, engineer of the board, under the supervision of R. B. Fitz-Randolph, chief of the Division of Food, Drugs, Water and Sewerage, and adopted by the Board of Health of the State of New Jersey, June 23, 1913.

MEETING ON IRON AND STEEL.

A meeting of the American Institute of Mining Engineers under the auspices of the Iron and Steel Committee of the Institute, will be held in New York on October 16 and 17.

THE FINANCING OF ROAD ENGINEERING.

RECENTLY The Surveyor (London) published an article by Reginald Ryves, A.M.I.C.E., containing suggestions as to the policy which should be adopted in the United Kingdom for the raising of funds for road maintenance and improvement, and as to the manner in which these funds should be expended. Highway finance is a very different problem in Canada from what it is in the British Isles, where roads are short and population is dense; but there are many suggestions in the article mentioned which Canadian highway engineers will find practical.

The papers contributed to the Third International Road Congress on the subject of highway finance do not admit of summary in a form conveying correct ideas as to the merits of different methods of raising and applying revenue for road construction and maintenance; the reports are, nevertheless, very illuminating if we study the methods pursued in each country with due consideration for the prevailing circumstances. In nearly all countries the financing of road construction and maintenance is closely bound up with or is greatly influenced by the general principles of taxation adopted, and beyond this the methods followed depend very much upon the stage of development which the road system has reached. In some countries considerable sums are raised by the taxing of vehicles and from tolls, and in some cases payments are exacted from persons who habitually, or occasionally, use the roads in such a manner as to cause unusual wear and tear. In India vehicles are taxed and tolls are collected, and in some parts of that country the sums raised from tolls collected by the district boards are not only sufficient to defray the expenses of maintaining the roads, but leave considerable surpluses for other purposes. Such a tax is not more unreasonable in principle than the tax in this country upon certain classes of users of postal services, who pay much more than the cost of the service for the benefit of the country at large.

The expediency of any system or of particular measures depends upon the relations otherwise established between local and national finances, which may vary greatly, the national treasury being, in some countries, largely replenished by contributions from local taxation.

We have also to consider the extent to which the roads are used by certain groups of traders as well as in general trade and commerce, the manner in which the population is distributed, and the nature of their occupation. The equity of any particular system also depends upon whether the soil and climate, taken together, are much more favorable to road maintenance in some localities than they are in others. In countries in which the climate is much the same in all parts, and where the geological conditions are equally favorable as regards the cost of maintaining roads, and where, further, the population and local resources are fairly evenly distributed, it may be equitable and economical to charge the local authority with the cost of maintaining all roads, even when some of these carry a large proportion of through traffic.

When, however, the main roads traverse varying strata and areas differing considerably in climate, and where the population is unevenly distributed, and is engaged in many different callings, it is not equitable to charge the local authority with the cost of maintaining

*The reader is referred to an article in last week's issue descriptive of the Road Board and its methods of financing.

roads for through traffic, and may even be inequitable to make each authority maintain the roads for local traffic, unless the area of any such authority is fairly large. In an almost purely agricultural country, or one in which the distribution of industries and of the soils is very symmetrical, the consideration that the more costly roads are usually those running through rich soils is of some importance; but it is of very small importance in a country which is complex as regards soils, climates, and the distribution of population and of wealth, more especially when the population of that country includes a large spending element as distinct from the elements of primary economic significance.

The United Kingdom is such a country. In it financial equity can only be secured by defraying a considerable part of the costs of road maintenance out of the King's taxes, and a fair economic distribution of burdens can only be secured by something in the nature of a wheel tax, the whole of which would not necessarily be paid by those upon whom it was imposed, but would naturally be to a great extent, distributed among the persons directly or indirectly benefiting from the carriage of goods over the roads. The customer pays. All classes do not benefit equally from the existence of an efficient highway system, and those who use the roads as a means of rapidly amassing wealth, or as an accessory in the dissipation of wealth, should be taxed to pay for road maintenance, not only because they use the roads for such purposes, but also because they are the strong, active and efficient elements in the community. To a considerable extent roads are maintained by persons who use them and benefit by them less than any other classes of the community. It is desirable that taxes raised from users of the roads should be devoted to road maintenance, not as a punishment for the use of the roads, but because there will be a constant proportion between the amount of wear and tear and the amount of money raised, and it is here suggested that a wheel tax should be imposed on all vehicles, including bicycles, for the purpose of road maintenance. The sums raised from motor and petrol taxes should be included. These sums are at present devoted to a quite distinct purpose—that is, road improvement. This is much better than carrying out such improvements by means of loans (the loans granted by the Road Board* being only such in a secondary sense, and involving no charge upon the community for interest), but this must be regarded as a temporary expedient for rendering the road system as a whole more effective, and the aim should be to establish a state of equilibrium in which all sums raised by taxes on vehicles should be devoted to road maintenance, and to such minor improvements as do not lead to an increase in the cost of maintenance.

So far the improvements carried out with the Road Board funds have largely been, as a Scottish reporter to the Road Congress has expressed it, "quasi-permanent" rather than permanent in the true sense, and no attempt has yet been made to undertake generally such engineering works as are needed in some cases to make roads more efficient, and, in many other cases, to render them less costly in annual maintenance. It should be clearly understood that the policy here advocated—viz., the attainment of an equilibrium, and the allocation of Road Board fund to road maintenance proper—includes as a preliminary the extension of the wheel tax at the earliest possible date, the "hoarding" of Road Board funds until a sufficient sum is in hand and the carrying out once for all in each case, on definite stretches of road, such improvements as are necessary. It is further suggested that the expenditure of the Road Board fund should be to some extent rhythmic, and that, in addition to the annual expenditure on maintenance, there should be a steady hoarding of a surplus to be devoted, from time to time, to works of road improvement. One advantage of this system would be that, while the money was accumulating, there would be time for investigations into the different schemes of road improvement put forward, for the preparation of the plans, and for all preliminary work, so that when the time came to spend the money the whole of the improvements staff could be employed in furthering the executive work. Outside the larger cities, at any rate, the carrying out of road improvements by means of loans on which interest has to be paid is not sound finance. How can it be good finance to pay, say, £1,600 for an improvement which actually cost only £1,000? In the case of a long-term loan the total sum paid may be more than twice that actually expended on the work.

In the United Kingdom the conditions of trade and of business and personal activitity generally are such that a wheel tax on the broadest possible basis is a very fair method of raising revenue for the purpose of maintaining roads. If it can be argued that persons who do not use the roads benefit indirectly as much as those who do use the roads, it may equally well be argued that persons who do not actually use vehicles pay indirectly a full share of the cost of running such vehicles as are used in the distribution of goods. With a better organization of road maintenance, including an increase in the sizes of administrative areas, closer relations between one highway authority and another, and some general supervision of finance, procedure and staffs, by a body such as the Road Board, the funds raised at present by local taxation, added to those derived from vehicle and petrol taxes, and increased by an extension of the wheel tax would, it may safely be asserted, be amply sufficient for all purposes of road maintenance for a very long time to come.

CORUNDUM.

In spite of the large increase, in late years, in the manufacture and consumption of artificial abrasives, such as carborundum, alundum, etc., natural corundum is still preferred for certain purposes, and the Canadian deposits of this mineral yield practically the entire supply. In 1912 the production amounted to 1,960 tons, valued at $239,091, according to statistics contained in Economic Minerals and Mining Industries of Canada, by J. McLeish.

The corundum mines are situated in the eastern portion of the province of Ontario, in the townships of Carlow and Raglan, and mining operations have been in progress since 1900. At present, mining is being conducted solely by one corporation—the Manufacturers' Corundum Company—who have acquired the mines and mills formerly operated by the Ontario Corundum Company, in Carlow, and the Canada Corundum Company, in Raglan.

The corundum occurs in the form of crystals of various sizes, disseminated in syenite, and is won by quarrying the matrix, hand-sorting the broken rock, and crushing the richer material, with subsequent wet concentration. The average corundum content of the rock treated does not much exceed 6 per cent., and, as from 1½ to 2 per cent. are lost in concentrating, the recovery represents about 4 per cent. of the crude material.

Corundum-bearing rocks were first recognized in this area in 1897, and the mineral is found sparingly, but widely distributed in the rocks of this district.

MECHANICAL GRAVITY FILTRATION AT SASKATOON

TYPICAL RECORDS OF PLANT OPERATION WITH RESPECT TO QUANTITY OF WATER FILTERED, CHEMICAL TREATMENT, BACTERIAL REMOVAL AND COSTS.*—DESCRIPTION OF THE PLANT

By GEORGE T. CLARK,
City Engineer, Saskatoon.

THE city of Saskatoon obtains its water supply from the south branch of the Saskatchewan River. This river and its tributaries are being polluted by the sewage from a number of towns and cities, including Calgary, McLeod, Lethbridge and Medicine Hat. In addition to being contaminated, the water of this river is very turbid at certain seasons of the year, and it is generally believed that a turbidity in the water such as is presented in this case, consisting to a large extent of fine quartz particles, predisposes to enteric conditions.

For these two reasons, therefore, namely, periods of excessive turbidity and danger of contamination, the civic authorities decided that it was advisable to take the necessary steps to purify the water, and the writer was requested by the city to report on the subject of filtration. Before doing so, some filtration plants of different types were visited, including among others those at Albany, N.Y.; Hackensack, N.Y.; Harrisburg, Pa.; Philadelphia, Pa., and Columbus, Ohio; and the outstanding features of each were noted.

Requirements of Water Being Used for Domestic Purposes.—Water which is required for domestic purposes should possess the following qualities:—

(1) It should be free from disease-producing germs.

(2) It should be free from those allied organic forms, which are not conducive to health, although they may not as yet be recognized as accompanying disease.

(3) It must be uniformly clear and free from turbidity, whether such be produced by mineral or organic matter.

(4) It must be free from color, odor and taste.

The methods adopted by the city of Saskatoon to accomplish these results may be divided into three steps, viz., sedimentation, filtration and sterilization.

Sedimentation.—The sedimentation basin has a capacity sufficient to give the water 8 hours' subsidence, when the filter is working at full capacity, and is divided into two parts by a weir wall across the centre. In the north half of the basin, plain sedimentation takes place, and in the south half, sedimentation and coagulation.

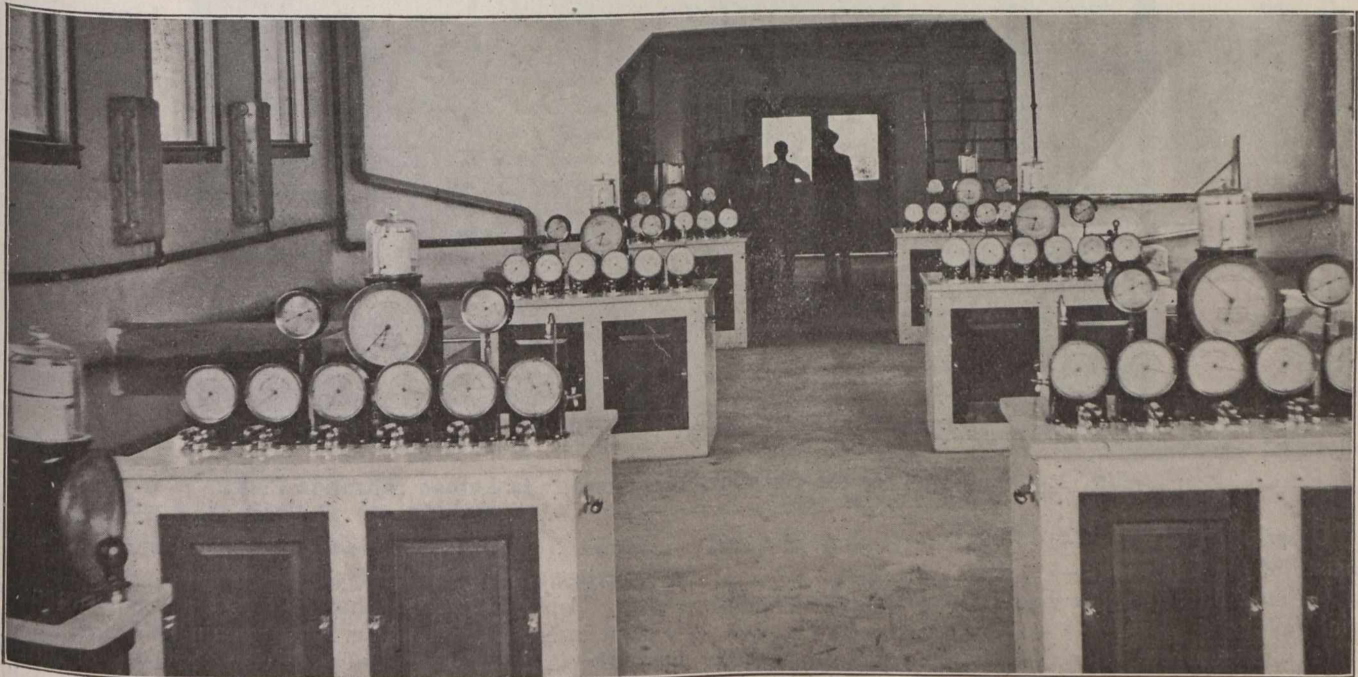


Fig. 1.—Section of Laboratory, Saskatoon Filtration Plant.

The coagulant used is sulphate of alumina, because the water has a sufficient alkalinity content, so that sulphate of alumina presents the necessary reaction to form an alumina hydrate, which, in precipitating, coagulates much of the organic matter, and drags down the finer suspended matter.

Provision has been made for applying the coagulant at three points: (1) When the water enters the basin; (2) when it passes over the weir; (3) just before it enters the filters.

The solution of sulphate of alumina used is 350 lbs. to 1,980 Imperial gallons of water or 1.8% solution.

Filtration.—The three best known types of filters were duly considered before a decision was arrived at, as to which one was best suited to our purpose. A very

* These Tables formed the basis of Mr. Clark's paper to the Canadian Public Health Association in Regina last month.

strong point in favor of the pressure filter was that, with this type of installation one system of pumps would have been all that was necessary to deliver the water from the river direct to the distributing system, whereas, with either of the other two systems a double pumping is necessary. The excessive turbidity of the water, however, made preliminary sedimentation absolutely necessary, and the idea of installing pressure filters had, therefore, to be abandoned. The gravity mechanical filter was chosen over the slow sand type for the following reasons:—

(1) The mechanical filter will handle 50 times more water per unit of area per day than the slow sand filter.

(2) The mechanical filter is, on account of being much smaller in area, much more easily protected from excessive cold.

(3) The initial cost of construction is about one-half.

(4) The cost of operating slow sand filters in the case of highly turbid waters is much in excess of mechanical filters.

(5) Cleaning the surface of slow sand filters requires the dangerous personal contact of workmen.

the form of a .5 per cent solution, and is applied to the water at the point where it enters the filter beds.

The total amount of hypochlorite used by us since the plant was first put in operation in June, 1912, has been only 900 lbs.

Results.—Table I. appended hereto is a typical monthly operating cost sheet. It will be noted that the chief items of expense are salaries of superintendent and operators, and the charge for interest and sinking fund. The cost for filtering for the month of August, 1913, per 1,000 Imperial gallons was 1.93 cents.

Table II. shows in detail the operation of the plant during the month of August. The quantity of water pumped and filtered, the chemicals used, and the turbidity of the water is given for each day.

Table III. illustrates clearly how the amount of coagulant required, and the amount of wash water used, vary directly as the turbidity. The amount of coagulant required varies from about one-quarter to one and one-half grains per gallon with an average for 8 months of ¾ of a grain, while the amount of wash water required

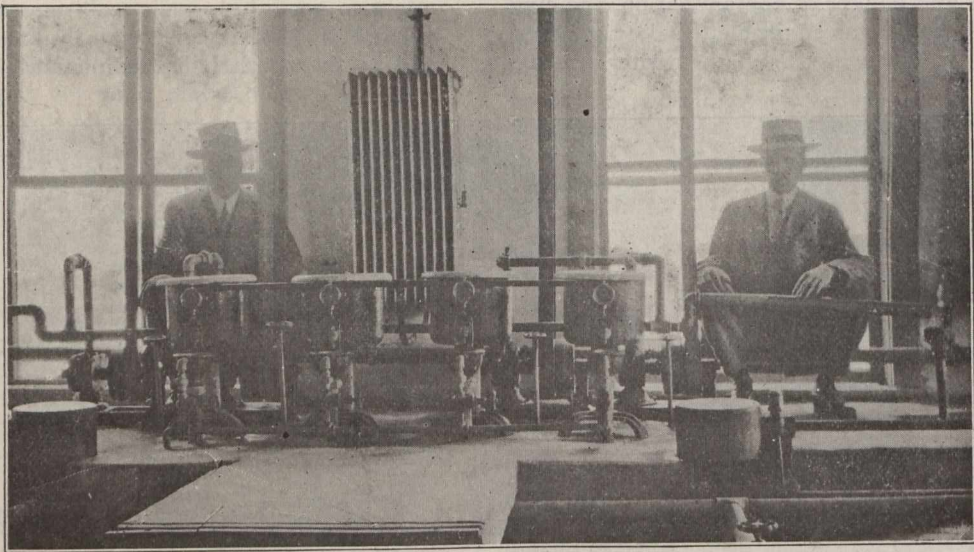


Fig. 2.—Apparatus for the Chemical Treatment, Saskatoon Filtration Plant.

Description of Plant.—The mechanical plant installed consists of the following:—

(1) One filtered water basin, capacity 125,000 Imperial gallons.

(2) Six concrete filter units, each with an effective filtering area of 290 sq. ft. The filtering material consists of an 8-inch layer of gravel, graded in sizes from .2 to .5 of an inch, the larger pebbles being placed on the bottom, and a 30-inch layer of sand graded from .36 of a millimeter to .55 of a millimeter, and consisting of hard silicious material free from vegetable matter or other foreign substance.

(3) A wash water pump and motor.

(4) An air compressor.

(5) A complete apparatus for preparing and feeding sulphate of alumina and hypochlorite of lime.

(6) Hydraulically operated valves for controlling the operations of the filter units.

Sterilization.—This is the third operation, which is sometimes required to be performed in cases where harmful bacteria are still present in the filtered water. It consists in our case of the addition of hypochlorite of lime in

varies from two and one-half to five per cent., with an average for 8 months of 3½%.

Table IV. shows that although the superintendence and interest and sinking fund remain constant, the turbidity is of sufficient range to vary the cost of filtering from a minimum of 1.4 cents per 1,000 Imperial gallons to a maximum of 2.16 cents, or an average for the eight months of 1.77 cents.

It is of interest here to note that the turbidity of the South Saskatchewan River water varies from 30 to 3,750 parts per million.

Table V. shows the bacterial removal efficiency for 8 months. For 6 months the removal has been 97%. For the month of February the removal was only 80%, but the bacterial count in the raw water was very small. The high count in the raw water in March is accounted for by the melting of the snow during that month, and the consequent depositing in the river of the filth collected in the snow during the winter months, and also by the increased volume of water underneath the ice scouring the river bottom.

A study of these records shows that the plant has, in respect to wash water required and bacterial removal, ful-

Table II.—Summary of Water Filtered and Chemical Distribution for Month of August.

Date.		Venturi, gallons per day.	Wash-water, gallons per day.	Alum used, grains per day.	Alum used, grains per gal.	Chloride, grains per day.	Chloride, grains per gal.	Turbidity, raw.	Turbidity, treated.
August	1st ...	2,043,000	72,000	1,208,644	0.57	123,600	0.058	130 p.p.m.	100 p.p.m.
“	2nd ...	2,027,000	72,000	938,304	0.45	185,380	0.089	130 “	100 “
“	3rd ...	1,468,000	72,000	982,584	0.64	77,250	0.05	130 “	100 “
“	4th ...	2,082,000	72,000	1,009,152	0.45	47,628	0.06	110 “	65 “
“	5th ...	2,081,000	72,000	1,009,152	0.45	126,908	0.059	120 “	65 “
“	6th ...	1,856,000	72,000	912,744	0.47	63,504	0.060	120 “	100 “
“	7th ...	1,827,000	72,000	623,520	0.33	0	0	100 “	90 “
“	8th ...	1,772,000	72,000	752,084	0.41	0	0	100 “	90 “
“	9th ...	1,643,000	72,000	623,520	0.36	0	0	100 “	85 “
“	10th ...	1,464,000	.....	623,520	0.43	0	0	75 “	55 “
“	11th ...	1,706,000	72,000	703,860	0.4	0	0	75 “	55 “
“	12th ...	1,737,000	60,000	623,520	0.35	0	0	75 “	55 “
“	13th ...	1,817,000	60,000	691,584	0.35	0	0	95 “	75 “
“	14th ...	1,688,000	60,000	665,860	0.38	0	0	75 “	55 “
“	15th ...	1,748,000	60,000	666,060	0.36	0	0	65 “	50 “
“	16th ...	1,793,000	60,000	666,060	0.36	0	0	65 “	45 “
“	17th ...	1,487,000	.....	623,520	0.40	0	0	65 “	45 “
“	18th ...	1,750,000	60,000	623,520	0.34	0	0	80 “	55 “
“	19th ...	1,660,000	60,000	768,132	0.45	0	0	130 “	80 “
“	20th ...	1,842,000	60,000	1,328,863	0.7	0	0	180 “	70 “
“	21st ...	1,701,000	60,000	1,238,823	0.7	74,088	0.07	150 “	45 “
“	22nd ...	1,869,000	60,000	1,210,000	0.63	127,008	0.066	180 “	45 “
“	23rd ...	1,893,000	50,000	1,210,008	0.62	127,008	0.065	250 “	65 “
“	24th ...	1,559,000	60,000	1,067,728	0.66	127,008	0.078	200 “	70 “
“	25th ...	1,937,000	60,000	1,158,203	0.58	68,790	0.06	180 “	70 “
“	26th ...	1,917,000	72,000	1,702,913	0.8	108,528	0.09	250 “	70 “
“	27th ...	1,920,000	72,000	1,953,542	0.98	186,048	0.093	350 “	65 “
“	28th ...	1,856,000	72,000	1,869,999	0.96	186,048	0.096	400 “	45 “
“	29th ...	1,910,000	72,000	1,524,839	0.76	54,264	0.094	300 “	30 “
“	30th ...	2,061,000	72,000	1,438,727	0.69	0	0	300 “	35 “
“	31st ...	1,347,000	72,000	1,451,200	1.plus	0	0	500 “	100 “
		55,361,000	1,922,000	31,870,204	0.556	1,683,060	0.063		

Water pumped to city mains.......55,361,000 gallons
Wash-water used .... 1,922,000 “

Total water filtered ....57,283,000 gallons

Pounds of sulphate of alumina 4,552.8
Pounds of hypochlorite of lime used 240
Average turbidity of raw water ....167 p.p.m.
Average turbidity of treated water .... 67 p.p.m.
Per cent. reduction turbidity by sedimentation 60 p.p.m.

filled the guarantee given by the Roberts Filter Manufacturing Company who installed it.

Table I.—Monthly Expense Report for the Month of August, 1913.—Filtration Plant.

Salaries of operators and superintendent .....$	315.00
Bacteriologist	58.33
Additional labor, none	
Alum, 4,550 lbs. at $2.25 per cwt............	102.37
Hypochlorite, 240 lbs., at $2.74 per cwt.	6.58
Wash water, 1,922,000 gallons at 6 cents per 1,000 gallons	115.32
Stores, none	
Power, 1,077 kw.h. at 6 cents per kw.h.	64.62
Light, 235 kw.h. at 6 cents per kw.h.	14.10
Heat, none	
Repairs, none	
Laboratory, fixed charge of	25.00
Interest and sinking fund	400.00
Total cost for the month ....$	1,101.32

Water filtered for month, 57,283,000 gallons.
•Cost of filtering, per 100,000 gallons, $1.93.

Table III.—Summary Showing Average for Eight Months' Operation.

	Alum.	Wash-water.	Filtered water.	Cost per 1,000 gals.
Jan.	None	1,300,000	78,095,704	1.23 cents
Feb.	None	1,213,968	75,631,738	1.19 “
Mar.	1,900	2,323,000	82,321,140	1.27 “
Apr.	19,380	4,388,880	79,591,588	2.04 “
May	11,580	2,800,000	61,919,060	2.13 “
June	12,675	2,842,800	59,416,800	2.30 “
July	7,475	2,316,000	58,541,000	2.04 “
Aug.	4,550	1,922,000	57,083,000	1.93 “
	57,560	19,610,640	552,600,030	14.13 cents

Average grains of alum per gallon for period of excessive turbidity 1.52
Average grains of alum per gallon for period of normal turbidity 0.28
Average grains of alum per gallon for period of eight months 0.73
Average amount of wash-water for period of excessive turbidity ....4.9 %
Average amount of wash-water for period of normal turbidity 2.58%

Average amount of wash-water for period of eight months 3.45%

Table IV.—Average Cost of Operation.

Average cost of filtering 1,000 Imperial gallons during period of excessive turbidity .....2.16 cents
Average cost of filtering 1,000 Imperial gallons during period of normal turbidity ....1.4 "
Average cost of filtering 1,000 Imperial gallons during period of eight months ....1.77 "

Table V.—Bacterial Removal.

Month.	Bacteria. Raw water.	Bacteria. Filtered water.	Efficiency. Per cent. removal.
January, 1913	27.0	1.4	98.5
February	2.5	0.5	80.0
March	11,144.0	16.0	99.8
April	4,644.0	20.0	99.6
May	4,172.0	37.0	96.7
June	2,553.0	28.0	99.0
July	7,358.0	21.0	99.7
August	2,199.0	42.0	98.1

THE LINCOLN HIGHWAY.

Thirteen States will be traversed by the Lincoln Highway, the route of which has been definitely announced. They are New York, New Jersey, Pennsylvania, Ohio, Indiana, Illinois, Iowa, Nebraska, Wyoming, Colorado, Utah, Nevada and California.

Starting in New York City, the Highway passes through Jersey City, Newark and Trenton to Philadelphia, then west to Pittsburg, through the north central section of Ohio, over to Fort Wayne and South Bend, skirts Chicago, enters Joliet, Rochelle, Sterling and other Illinois cities, reaches Iowa at Clinton and leaves at Council Bluffs, passes through Omaha, goes to Denver and north to Cheyenne, west through Green River and Evanston to Salt Lake City, finds its way into Nevada by way of Tippet's ranch, and after reaching Reno, goes to Lake Tahoe, California, finally ending on the Pacific seaboard at Oakland and San Francisco. The directors of the Association have endeavored to select a route of easy grades, yet combining the scenic splendors of the country.

Makers of carbon black at Wilsonburg, W. Va., obtain free power in a novel manner. The product is deposited from the flames of natural gas, and power was originally supplied by a steam boiler and engine. The gas issued at a pressure of 950 pounds from a well 3,000 feet deep. It was suggested that this pressure might be utilized, and accordingly the gas was led in place of steam to the engine, which was thus driven, and acted as a reducing valve, delivering the gas at low pressure to a discharge tank feeding the carbon buildings. The engine, requiring no attendant, continues to give uniform and satisfactory service.

The Canadian General Electric Company, Limited, have just acquired by purchase all the plant and assets of the Stratford Mill Building Company, at which plant in future will be manufactured not only the flour mill machinery heretofore manufactured by the Stratford Mill Building Company, but also the wider range of machinery and equipment as produced by the Allis-Chalmers Company. Mr. William Preston, who has been the president of the Stratford Mill Building Company, will now act as manager of the flour mill machinery department of the Canadian Allis-Chalmers Company.

BELT CONVEYERS.

By Reginald Trautschold, M.E.

(PART II.)

(Continued from page 480, Sept. 18th issue.)

THE operation that presents the greatest difficulty in any belt conveyer system, if wear and tear are to be kept at a minimum, is that of loading the conveyer, for it is at the instant that the load comes in contact with the conveyer belt that the main wear occurs and greatest depreciation of equipment takes place. Loading should always—when practicable—be accomplished through chutes discharging in the direction of conveyer travel, and it is in the design of these chutes that one of the greatest problems of an efficient installation is presented. The slope of the chute should be such that the velocity of the material as it leaves the chute is as nearly as possible the same as that at which the conveyer belt is running. The bottom of the chute should also be provided with an adjustable curved lip, conforming to the trough of the belt and turning upward sufficiently to throw its discharge forward in a plane approaching that of the conveyer belt, thus minimizing the shock of impact as the load strikes the belt and is carried forward by it. The loading chute should always be located slightly in advance of a troughing idler and should be provided with parallel skirt boards extending along the conveyer and parallel to the belt, an inch or so above it, for a distance equal to about twice the distance between troughing idlers—i.e., a troughing idler should be located just back of the chute, one not quite midway along the skirt boards, and one just before the load leaves the confines of the guides. These skirt boards should be separated by a space a few inches less than the width of the belt—less than the section of belt covered with load—and should advisably have triangular cleats attached to their inner sides for the section lying in the path of the material descending the chute—such cleats tend to throw the load towards the centre of the conveyer belt and thus minimize necessary rearrangement of load as it passes from between the skirt boards.

One drawback to what would otherwise be probably about the most efficient and economical mechanical conveying system that could be devised is that belt conveyers are limited as to the inclination at which they can be efficiently operated, necessitating considerable space if any considerable elevation is to be attained; that is, the height through which a load can be raised in a given distance. This limitation is governed to considerable extent by the angle of repose of the material conveyed—particularly the angle of repose of the material on the belt—for just as soon as the inclination of the conveyer is great enough to cause a slippage of the load on the belt disastrous wear occurs and depreciation more than offsets any possible gain of simplicity and convenience of system, etc. The tendency towards agitation of load by oscillation of the loaded conveyer belt as it passes over troughing idlers also augments the harm of excessive inclination of conveyer, so that, with the average class of material handled on such systems, it is dangerous to have the inclination of the conveyer from the horizontal greatly exceed 21 or 22 degrees—equivalent to a rise of about 36 to 37 feet per 100 feet of conveyer. With this one limitation and, of course, the disadvantage that belt conveyers cannot turn corners and must be run, therefore, in one general direction, a belt conveyer may be installed in almost any position, including horizontal, inclined, inclined with horizontal stretches of conveyer and with the belt rising in a gradual curve from a horizontal to an inclined plane. The latter arrangement is theoretically limited to the curve that would be assumed by a fully loaded belt supported only at points of tangency with the horizontal and inclined planes of the conveyer when the tension in the belt is that necessary for the satisfactory operation of the conveyer—the pull required to draw the loaded belt along at the proper speed. This curve would be a parabola, but in practice such extreme refinement of curve is not practicable and the troughing idlers for the curved section of conveyer are usually mounted so that the conveyer belt resting on them will follow the arc of a circle of about 300-foot radius. This proportion is usually satisfactory for belts of any ordinary width and the conveyer fully loaded with the average class of material usually handled by belt conveyers—the fully loaded belt will then rest on the troughing idlers, though the belt of an empty conveyer will frequently not touch them.

It is in the consumption of power that the belt conveyer has a decided advantage over the types of conveyers already discussed, and with its comparatively large carrying capacity, due to the high speed at which it can be run, when handling ordinary classes of material in bulk, it becomes one of the most valuable and economical of labor-saving devices. As in the case of any mechanical type of conveyer, power is required for three distinct operations when operating the system: 1st, for running the conveyer itself, i.e., the power required to operate the driving machinery, pull the belt over the idlers—neglecting all load other than the weight of the moving parts—etc.; 2nd, for conveying the load itself; and 3rd, for elevating the load, should the conveyer be an inclined one. The power required to pull the belt over the idlers varies with the construction of the troughing and return idlers and is naturally considerably less in conveyers with ball-bearing idlers than in conveyers employing less economical mechanisms, but this item of power is in reality but a comparatively small percentage of the total power required and when the inefficiencies and loss of power in the driving mechanisms—usually consisting of a train of gears—is taken into consideration the power requirements for running an empty conveyer really have comparatively little effect upon the total amount of power that must be supplied and may be considered with safety as bearing some definite relation to the width of the belt and the weight of the moving parts. The second demand for power, that for moving the load itself, is not so much effected by the refinements of idler construction and varies practically with the speed of the conveyer and the load handled, irrespective of size of conveyer, etc. Power necessary to elevate the load is very nearly that theoretical amount that would be required to raise the specified load through a vertical distance equal to the difference in elevation between the point at which the conveyer is loaded and the highest elevation to which the load is carried—for practical purposes, the difference in elevation between the two ends of the conveyer—as no appreciable increase in resistance to the movement of load takes place in an inclined conveyer other than the overcoming of the force of gravity. In the derivation of the following formula (Formula XIV.) conservative values for all variable factors—values obtained from numerous experiments and examination of data from a large number of efficient installations of belt conveyers—are employed and the results from its use agree very closely with the power demands for the ordinary efficient installation. Exceptional installations are found that discount this formula but the inefficiencies of the ordinary driving mechanisms make dependence on other formulæ for ascertaining horsepower requirements that give smaller results dangerous. Formula XIV. gives the total horsepower required to drive the average efficient belt conveyer when continuously and uniformly loaded to its capacity, but does not allow for the additional power requirement for trippers or fixed dumps. Such discharging devices all consume approximately the same amount of power, irrespective of load carried, and Formula XIV.-a gives values that should be allowed for each discharging device of such type for conveyers from 12 to 36 inches in width, the average range of sizes found in practice. For conveyers narrower than 12 inches, an allowance equal to that for a 12-inch conveyer should be made for each discharging device and for conveyers of over 36 inches in width the allowance for 36-inch conveyers is usually ample, unless the conveyer should be one of exceptional size. Chart III. gives the same data as Formula XIV. in a convenient form for rapid calculations and sufficiently accurate results are attainable from its use for all practical purposes.

Horsepower:

W = Weight of load handled in tons per hour (capacity).
V = Velocity (speed) of Conveyer in feet per minute.
L = Length of Conveyer in feet—distance between end pulleys.
H = Height to which load is elevated in feet (incl. Conv.)
= Difference in elevation in length of Conveyer.
w = Width of belt (Conveyer) in inches.
W' = Weight of load handled per minute per foot of Conveyer in lbs.
= 2000 W/60 V.
W_b = Weight of moving parts of Conveyer (belt) per foot in lbs.
= 0.7425 w.
f_s = Speed factor.
= 0.004 w—from experiment.
f_l = Load factor.
= 0.080—from experiment.

Horsepower required to run Conveyer empty :—

$$= \frac{W_b \times f_s \times V \times L}{33{,}000} \quad \frac{0.00009\, w^2VL}{1000}$$

Horsepower required to convey load :—

$$= \frac{W' \times f_l \times V \times L}{33{,}000} = \frac{0.08\, WL}{1000}$$

Horsepower required to elevate load :—(Inclined Conveyer)

$$= \frac{2000\, W \times V \times H}{60\, V \times 33{,}000} = \frac{WH}{1000}$$

Then, total horsepower required :—

$$HP = \frac{(0.00009\, w^2V + 0.08\, W)L + WH}{1000} \qquad \text{Formula XIV.}$$

Additional horsepower required for each tripper or fixed dump :—

$$HP = \frac{(w - 10)}{8} \qquad \text{Formula XIV-a.}$$

(Conveyers 12″ to 36″ inclusive)

Though exceedingly economical in the consumption of power, belt conveyers are expensive as far as first cost is concerned if satisfactory wear and freedom from the annoyance of break-downs are to be obtained and the true economic value of the equipment realized. That is, all apparatus should be of the highest grade; particularly the belt, which should be, as previously stated, of duck-rubber construction with a suitably thick resilient cover of rubber to withstand the abrasive wear of the load moving on its carrying surface—a certain readjustment in position of load on the belt being unavoidable in even the best designed and most carefully installed conveyers. Owing to the extreme simplicity of construction, the cost of the various component parts of a belt conveyer vary closely either with the width of the belt, as for conveyer pulleys, drive, etc.; or with both the width and length of conveyer, as for idlers, belt, etc., and a conservatively accurate equation can be derived for ascertaining the approximate cost of any belt conveyer of given size. Such an equation follows, Formula XV., which gives the total average cost of a conveyer equipped with a high-grade rubber belt and machinery of a high class. A similar conveyer, equipped with a good grade of stitched canvas conveyer belt, would cost but about half as much and systems may be purchased for any price between these two limits, depending upon the character and quality of the conveyer belt. The best grade of belt is really the most economical, however, as a conveyer so equipped will have a much longer life than one where false economy is attempted by the purchase of an inferior belt whose depreciation is bound to be rapid. In fact, it is only with the highest grade of all equipment that the full economic value of a belt conveyer system can be realized—this point cannot be too strongly emphasized. Table VII. gives equations for ascertaining the approximate cost of the various discharging devices which are customarily employed with belt conveyer systems, all of which vary approximately directly with the width of the conveyer (belt) rather than with the capacity of the system when handling any particular class and weight of material.

Initial Cost:

C = Cost of equipment in dollars.
w = Width of Conveyer (belt) in inches.
L = Length of Conveyer in feet—distance between end pulleys.

Cost of idlers per foot of Conveyer = 0.184 w — 0.899
" belt " " = 0.303 w — 1.261
" other machinery = 4.633 w

$C = (0.487\,w - 2.16)L + 4.633\,w$ Formula XV.

Table VII.—Approximate Cost of Discharging Devices for Belt Conveyers.

Apparatus	Cost in dollars
Automatic Tripper	$15.7833\,w + 189 + 1.13L_t$
Hand-propelled Tripper	$9.0\,w + 106.28 + 1.13\,L_t$
Fixed Dump	$2.8\,w + 16.4$

w = width of Conveyer (belt) in inches.
L_t = Length of Tripper Track—total travel of Tripper.

Although the carrying capacity of a belt conveyer varies with the square of the width of the conveyer belt, the necessity of loading devices, discharging apparatus, etc., that varies in cost with the size of conveyer, permits the expression of the average cost of a belt conveyer system in terms of the carrying capacity of the conveyer—i.e., average carrying capacity. Such classification is not as accurate for ascertaining the approximate cost of such a system as the formula based on the width of the belt, but for purposes of arriving at the average net cost of operation of a system, where only relatively small percentages of the initial cost enter into the question, an equation for approximating the cost of equipment, expressed in terms of the average tonnage per hour capacity, is sufficiently accurate for forming a conservative calculation of the average net operating cost of the ordinary belt conveyer installation. Particularly is this so for installations where the material handled is particularly heavy and where the initial cost ascertained by such an equation would be correspondingly low, the depreciation charge is apt to be very much greater than in an ordinary installation—the two inaccuracies, as to formula, thus tend to compensate for one another and the results obtained by the use of the formula for arriving at the measure of economic value of the system is approximately correct in any case. Depreciation on all component parts of a belt conveyer are not equal, of course, but a fairly reliable average value—one for the relatively expensive belt and the other for the balance of the machinery or equipment—does exist, provided for in the derivation of Formula XVI., which permits a close calculation of the true economic value of any belt conveyer system if the cost of power is known and the system is kept in good working condition and subject to efficient operation—i.e., is used frequently, for no conveying installation can be a really efficient one if allowed to remain idle much of the time.

Net Operating Cost (N.O.C.) of Belt Conveyers:—

L = Length of Conveyer in feet—maximum distance load is carried
H = Height (distance) through which load is elevated.
W = Weight of load conveyed in tons per hour (capacity).
N = Number of hours (total) Conveyer is in use per year.

Average Cost of Equipment:—
= 0.0904 WL + 1.07 W.

Fixed Charges:—

Interest	6% total cost	= 0.00768 WL + 0.091 W
Insurance....	1%	
Taxes	2%—¾ cost	

Depreciation, renewals, etc.:—

On belt	0.01990 WL
machinery	0.00317 WL + 0.107 W
Depreciation account..	0.00025 WL + 0.011 W
Total Depreciation, etc.	0.02332 WL + 0.118 W

Yearly Burden:
= 0.031 WL + 0.209 W

Horsepower, attendance, supplies, etc.:—
P_c = Price (cost) of a horsepower per hour.
Average consumption of power = 0.00021 WL + 0.001 WH

	Horizontal Conveyer	Inclined Conveyer
Cost of Power	$0.00021\,WLNP_c$	$0.001\,WHNP_c$
Attendance, etc.	0.0000122 WLN	negliable
Supplies, etc. ..	0.0000128 WLN	negliable

Burden depending upon use of Conveyer:—
$= (0.00021\,WP_c + 0.000025\,W)LN + 0.001\,WHNP_c$

Then:

Net Operating Cost (N.O.C.) per ton:—

$$N.O.C. = \frac{31000\,L + 209000 + (210\,P_c + 25)LN + 1000\,HNP_c}{1{,}000{,}000\,N}$$ Formula XVI.

Examples.

1. Conditions:—
   Length of Conveyer 100′—0″ = L
   Material Elevated.. 20′—0″ = H
   Service............ 2400 hours per year = N
   Cost of Power .... $0.02 per horsepower per hour = P_c

$$N.O.C. = \frac{3100000+209000+7008000+960000}{2{,}400{,}000{,}000} = \$0.00470 \text{ per ton conv'd}$$

2. Conditions:—
   The same as in the preceding example except that service is but 1200 hours per year.

$$N.O.C. = \frac{3100000+209000+3504000+480000}{1{,}200{,}000{,}000} = \$0.00608 \text{ per ton conv'd}$$

The typical examples cited well indicate the real value of the belt conveyer as a means of transferring material from place to place, as the conditions assumed are very frequently found in practice. An interesting point is brought out by these examples, namely, that a belt conveyer is much more economical if in continual use than if used only occasionally. This is due to the facts that the system is very economical in the consumption of power, that the expense for attendance or labor is low when charged to actual tonnage handled, and that supplies, such as waste, lubricants, etc., are also low, while the burden of interest on investment, taxes, insurance, etc., is relatively high and is constant, no matter how frequently the conveyer is used. The burden of depreciation which is charged as the same in the two examples and so proportioned in Formula XVI., does not depend upon the hours of operation—provided, of course, that the conveyer is in use a fair number of hours each year—as depreciation is almost as rapid in an idle conveyer as in one that is in continual use, for proper attention and care is rarely accorded the equipment unless it is in actual service. In fact, unless the conveyer belt is carefully cleaned, removed from the conveyer and stored in a place of even temperature, free from acid, hydro-carbonaceous fumes,

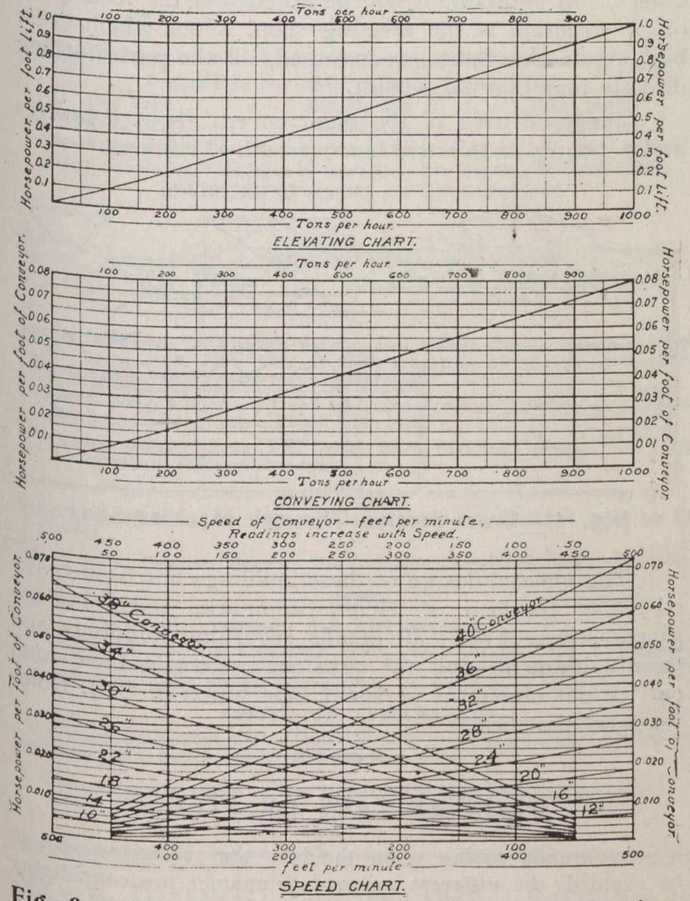


Fig. 3.—Horse-power Required for Conveyers Continuously and Uniformly Loaded.

NOTE.—To ascertain total horsepower required, multiply the sum of Speed Chart and Conveying Chart readings by total length of Conveyer in feet and add the Elevating Chart reading multiplied by total lift in feet. For each discharging device add an additional 1/8 horsepower for each inch of Conveyer (belt) in excess of 10 inches.

moisture, etc., etc., its deterioration may be even more rapid than if actually used for carrying material for, in use, particles of the load have a tendency to stick to the belt and to protect it from the injurious effects of many agents. This all emphasizes the economic fact that the more economic a piece of apparatus the greater the necessity of its continual use in order to realize the maximum benefits.

In this discussion, no attempt has been made to indicate the wide use to which belt conveyers may be put, such as picking conveyers for the sorting of ores, etc., the handling of mail in post offices, packages in department shops, cements in bags, etc., etc., but the discussion has been limited rather to one of conveyers for handling material in bulk. The laws and rules that have been laid down, however, can easily be modified to meet almost any condition of service, for the power consumption of belt conveyers depends almost entirely upon the load carried, distance of transfer, and inclination of conveyer. The question of width of conveyer (size) has little effect upon the consumption of power. Initial cost, on the other hand, really depends almost entirely upon the size of the conveyer so that only a modification of the various formulæ that have been given need be made to fit almost any special use of belt conveyers. Reference will also be made to this class of conveyer when describing certain special installations and operations, for such equipment is found in almost any modern enterprise.

THE CANADIAN LOCOMOTIVE COMPANY'S NEW PLANT.

An idea of the radically different layout of shops at the Canadian Locomotive Company's plant, at Kingston, Ont., as at present being changed, may be gathered from the accompanying plan. On the completion of the buildings there shown, the whole plant will be essentially new, as while three of the buildings are shown as being old, the only one of these three that goes back ten years is the machine shop to the right, completed some few years ago. The power house has only been in operation about eight years, and the boiler shop is less than two years old, so that with the new shops, the plant will be almost entirely new throughout, replacing the antiquated buildings with which the company has heretofore been compelled to do business.

The whole area shown in the plan has been more or less covered with a miscellaneous collection of old stone buildings, scarcely adapted to the work done, except under adverse conditions of operation. The problem presented was that of removing these old buildings, and re-

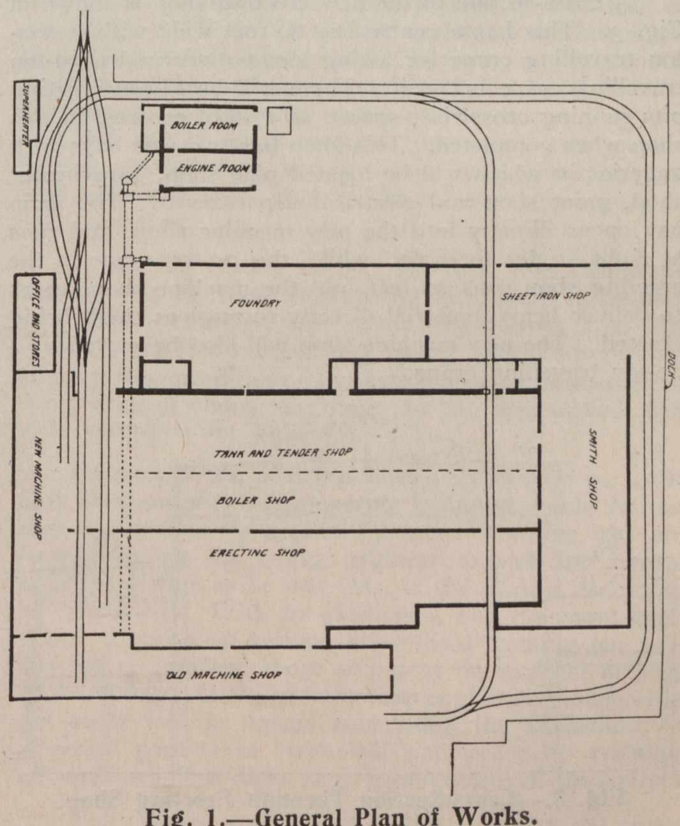


Fig. 1.—General Plan of Works.

placing them with newer ones without interfering with the locomotive construction work. This is being accomplished by razing the old buildings one at a time, and on the cleared site, erecting the new ones.

The work of reconstruction was first commenced on the buildings to the north of the old boiler shop, erecting the new tank and tender shop on ground unoccupied, and then tearing down the old tender shop for the erection of the new foundry and yard runways on the site of same. Following this, the old foundry has been torn down, and on its site a portion of the new erection shop is now being erected.

Fig. 2 shows an interior view of the centre bay of the foundry, which is used for moulding all heavy parts. The building has a high monitor with continuous sash operating the whole length, so that all smoke and gases can find an easy exit.

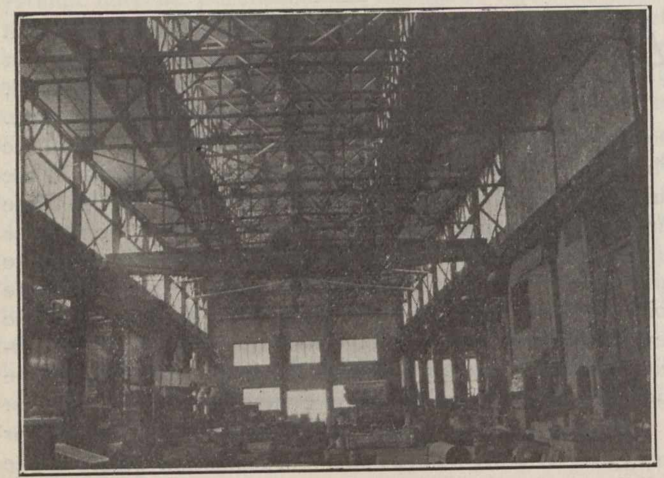


Fig. 2.—View of Centre Bay of Foundry.

A cross-section of the new erecting shop is shown in Fig. 3. This has a centre bay 80 feet wide with a 200-ton travelling crane for lifting locomotives and a 20-ton travelling crane below it. There will be fifteen erecting pits running crosswise, spaced at 17-foot centres, in this shop when completed. This shop has two side bays with galleries in which will be located pipe shop, superheater shop, paint shop and electrical departments. The main bay opens directly into the new machine shop, and runs at right angles to same, while the 20-ton crane in the erecting shop runs 20 feet into the machine shop, so as to deliver heavy material directly to engines there being erected. The new machine shop will also be served by a 20-ton travelling crane.

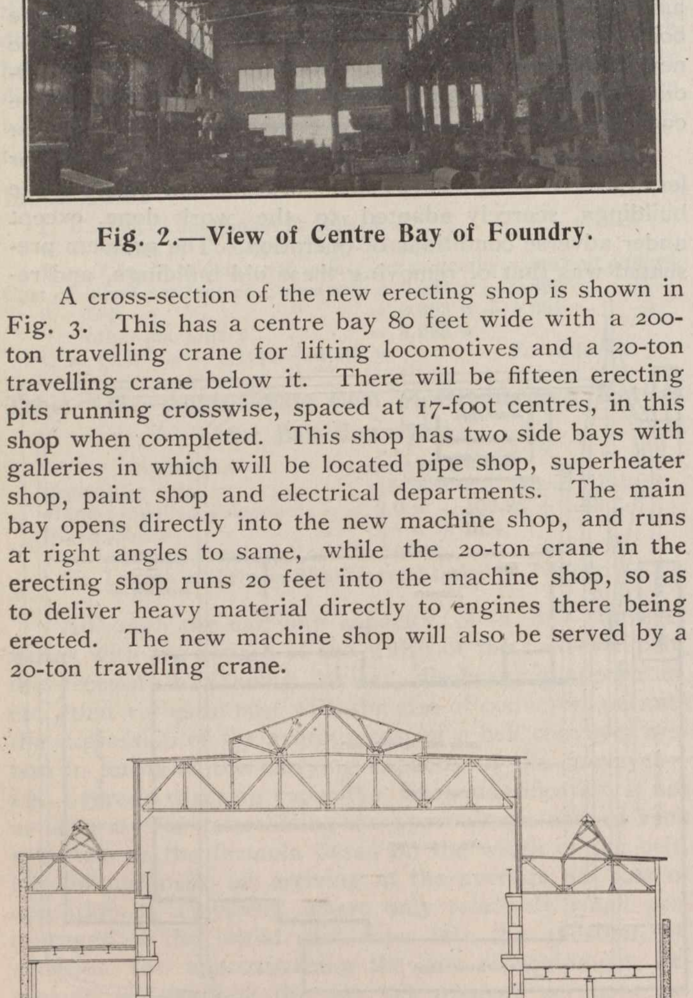


Fig. 3.—Cross-Section Through Erecting Shop.

A carpenter and pattern shop with pattern storage is being erected on a new site. As soon as these are completed the present carpenter shop, located at the south end of the old boiler shop and new tank and tender shop, will be torn down to provide space for a new blacksmith and hammer shop to be erected on this site. Following this, the old blacksmith shop will be razed and an addition to the new erecting shop and the old boiler shop will be built.

After these buildings are completed the old erecting shop and stores and office building running on Ontario Street will be demolished, and on this site a new four-story reinforced concrete store and office building, and a new machine shop will be built.

The convenience of the layout is at once apparent. Every building will be in open communication with all the others. In addition, it will be noted that the focal point of construction is the erecting shop, about which every building in the plant is arranged, all the parts feeding directly into that final point.

The total area of the plant covers about 9.5 acres and 7.5 acres of this will be covered by buildings.

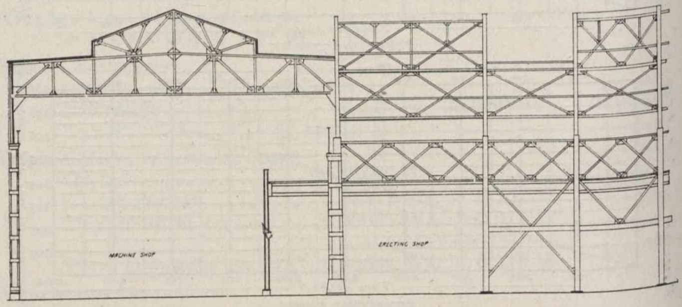


Fig. 4.—Cross-Section Through Machine Shop.

The general design of these buildings has been worked out by the firm of Henry Goldmark, consulting engineers, New York; all details regarding buildings and their equipment, and the construction work, have been carried out under the personal supervision of C. J. Goldmark, of that firm.

RAILWAY CARS OF STEEL.

Apparently acting upon the idea that collisions cannot be avoïded, the different railroad companies are considering the advantages that will follow the introducing of all-steel cars in their rolling stock equipment. While one might suppose that this change would add largely to the element of cost, it is a fact that the outlay per passenger carried for the two styles of cars is about the same.

This practical identity of cost is due to the fact that although steel cars cost $17,000 each and wooden cars only $8,000 each, the former cars are seventy feet long and the latter only fifty-four feet, and there is a further advantage in favor of the steel construction by reason of greater durability. Of course, the two main points in favor of steel cars are that they do not crumple up after the shock of a collision and they do not burn in the event of the always possible and usually probable fire.

It is now generally recognized that if the Bar Harbor Express had been made up of steel cars exclusively at the time of the North Haven disaster, there would have been no lives lost. Just how steel cars behave under such conditions is shown by the experience of a collision in Pennsylvania early in the present year, when a passenger train going thirty-five miles an hour crashed into another standing still and no one was injured.

Of course, from the railroad point of view, the main question is, How does the steel construction affect the question of cost? At first it was thought that the saving in maintenance on the new style cars over the wooden ones would take care of interest on the larger investment. This has not yet been achieved, but it is being closely approached as the railroads discover and remedy the faults of the first steel cars delivered.

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CONTENTS OF THIS ISSUE.

THE VALUE OF ENGINEERING TRAINING.

The resumption of technical instruction in the universities this week brings into touch with engineering courses a large and increasing number of men, among whom will be engineers of the future. The fact that engineering, although one of the oldest of the arts, has only within the past generation or two become generally recognized among the learned professions, makes it somewhat difficult for the student in engineering to choose between the courses which the calendar presents. There are no regulations existing such as are common to the oldest and most widely recognized professions, the scope and prospects of which are generally well defined. The field of engineering has broadened so much during the past twenty-five years that it is no longer possible to say just what it includes or excludes. It has no hard and fast lines of limitation, nor yet are the lines of division between its various branches quite distinct.

In the case of the three more important branches, viz., civil, mechanical and electrical, into which it has been frequently found convenient to roughly sub-divide the scope of the profession, there is often a considerable amount of overlapping, especially in the case with mechanical and electrical engineering. The boundary line is very indistinct, and it is difficult to say to which branch of the science many phases of development work belong. For instance, the mere replacement of a steam engine by an electric motor to drive the main shafting of a plant can hardly be called a piece of electrical engineering; but if special electric appliances are introduced to perform duties which cannot be done, or not done as well, by purely mechanical machinery, we have electrical engineering in the true sense of the term. The two branches are in many respects, upon the same general footing, nevertheless, and the majority of principles upon which the university courses are based, apply equally to both branches.

It will be readily noted, however, that while mechanical and electrical engineering have much in common they differ entirely from civil engineering. In this branch every new undertaking of any magnitude involves entirely new conditions, and introduces unforeseen problems, each of which may have to be approached with little precedent for guidance.

Opinion in the past has been very divided as to the best lines on which engineering training should be carried out. Formerly a purely practical training was preferred, leaving the young engineer to pick for himself such knowledge as he was able, of the science underlying his profession. With its expansion, and the rapid application of technical science, theoretical training has been brought to the fore, more or less at the expense of practical training. At the present time engineering authorities are fairly well in unison concerning the advisability of alternate periods of technical and practical training, although opinions differ as to arrangement of the courses.

This policy also applies with force to the other branches of the engineering profession. Its importance is such that a man who is beginning a course in engineering should be conversant with the general evolution of the nature of the training which he hopes to acquire. From a knowledge of its history the necessity will present itself to him of keeping always in mind the fact that the university course does not turn him out an engineer; but that by the practical application of the principles which he acquires thereby he may be better enabled to become an engineer.

CANADIAN ENGINEERS AND ROAD CONVENTIONS.

That for years to come highway problems will occupy a most prominent place in Canadian municipal affairs is a potent reason why our road engineers should take cognizance of the road conventions that are being held within attending distance. The American Road Congress in Detroit this week has gathered from far and near the pioneers of scientific road construction in America, and their views and experiences as related in the discussions following the numerous papers presented, cannot be surpassed in value as enlightenment on the many factors upon which such work is contingent.

Another convention that should receive the attention of our men in highway engineering is that of the American Road Builders' Association, to be held in Philadelphia in December. A tentative programme of this Good Roads Congress appears in another column, and further information respecting the plans for it will be published shortly.

The Ontario Good Roads Association passed a resolution worthy of note last week, deciding to extend to the American Road Builders' Association an invitation to hold its 1914 convention in Toronto. The invitation will be delivered in person by the president and secretary at the coming convention in Philadelphia.

If it meets with acceptance, Canada should at once prepare to show the American Road Builders' Association the immensity of the Canadian road problem, coupling with it a well-defined policy showing how its many difficulties are to be overcome.

Canada's road problem is merely a revised version of the same questions that have been before the highway officials of other countries, and that, in many instances, are still pending solution. Chief among the influences retarding a settlement by standardization of road construction has been the introduction of faster and heavier vehicles. Practically all countries are of an opinion concerning the certainty of the change which methods of road construction must shortly undergo, to meet the motor-driven vehicle as a successor to the steel-tired horse-drawn vehicle. More up-to-date systems of road engineering must be adopted if the expense of maintenance is not to become excessive.

But until the battle for supremacy between the new and the old has been fought to such a stage that the engineer may be justified in practically eliminating one of them from consideration, there will be no standard road or pavement. Before the advent of the automobile there was a single class of traffic, varying only in intensity. Since then motor-driven vehicles equipped with rubber tires have destroyed the old standard construction to such an extent that ordinary macadam is not likely to regain the place it held as a satisfactory type of road for general use.

Thus the problem has resolved itself into a selection, for each particular piece of road, of the type that will serve local conditions best. This requires a highway engineer to have a very comprehensive knowledge of the characteristics of all pavements in use, since there is no standard for his guidance.

Such considerations as these should emphasize the advantages to be derived from a participation in the proceedings of the road conventions.

RE PROPOSED CANADIAN INSTITUTION OF MUNICIPAL ENGINEERS.

An informal meeting of the engineers attending the Canadian Public Health Convention at Regina was held on Friday, September 19th, to discuss the question of forming a Canadian Institution of Municipal Engineers.

Mr. Wynne-Roberts (Regina), the convenor, submitted the correspondence which he had with several engineers, the great majority of whom approved of the idea. Letters had been received from city engineers located in many parts of the Dominion. Those from Toronto and Winnipeg were not favorable, but those from Edmonton, Regina, Battleford, Vancouver, London, New Westminster, Calgary, St. John, N.B., Halifax, Ottawa, Fort William, St. Catharines, Glace Bay, C.B., Peterborough, Guelph, Sydney, N.B., and Hamilton were favorable. Some desired more information. Representatives from Battleford, Saskatoon, Prince Albert, Swift Current and Toronto, who had not already written expressing their views, were present and verbally stated their opinions.

After fully discussing the matter from various viewpoints, it was unanimously resolved: "That this meeting of the engineers present at the Annual Convention of the Canadian Public Health Association, held in Regina, after considering the question and perusing the letters received from city engineers in various parts of Canada, is of the opinion that it is desirable to form a Canadian Institution of Municipal Engineers, and that a Provisional Committee be appointed to enquire into and adopt the most advisable steps for its formation." The names of the committee members will be published later on, after their individual consent to act has been obtained.

EDITORIAL COMMENT.

If properly carried out, Calgary's intention of planning street grading to meet requirements of several years to come, so as to keep well ahead of civic improvements, will save the city a lot of money. This desirable policy will enable the laying of water-mains, sewers and street paving to be executed without apprehension of early subsequent disturbance, and it will also obviate alterations to residential property occasioned by the cutting down of grades, in connection with pavement work. The city requires much grading work to be done in places, and the step which the City Commissioners are taking is a matter of great permanent importance to property holders in particular, and the citizens generally.

Especially in the case of street pavements, we hear so much of their disturbance for the laying of water-mains, etc., that the plan which Calgary purposes to follow should be considered by every city and town in Canada, and it seems practicable enough to be continued if once established.

CORRECTION.

In Mr. V. J. Elmont's paper in last week's issue, the table on page 486 is not explicit without further explanation. The bending moment values are arranged vertically under the different values of $\frac{x}{l}$ and horizontally opposite the different values of $\frac{y}{l}$. In the table also, "o.x" simply means "o."

THE CHEMICAL AND BIOLOGICAL EFFECT OF WATER FILTRATION

ORGANISMS IN EARTH AND WATER AND THEIR FUNCTIONS—EFFORTS TO ELIMINATE PATHOGENIC BACTERIA IN WATER BY FILTRATION—THE FILTER FILM AND ITS WORK—AUXILIARY CHEMICAL TREATMENT—EXTREME PURIFICATION DANGEROUS

By H. W. COWAN,
Chief Engineer, Bell Filtration Co. of Canada, Limited.

MUCH argument has taken place as to whether bacteria are a form of plant or animal life. One of the lowest forms of plant life, known to the botanical microscopist as oscillariae, possesses similar characteristics to the types of organisms called bacteria.

The chief difference is the presence of chlorophyll in oscillariae, or the green coloring matter which enables the plant to derive nourishment from such simple foods as it can procure from the air and soil, in which it is present. It is the absence of chlorophyll in bacteria which forces them to live on more complex foods. Both have the power of motility, the same form, the same method of thread and spore formation, and may both be considered as true plants.

The simplest forms are typical of bacteria, spherical, cylindrical or spiral. They are so minute that their diameters range from 0.000012 to 0.0003 inches. A coating of some gelatinous membrane seems to envelop most species, serving as a cement to keep them together. Their internal structure of protoplasm has never been definitely decided on, and is still much a matter of conjecture.

When massed into clusters bacteria are known as zoogloea, which differ from a colony in that the latter is formed when a single bacterium is cultivated in some mass which presents too much resistance for the separation of the bacteria to any distance. Varying species form different characteristics in their colonies, which serve as a means of identification when under examination.

Bacteria multiply very rapidly, unless in unsuitable conditions, by the simple process of dividing in two, a process which can go on indefinitely until as many as 16,000,000 are produced in twenty-four hours. In addition to this simple method of propagation, some species produce spores. These are round or oval pieces of bacteria protoplasm, which develop until they finally break out of the original organism. When the original germ cannot exist, the spores are still to be found resisting very adverse conditions, and acting as a means of perpetuating the species.

A means of motility is supplied to many species, which have stringy membranes attached to them, sometimes one, two, or many, sometimes at one end, and sometimes at both. By lashing these membranes back and forward, a means of propulsion is supplied, which is very active when the germs are immersed in liquids.

The food of bacterial organisms is secured from the dead bodies of animals or plants, and their excretions, which they rapidly decompose in their operations for assimilation. Probably the rapidity of multiplication is due to not having to manufacture food, as in the case of other plants. In effecting the decomposition of substances, many chemical and physical changes are wrought, extensively made use of in the maceration industries.

The manufacture of linen, jute, hemp, fibre, leather, sponges, and the products of fermentation, is chiefly dependent on the action of various forms of bacterial life. In still more important functions are bacteria necessary for the continuity of life, and the preservation of mankind. For the purpose of showing this some digression is allowable for consideration of other plants and their mode of existence.

No life could exist if the earth were littered with dead matter, but bacteria, acting as scavengers, and putrefactive changes prevent such a happening. The earth's surface has been the producer of the countless years of life. Plant life has extracted food from its soil and air without apparently diminishing the food supply.

The animal kingdom breathes oxygen and exhales it as carbon dioxide, which the vegetable kingdom inhales and returns as free oxygen to complete the cycle. Plants also consume nitrogenous food from the soil, in the form of nitrates, in combination with gaseous products of the air and other elements. These solar energy transforms into starches, proteids, sugars, fats, etc., to supply animal life with nutrition.

Carbonic acid and water are returned by the animal in the assimilation of its food, to be again absorbed by plant life, but nitrogenous food is not returned in total. Most of the nitrogen consumed by animal life is turned into albumens and the balance excreted. Even when the animal dies, the nitrogen is too complex in its compounds to form plant food, when recovered by disintegration.

The bacteria of decomposition and putrefaction now set to work to reduce most of the nitrogen compounds into suitable feeding material for the plant, leaving the balance as nitrites, which in turn are too simple for plant food.

The soil abounds with organisms called nitrifying bacteria which unite these nitrites with oxygen and transpose them into the nitrates necessary for the existence of the vegetable world. In decomposing, dead animal life frees a proportion of nitrogen which passes into the air, thus reducing the supply of nitrogenous food returned to the soil. More is lost in excretions taken direct to the sea in the form of sewage, while many of the chemicals used in the manufacture of explosives and other articles of commerce consume a large amount.

The farmer makes up this deficiency by the application of chemical fertilizers to the ground, but were the same soil freed from all plant life, and exposed to the air for a period, nitrogen fixation would be secured through the activity of bacteria in the earth. Not only in this way is dispersed nitrogen recovered, but also by an active co-operation of germ life with certain leguminous plants. These organisms attach themselves in globules or clusters to the roots of the vegetables, and with both agencies at work some nitrogen is fixed in the fibrous structure of the legume. Disintegration and rotting of the plant enables the stored-up nitrogen to be fixed in the soil.

In the scheme of life, therefore, bacteria have very important and definite functions to perform. Without them the recovery of nitrogen for plant food would be impossible, and the circle of life created by the energy of heat would cease. Were it possible to destroy germ life as a whole, the result would be the total extinction of all forms of life.

There are, however, other types of bacteria which are pathogenic, and have the power of reproduction in the human body, causing many diseases to which humanity is subject. The proportion of these to the harmless bacteria is fortunately small, but as they give rise to such sickness as typhoid, cholera, diphtheria, tuberculosis, lockjaw, anthrax, influenza, etc., they must be kept down. These germs produce by-products which act as virulent poisons to the human system, causing the diseases enumerated together with many others. They gain access through the mouth, nostrils, cuts and breaks in the skin, and set about reproduction by incubation until the disease gets a hold on the body. If the powers of resistance of the body are very great, the organisms are disposed of, and the sickness is warded off. These resistive forces are not yet fully known, but science has established the presence of certain products in the body termed alexines which kill non-pathogenic germs. To combat the alexines the pathogenic bacteria create lysines to neutralize their action, and make the way clear for their depredations.

The invading bacteria are then attacked by the white corpuscles of the blood, which leave their usual habitation in the blood vessels and surround the attacking germs. The evidence of this is generally given by the appearance of inflammations, either internal or external, which break out and give off pus should the corpuscles be vanquished. With such contending influences in the body, disease is warded off by those in robust health, and the importance of maintaining these resistive powers cannot be over-estimated, otherwise they will become useless through dissuetude.

The chief means of conveying the harmful bacteria to the body is by means of liquids which act as carrying agents in a greater degree than any other source. In consequence, our drinking water supplies are of national importance, and the elimination of harmful or pathogenic germs from them is the first essential to disease prevention.

Methods of Filtration.—The methods of filtration generally employed are to filter all water used for drinking purposes by means of sand filters, of which there are three distinct types—slow sand, gravity mechanical, and pressure mechanical. Of these the first and last are most commonly used in the older countries, while on the American continent the first and second are favored. In the slow sand filter the water is allowed to flow through beds of sand and gravel, into collecting pipes placed under the filtering material, at rates varying from one to six million gallons per day. They are generally constructed of brick and concrete, or both, and occupy a large area. Gravity mechanical filters are frequently constructed of the same materials, or of wood or steel, containing sand overlying gravel, while pressure filters are entirely composed of steel. Both of these latter types operate at rates up to one hundred and seventy-five million gallons per day. The ratings given are for an area of one acre.

Before the sand in all types of filters performs effective work, it must be coated with a film which retains the bacteria in the passage of the water through the filter. The slow sand filter forms this filter naturally by the growth of vegetation, the deposit of fine clay particles, and the agglomeration of organisms. In the mechanical type the film is deposited by the addition of alum to the water, before it is applied to the sand bed. The alum reacts with the lime in the water, or with added lime if the water is deficient, and forms a gel or albuminous coagulant which is insoluble, and deposits on the sand bed.

In course of time this film becomes too impervious, and it is necessary to clean the surface of the filter to allow the water to find its way through. In the slow sand filter this is performed by scraping off the surface to, a depth of about ⅞ of an inch, and passing through a sand washer to make it ready for replacing when the sand bed gets too shallow to work satisfactorily. In the gravity mechanical and the pressure mechanical filters cleaning is carried out by the operation of valves to force the water back through the sand bed, where it is run to waste. Agitation is performed by means of compressed air or mechanical means to break up the sand, so that the reverse flow of water may do its work.

In the slow sand and gravity mechanical types of filters, water flows in by gravity or is raised by a pump, and allowed to flow through the filter under atmospheric pressure only, into a clear water reservoir from which the filtered water is pumped to the service pipes. In the pressure type of filter the water is forced through by means of a pump, or sufficient height of water to supply an equivalent pressure. The pressure filter is totally enclosed, while the other types are open.

It does not fall within the scope of this paper to enlarge on the merits of any particular type, beyond saying that with a properly designed plant and proper operation, they should all give equally high bacterial reduction. On leaving the filters it is common practice on this continent to treat the effluent with chlorine to further reduce the bacteria content, and approach as nearly as possible a sterile water. With this practice the writer is not at all inclined to agree.

Chemistry of Filtration.—It is well known that the work performed by sand filters is to remove suspended solids, and to act in such a way that both chemical and biological changes are wrought in the treated water. In considering the presence of dissolved substances in the water, it is found that chlorides do not vary much, neither increasing or diminishing in passing through the filters. Nitrates vary either to a greater or lesser extent, and sulphates and carbonates remain pretty much the same. In both slow sand and mechanical filters, the chlorine content, as indicated by the presence of chlorides, seldom varies, while in both cases the carbonates are reduced about one grain per gallon. Albuminoid ammonia is reduced by mechanical filters from 15 to 90%, according to the water treated, and an average of about 60% in the case of slow sand filters.

Free or saline ammonia is reduced from 33 to 50%, and sometimes as high as 95%, in mechanical and slow sand filters respectively. The oxygen absorbed varies from 50 to 90% reduction with mechanical filters, as against 40 to 50% with slow sand filters.

Mechanical filters reduce nitrates and nitrites from 5 to 60%, while the slow sand filter ranges from 10 to 30%. Before discussing how these changes may be brought about by filtration, it is interesting to note that mechanical filters are much more uniform in their results than slow sand filters in the reduction of albuminoid ammonia. In three months' observation of tests made every third day, while the raw water content varied from .002 to .0067 grains per gallon, the effluent only varied in its quantity from .002 to .00265 in one series of tests. Another series during the same period, showed the variation from .003 to .0039, with the raw water containing from .0046 to .0067 grains per gallon. At the same time tests were made with slow sand filters treating the same water, in which albuminoid ammonia was present in quantities of .0063 to .0064 grains per gallon, the effluent varied from .0035 to .0059 grains per gallon. The mechanical filters, therefore, while treating water with considerable variation in quantity of albuminoid ammonia, contained practically the same amount in the effluent. In the slow sand tests the results were just the reverse, and laboratory practice further accentuates the difference.

In mechanical filters, sulphates increase from one-half to one grain per gallon, due to the addition of alum which dissociates sulphuric acid in hydration.

The presence of chlorides, unless they can be accounted for by proximity to the sea, or natural salt deposits, gives an indication of sewage pollution of the water supply. Before the advent of bacteriology, nitrates were used to determine the standard of purity, but their presence is no longer considered except to call for confirmation of sewage pollution by bacterial tests. Water high in nitrites, however, should be condemned, until exhaustive tests have been made and their source accounted for. More free ammonia than albuminoid ammonia is a sure indication of the presence of polluting matters, as in normal waters the albuminoid at least equals free ammonia. If such oxygen is consumed in testing, the probability is that pollution has occurred unless with waters high in color, where the original oxygen has been depleted in oxidizing the vegetation.

Bacterial reduction in all filters of the types mentioned, operated on the same water with the same care, and with suitable rates of filtration, with suitable water for all types, should be much the same, ranging from 85 to 100%, according to the count of bacteria in the untreated water.

The Filter Film.—In performing these changes consideration must be given to the nature of the film on the sand, and its action, so that we may be able to judge what is most likely to give constant results when dealing with any particular type of water. The film on the slow sand filter is composed of fine particles of clay and mud, of green and blue algae, fungus, bacteria, etc., which very soon propagate under favorable conditions when the water contains the original propagators. The bacterial bodies present mass themselves in zoogloea, or into colonies, and putrefactive changes in many of the diatoms produce slimy brownish masses of matter. These form a net-work over the surface of the sand, which is bound together by the active diatoms, and the whole mass coheres and feeds on other organisms, or the same placed thereon in the act of filtering. At the same time there is constant destruction going on in the film, between opposing plants, which is the primary cause of the expert attention required in the care of slow sand filters, so that the film may be guarded against rupture. Algae has quite a purifying action in the removal of bacteria, without the assistance of other diatoms, and performs useful functions in the purification of stored waters.

The whole of this mass is of a gelatinous, viscid, and sticky nature, eminently suitable for adhesion of particles coming in contact with it. Each particle of sand on the upper layers of the filter becomes wrapped in a coating of the sticky substance, and a drop of water flowing around that particle will leave any minute organisms sticking to the coating on the sand, to be sucked in and retained, if not disturbed by vibration or variations of flow in the passage of the water.

The vegetation in this film is suited to the action of nitrifying bacteria, which transform the ammonia content of the raw water into nitrates and nitrites, reducing the ammonia and increasing the nitrogen. Where a reduction of one is shown, without an increase of the other, the ammonia content has been very small, in other cases there may be sufficient ammonia present in organic matters in the water for the nitrogen to show an increase not wholly due to transformation of ammonia products into nitrogenous from the water.

Albuminoid ammonia, on the other hand, forms food for many forms of bacteria, which transform it into various fatty compounds, gases, and water. Decomposition again sets in, and nitrates, ammonia, carbonic acid and water are the final products. Thus we can readily see that the feeding stuffs necessary to the life of bacteria on the sand bed, are drawn from the water, with the consequent reduction of these food stuffs after the water is filtered.

In the film formed in mechanical filters the work performed appears to be mostly of an absorptive nature, the deposit being more like a membrane full of minute cells, which are closed, and present a very large surface when wrapping round the particles of sand on the upper layers of the filter. These minute cells of the gel are continuously opening and closing, giving up the necessary amount of water each time to equalize the vapor pressure with the surrounding fluid. It has been found that by removing the water from colloidal substances, various chemical compounds holding varying amounts of water are not formed in cycles, but that the water content changes continuously. Thus the coagulation of a hydrate makes a kind of tissue, neither solid or liquid, which encloses liquid. With this construction it may readily be understood that the enclosed water in the cells may, in being replaced by other water containing a minute organism, leave the organism in the sticky cell, when it opens to allow of the absorption of a fresh quantity of liquid.

Heat is destructive of the adsorptive properties of the gel membrane, probably by contracting or stretching the formation until the cells collapse into a flat plane. The great surface tension of the culloid and the pulsation movement of the innumerable cells, in the opening and closing, explain the suction-like action of the firm in drawing in gelatinous or minute substances, while its viscosity and stickiness aid in the retention of these foreign matters.

Every weathering process in nature is productive of some form of gel in regard to its minerals, stalactitic, botryoidal, or glassy in form, with fibrous fractures, sometimes being found even in a gelatinous state. The filtering action of nature in well waters and successful infiltrations is probably due to the action of these gels. Their absence in some vicinities certainly accounts for the failure of similar constructions, when these are apparently exactly the same, but in a locality with a totally different mineral deposit.

Biological and Aesthetic Considerations.—In common with the changes caused chemically and bacterially, there are many other biological changes desirable for the securing of the more aesthetic qualities of a water supply, such as color, taste, and odor. The mechanical filter is highly successful in treating waters which have to be dealt with in regard to these qualities. The slow sand filter rarely removes more than 20% of the color, while with the mechanical filter total elimination is possible. Odors which are caused by decomposition of vegetable matter are rarely disagreeable, but living organisms, or vegetation may also cause them. Many forms of bacterial or organic growth give off matters of an oily nature, which have a smell peculiar to the species from which they are exuded, in a way analogous to the poisons given off in the body by pathogenic bacteria.

Agitation may break up these bubbles of oil and spread them through the water until the odor is accentuated. In the same way heat, when applied, scatters the oily products and exaggerates the odor until it can be definitely compared with others known to the physical sense. The number of such organisms present in the raw water determine the intensity of the odor, and the various intensities may make the smells appear different, while they are really produced by the same organism.

It is possible that the substances producing the aforementioned qualities may have a poisonous effect on the human system, but unfortunately science has not yet been successful in demonstrating this.

Odors of decomposition are usually set up in the water pipes of a system, by the action of the filaments of plant life attaching themselves to the inside of the walls, propagating there, then becoming detached when in a state of partial decomposition. This is the frequent cause of pitted pipes, as the preservative coating is detached along with the organism, allowing rust to set in. Every system should be flushed out completely and thoroughly, periodically, as a safeguard to the preserving of the pipes against such action, and the maintaining of the physical qualities of the water at the highest standard.

Color is entirely the result of dissolved vegetable matter, and is, therefore, generally associated with taste or odor produced by the same substances. The oxygen used in the oxidizing of the vegetation in solution sometimes gives an insipid taste to the water, which is simply removed by aeration, to replace the occluded oxygen.

In the removal of odors due to organisms, filtration is effective, while the absorptive tendencies of coagulants collect the globules of oil, together with the organisms producing them. Products of decomposition are retained in the same manner, and those growths which attach themselves to the piping in the water system are prevented from passing into the supply. They cannot then become nauseating by detachment.

Nature has been copied as closely as possible in the filtration of public water supplies, and the results of slow sand and mechanical filters are practically the same as those performed naturally.

Auxiliary Chemical Treatment.—When water is too soft, it frequently sets up an acid reaction, particularly in the case of peat discolored supplies, which has the effect of dissolving the piping through which it is conveyed. This brings about lead poisoning to the consumer. The absence of mineral salts is a plausible cause of rickets and bone weakness.

Waters which are very hard may also be productive of plumbo solvency when they give an acid reaction, and are frequent causes of constipation and troubles of the digestive organs.

Extreme hardness leads to a stunted and ossified growth in individuals, as is well instanced in the Cretins, a race of dwarfed people who live near the Swiss borders, and use very hard waters.

The commercial side is also important, as the extra cost of fuel with hard waters, and the high cost of soap to a community is very burdensome.

With such waters hardening should take place prior to filtration, or softening where necessary, by the addition of lime water to increase hardness, or an excess to reduce the same trouble.

Danger in Extreme Purification.—A note of warning might well be sounded before attempting to exceed the results produced by natural means, as in the tendency in Canada at the present time.

The exigencies of modern civilization demand the collection of human beings in congested sites for the pursuit of industry. The consequent polluting of water supplies, with the subsequent necessity for treating them follows.

In the old tribal times there were no large communities gathered together for a long period of time. The people were constantly moving from one camping ground to another, and oxidation had time to effect purification after a site had been deserted. The spread of disease was to a great extent safeguarded by the absence of a means of conveyance in the shape of water systems, public vehicles, etc., and the water supply was carefully guarded from pollution by those in the camp using them. The dread intestinal diseases of bacterial origin were not much heard of until the commencement of the industrial era, and most of the scourges which attacked communities were of a zymotic nature rather than an intestinal.

Is there not a possibility that attempts to purify our drinking supplies are being carried too far? Would it not be wise to determine what is the maximum extent to which it is safe to go?

The healthiest communities are those with natural water supplies, often carrying a large bacteria count of harmless germs, with a small proportion of mineral salts. Yet, modern demands cry out for sterilized drinking water. Even distilled water, devoid of all natural salts, is being largely consumed, while recent investigations into the large number of tubercular patients in navies using distilled water exclusively, point to the demineralization of the human system as conducive to the inroads of the tubercular germ. Much interest will be shown in the experiments now being conducted by French scientists to prove that the absence of mineral salts in drinking waters is a forerunner of the wasting disease.

An attempt has been made to show the vast importance of bacteria in the great scheme of existence. Are we not eliminating some of the bacteria which an all-seeing Providence has provided for the performance of vital functions in the body?

Professor Metchinkoff, in one of the most interesting and masterly treatises of modern times, in summing up the results of his investigations into the longevity of a certain European race, demonstrates clearly that the scouring action of bacteria present in their national beverage of sour milk is probably the reason for the felicity obtained by that people.

In our food and drinking supplies, water conveys bacteria directly from the soil, other bacteria are deposited after cooking by touch, from the air, and by contact, while fruit is mostly removed from its peel or skin, and therefore from the greater part of its bacterial life. Useful bacteria can therefore have drinking water as a possible conveyer only.

It is not known what action harmless germs have on the human body, and the body's curative agents have power to combat the inroads of harmful bacteria, when their numbers are not too great. As the proportion of harmful bacteria to harmless is small, an efficient filter removing about 98% of the total bacteria count in drinking water can leave few, if any, pathogenic germs to play havoc with the consumer. Even the few which might escape will perform good work in providing exercise for the resistive forces of the body, and preventing their becoming defunct through dissuetude.

Potable waters in Canada after filtration are invariably treated by chlorine as an additional preventive, with the tendency to produce bacterial sterility. This has been brought about by the use of filters whose operation is not all that can be desired, and is a slur on the engineering profession generally, which may have very far-reaching consequences. There are filters which can be relied on, without the use of sterilizing agents, and the sooner engineers make use of them, or design others to perform first-class work, the sooner will doubtful practice be removed.

Any of the types of filters described can be made to give such results if they are not hampered by considerations of cutting down cost.

The greatest evil is facing modern times in resorting to practice of whose effect we are ignorant, when natural means of treatment will give a margin of certain safety.

As has been pointed out, water may be the only source of organisms necessary for the proper performance of bio-chemical functions in the body. The removal of these germs would make the functions of the body entirely chemical, a position which might lead to the destruction of the body's tissues until it could be adjusted to the new order of things.

Chlorination, sterilization by ozone, distillation, and other means of securing final sterilization, are being carried on at the present time in entire ignorance of all the uses of the body of those very properties which are being destroyed.

The whole tendency of modern therapeuthy is towards prevention of disease by sanitation, or the use of antitoxines, or its retardation by small doses of reactionary drugs to stay the progress of the disease, until the recuperative powers can reassert themselves.

Why, then, should these very recuperative powers be weakened by extreme preventive measures?

A census of operative cases, such as appendicitis, in cities using chlorination, or other sterilization treatment, might produce interesting results. In cases of strangers succumbing to disease when in strange cities, a census might also be taken and consideration given as to whether their resistive powers had not been weakened by the water treatment in their home town.

Would it not be wise to withhold drastic treatment until the need for it has been scientifically demonstrated, and its effect on the body placed beyond doubt

The importance of this point is too great to be neglected and affords excuse for the somewhat lengthy discussion of bacterial life at the beginning of this paper.

PROGRAMME OF AMERICAN GOOD ROADS CONGRESS, PHILADELPHIA.

Plans for the Fourth American Good Roads Congress, to be held under the auspices of the American Road Builders' Association in the First Regiment Armory, Philadelphia, Pa., are being worked out in detail by the Convention Committee and officials having the matter in charge.

The following outline of programme shows the subjects to be discussed at this convention:—

Subject A—Organization:

1. Highway Officials—Their Duties and Powers.

2. Division of Expense, of Responsibility and of Authority Between the Various Municipal and Other Units Participating in a Road or Street Improvement.

3. The Relation to Each Other of the Contractor, the Chief Engineer, the Resident Engineer and the Inspector.

4. Details of Arrangements for the Use of Convict Labor.

Subject B.—Construction:

1. The Proper Determination of the Amount of Re-Alignment and of Grading to be Done.

2. The Factors Governing a Proper Selection of a Road or Street Pavement or Surfacing.

3. Materials and Methods Suitable for Road Surfaces.

4. Unit Price vs. Lump Sum Contracts.

5. Plant Equipment.

6. Preliminary Traffic Census.

7. Efficiency and Economy of Using One Size Crusher Run Stone Bituminous Concrete Pavements as a Substitute for Bituminous Pavements Constructed by Penetration Methods.

8. Dirt Roads.

Subject C—Maintenance:

1. Sub-organization for Securing Efficient Maintenance.

2. General Methods of Repairs and Renewals.

3. Methods of Dust Prevention.

4. Maintenance of Different Road Surfaces.

The general plan of providing for discussion of subjects, rather than long papers, which has been so successful in the past, will be adopted at this meeting. The speakers are being selected with reference to their fitness to discuss the various questions, and announcement of these assignments will shortly be made. The list of speakers will include the men who are recognized as the leading authorities in the United States and Canada.

In connection with the Congress and Convention, there will, as usual, be held an exhibition of road machinery, materials and appliances. This exhibition will be known as the Fifth Annual Good Roads Exhibition, and will include everything that enters into the construction, repair and maintenance of roads and pavements. This exhibition will also be held in the First Regiment Armory.

This association was the first to inaugurate these exhibitions and they have uniformly been successful, each having been larger and more complete than the one previous.

TUNNELING.

By Robert B. Sinclair,

Assistant Engineer, Jennings and Ross, Toronto.

TUNNELING is by no means a modern feat of engineering. In the early times the ancients resorted to it as a means of obtaining passage for their thoroughfares under their rivers, and also as a means toward drainage; but on the whole the operation was rather a crude piece of manipulating. That science has made great strides since those days, the instruments by which the great engineering obstacles can now be very quickly overcome, is but one of many illustrations. In the following paragraphs a few of the methods that are being followed in tunneling are briefly described.

Preliminary Surveys.—When it has been decided to tunnel in order to obtain a passage-way for railroads, electricity, waterpower, or whatever the case in question may be, we must have some idea of the obstacles which are to be overcome, such as the amount of material to be excavated; the nature of the material, whether loose gravel, rock or quick-sand, and also an idea of the surrounding country, as regards the necessary depth to rock, etc. A great many other data, which will be barely mentioned, must be gathered, and in order to obtain this a geological survey party is sent on to the field of operation. The information is obtained from the geologist's knowledge of the rock formation, and also from diamond drill borings, which are taken at intervals in the vicinity. Upon the rock formation depends the nature of the blasting, as it will be more efficient if the rock is attached perpendicularly to the stratification.

Generally speaking, a horizontal strata is very much weaker than a vertical strata, and, as a result, it needs heavier supports in the shape of tunnel lining, bracing, etc. Upon the geologist's report the character of the construction is to be based.

Centre Line of Tunnel.—Tunnels are divided into two classes—curvilinear and rectilinear. We will not follow the detail of curvilinear tunneling here, but will touch upon the rectilinear, as it affords a better discussion for a general treatise.

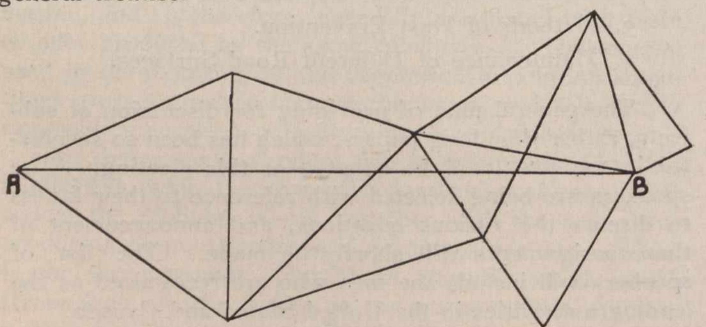

Fig. 1.

The centre line of a rectilinear tunnel is obtained by means of a triangulation survey. This must be carried on with the utmost accuracy. The angles and chainages must be read a number of times, and the results obtained by the method of least squares.

The triangulation method is illustrated very well by the above diagram shown in Fig. 1. It can be seen that the utmost accuracy can be obtained in this method of procedure. The line is staked out preliminary to the beginning of construction.

It might be said here that nearly all tunnels of any length are not worked completely from end to end, but have intermediate shafts by which the tunneling is carried on to much greater advantage.

The method of obtaining the line underground is illustrated in Fig. 2.

The depth is calculated from the profile of the tunnel. A-B is on the offset tunnel line. The plumb-bobs C and D give the direction of the line beneath the surface. A small tunnel is run to the main tunnel in question, giving a means by which the tunneling can be operated at this point.

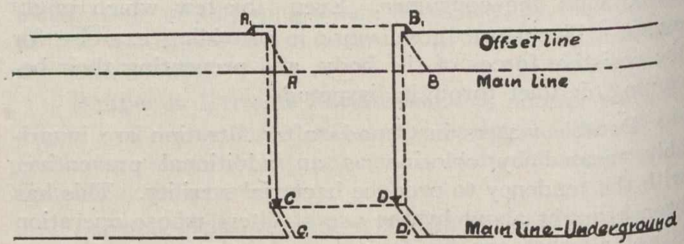

Fig. 2.

Different Methods of Tunneling.—The different methods of tunneling are in no way a small study by themselves. If we ponder for one moment over the subject we shall see the difficulty of preventing "cave-in" while the tunnel is under construction. This difficulty is off-set in a number of ways. Engineers of different nations have ways and means of their own, and from them are developed the methods by which every kind and condition of material may be encountered and successfully overcome.

We will see by the following how cleverly the methods are developed, and yet, after all, common sense is the one fundamental of them all. In fact, the basis of engineering is common sense and surveying.

Rock Tunnels.—Rock tunnels are carried through by the drift and the heading methods. The drift method is shown in the design by Fig. 3.

The parts 1, 2 and 3 are excavated, leaving supports 4 and 5, upon which is built the arch of the tunnel. At intervals along the side transverse cuts are made and filled in with the masonry. These support the arch after 4 and 5 have been cut away.

By Headings.—The more common method of rock tunneling is by the heading method.

Section I in the diagram (Fig. 4) is drilled through perhaps 200 feet to 300 feet in advance. Parts 2 are drilled into until finally we arrive at the point of constructing the arch structure. It is built up on the unexcavated rock below and is supported by 4 and 5, while fissure 3 is opened up. Parts 4 and 5 come next, and the lining is then inserted.

It might be interesting to mention the fact that rock tunnels do not require the heavy lining that is used in ground tunnels. This is very well understood on account of the fact that the rock walls are self-supporting, except where some crack or fissure allows the side to break off. These cracks and weakenings are caused by heavy blasting and also by the rock structure. If the strata is perpendicular to the side of the tunnel it will have greater tendency to cave-in than if the strata is parallel to the side. The St. Gothard tunnel is a very good example of the heading method of excavation. The tunnel was constructed in 1872-82, and is one of the longest tunnels at the present time. It connects France and Italy under the Alps Mountains, and is 9¼ miles in length.

Passing from rock to earth formation in connection with tunneling, the earth formation is much more difficult to successfully tunnel. Although it might not appear so on first consideration, the blasting and removing of rock is a very simple operation in comparison to the removing of soft material, in the face of a cave-in, quick-sand and a great many other obstacles, which cannot be gone into here.

A Good Method of Blasting.—The explosives used in the blasting operation consist principally of gun-powder, nitroglycerine and dynamite. The methods used are various, but one which is used a great deal and which seems most efficient is the American centre cut method.

In this method seven or eight holes are bored in the facing in the form of a polygon, the holes tending to terminate at the point. The holes are charged and fired, extricating the conical, or pyramidal structure. Another circle of holes is forced in a cylindrical form round about this opening. These are charged and fired, and a cylindrical shaped fissure is opened. In this way the blasting operation is carried on until the opening is brought to the required size and shape.

The distinguishing feature of the method is the way in which the opening is begun. The futility of making a blast without first weakening the substance by extricating the cone section can easily be understood. When this is done, the rest of the operation may be manipulated with comparatively little difficulty.

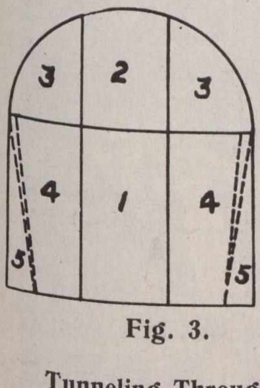

Fig. 3.

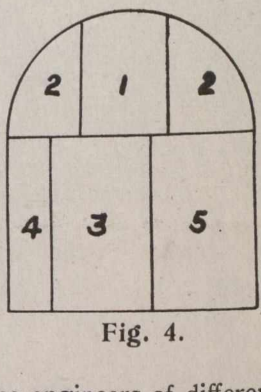

Fig. 4.

Tunneling Through Soil.—The engineers of different countries seem to have contrived methods by which every kind of loose structure may be successfully treated. In most respects the following methods are very much the same; the Belgian, English, German, Austrian and Italian differing only in the order in which the drifts and headings are excavated, and also in the different frame structure employed. The Belgian method consists of putting forward the arch before the walls are built; while in the German method the perimeter is excavated and lined before the core is removed. In types such as the English and the Austrian the whole fissure is excavated before the lining is placed, although, however, the excavation is never far in advance of the masonry work. The Italian method consists of excavating the lower half, lining it and filling it in again, followed by the work of excavating the upper half.

Submarine tunneling is perhaps the most expensive, and seems much more difficult than any of the other soft-ground tunnels, particularly in the case of tunnels which are constructed at small depths below the water bed. There is always a danger of flooding, and the materials encountered are extremely difficult to handle. Various methods are used, some of the most important being the shield method, the compressed air method, and when we come very close to river bed we use the cofferdam method, and pneumatic caissons.

The shield method is very interesting from a historical point of view. It was invented by Isambardt Brumel, a French engineer, in the early part of the 18th century. The Frenchman was gifted with a keen sense of observation. While cruising, he happened to observe the ingenious method of the ship worms in working their way into the wood. He noticed that as the animal bored its way in it applied a secretion which lined the opening and rendered the lining waterproof. Being an engineer, the idea intimated itself very strongly to his mind in connection with submarine tunneling. He immediately set to work to contrive a mechanical device which would give the same result as the boring of the small insect, and finally succeeded by inventing his universally known boring machine.

The invention consists of a circular boring disc placed immediately in front, which might be termed to represent the head of the insect, while the body is cylindrical in shape and constructed of steel in the form of a shell. In operation the earth is conveyed out and the tunnel is lined with steel tubing immediately in the wake of the boring machine. In this way it is kept perfectly water-tight, eliminating the possibility of cave-in, and making the otherwise difficult task into a comparatively simple operation.

HEWN OUT OF ROCK.

A peculiarity of the New South Wales Government dockyard on Cockatoo Island, in Sydney Harbor, is that it is hewn out of solid rock Historically, Cockatoo Island is of much interest, as it was the site of a large prison in the days when British convicts were deported to Australia. The present offices on the island are in the old prison buildings, the stone walls, barred windows, and iron-doored cells being still in evidence.

The formation of the island was originally quite unsuitable for a dockyard, as the solid rock rose sheer from the water to a height of 60 to 70 feet. By using convict labor, however, the rock was gradually cut back, first, to permit the building of graving docks, and later to make room for building slips and shops near water level. The work has been continued until at present two-thirds of the total area of thirty-three acres has been brought to a practically uniform level of about 15 feet above high tide.

When a beam of X-rays is passed through thin, rolled metal sheets to a photographic plate placed parallel to the sheet, H. B. Keene, of the University of Birmingham, finds that these patterns are of two classes, in one of which the central spot produced by the direct beam is surrounded by an irregular halo of smaller spots, while in the other the patches around the central spot are extended and form a faint but perfectly symmetrical design. The figures vary with the metal. Markings of the first kind are produced by metal sheets that are either well aged or recently annealed, and the symmetrical patterns are given by newly-rolled sheets. The spots are due to reflections from the micro-crystals within the metal; the symmetrical patterns are formed by the structure imparted to the metal by the rolling. Annealing a newly-rolled sheet changes the pattern from the second to the first class, and rolling an annealed sheet gives the reverse change.

WATERWHEEL GENERATORS

WATERWHEEL generators have recently been built to conform with the rapid development of hydraulic power for driving electric generators. The increased demands for such service require almost infinite combinations of capacity and speed range. Refinement in the design of both generators and waterwheels has made these changes possible; the successful operation of many high-voltage transmission lines and

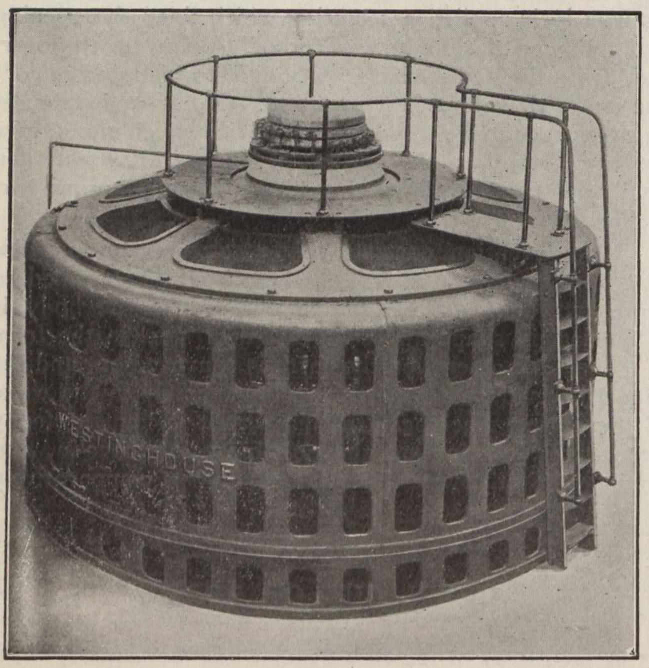

Fig. 1.—A 12,500-Kva., 6,600-Volt, 50-Cycle Generator Complete.

the ever-increasing demand for power, all aid materially in the utilization of many water powers heretofore considered either impracticable or inaccessible.

Two types of waterwheel generators are built—horizontal and vertical—depending upon the local conditions in each case.

Horizontal Type.—The standard horizontal unit is of the two-bearing, coupled type construction; that is, the generator includes shaft, two bearings, and a bedplate usually designed to allow for sliding the stator to one side in case ready access to either the stationary or rotating winding is desired. The stationary frame is made of a strong, rigid iron casting, into which soft steel laminations are dove-tailed and securely fastened.

Ventilating ducts are spaced at frequent intervals across the face of the armature punchings, allowing for perfect ventilation to all parts of the active material.

Form-wound, interchangeable armature coils fit into parallel open slots punched in these laminations, and these coils are held firmly in place by means of fibre wedges. The coils are insulated and impregnated with fabrics and compounds of high insulating qualities.

No single type of construction will meet the varied requirements in rotor design, therefore several well-tested methods are employed. When comparatively low peripheral speeds are encountered a cast-iron spider with bolted-on, or dove-tailed poles, is usually employed. For higher speeds cast steel, or steel plate construction may be used. In the case of very large relatively high-speed machines, the difficulty of securing perfect castings may lead to the well-proven laminated rim structure.

All field poles are made of thin steel laminations riveted together with overhanging pole tips provided to support the field windings.

Field coils are wound of heavy copper strap on edge, insulated in such a way that each individual turn is exposed to the ventilating air, and thus perfect radiation results. The coil is securely fastened between the rotating spider and the tips of the field poles by heavy coil supports.

All parts are carefully inspected during each step in the process of manufacture, and before the succeeding operation is started. When completed, the machine is carefully tested under conditions as nearly identical as possible to those which its future service will demand.

Vertical Type.—Westinghouse standard practice recommends that the generator be fitted with two guide bearings which are supported by brackets fastened to the stator frame. Also, a bedplate or pad on which the stationary part rests.

The roller, or thrust bearing, which supports the weight of the revolving part, may be mounted on top of the generator frame, between generator and turbine, or

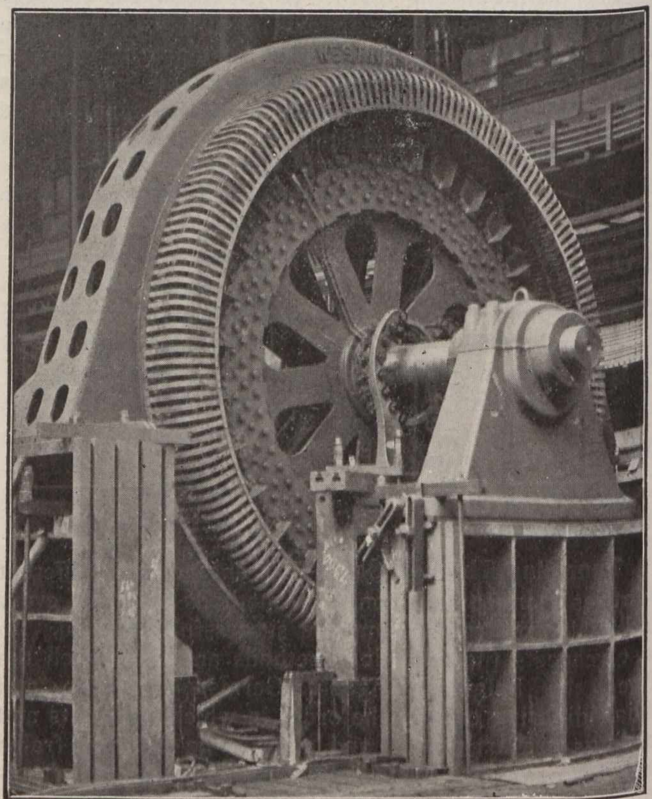

Fig. 2.—A 9,375-Kva., 6,600-Volt Unit, in Shop Testing Rig.

underneath the turbine. In case it is mounted on top of the generator frame, this frame must, of course, be made heavier and more expensive than in cases where it has only to support the stator punchings, winding and guide bearings. Wherever placed, this bearing usually supports not only the rotor of the generator, but also the turbine runner, and in addition takes care of any unbalanced water thrust.

A rigid cast iron frame, into which soft steel laminations are securely dove-tailed, forms the basis of the stator.

Form-wound, interchangeable armature coils are held in open slots by means of fibre wedges. The coils are vacuum dried and impregnated before the outside insulation is applied. This outside insulation consists of wrappings of paper and mica on the straight portions of the coils which lie in the slots, and servings of treated cloth over the V-shaped coil ends. After the outside insulation is applied the coils are treated with an insulating varnish which renders them moisture and oil-proof. An insulating coil is provided in each armature slot to prevent abrasion of the coil and a fibre wedge holds coil and cell firmly in position.

In case of failure of a waterwheel governor to act, the rotating part of both waterwheel and generator are subjected to unusual stresses, due to the overspeeding of these parts. The rotors here illustrated are designed for the maximum obtainable speeds which result in such instances. These overspeeds vary from 50 to 100 per cent. Due to the wide range of speeds encountered, no one type of rotor construction will give ideal results.

There are several designs of rotors, each one particularly well adapted for the requirements for which it is used. Comparatively low peripheral speeds may permit the use of a cast-iron spider with either bolted-on or dovetailed poles. A higher speed generator may demand an entirely different construction. For such work cast steel or rolled steel plates are often employed. In case of very large machines, it may be difficult to obtain perfect castings, and here the well-proven laminated rim may be employed.

Field coils are ordinarily wound with heavy copper strap on edge and insulated between turns with asbestos. This construction is particularly well adapted to give perfect radiating qualities, and because of the heavy strap used is practically indestructible. The coils are securely fastened between the rotating spider and projecting tips of the field poles by heavy coil supports.

Waterwheel generators of almost any practical capacity or speed for installation in the smallest isolated plant or the largest hydro-electric generating station have been furnished by the Westinghouse Electric and Manufacturing Company.

It is noticeable that the value and conservation of cheap fuel and power in the United States are being more fully appreciated each year. When it is borne in mind that coal in the States of Illinois, Ohio, Pennsylvania, Virginia and Alabama during the year 1910 averaged in price $1.08 per short ton at the mines, it will be better understood why these States occupy such prominent positions in the industrial world. The cost of transport in these States is not a serious item, for the cost of bituminous coal, according to quality purchased, ranges from $1.50 to $3.00 per ton, f.o.b. New York harbor. Coal in large quantities can be had in Pittsburg for $1.00 a ton, but even in remote parts of the above-named States the cost averages under $3 per ton. The supply of natural gas was at one time abundant and cheap, but extravagant waste has led to serious depletion and increase in price. Water power has been developed in some of these States, with the result that the cheap electrical power which is available, has contributed considerably to the development of the country around. As already stated, the movement in the United States towards the utilization of poor fuel is becoming stronger each year, and the result is the establishment of power plants where formerly it was not thought possible, and this is opening out new industrial centres to the advantage of all concerned.

NEW METHOD OF COOLING GAS ENGINES.

ORDINARILY about 30 per cent. of the heat value of the fuel passes from the hot gases to the cylinder walls and pistons, states Prof. Bertram Hopkinson, in a paper read before the Institute of Mechanical Engineers, at Cambridge, describing a new method of cooling the cylinder and piston of gas engines. In order to prevent the overheating of these parts under test conditions, it is necessary to provide a water jacket around the cylinder, and, in the case of large engines, to circulate water through the pistons and around the exhaust valves. Most of the disadvantages under which the gas engines labor are due directly or indirectly to this fact. The complicated and thick-walled castings required for the cylinders are apt to crack under the influence of the wide variations of temperature, and overheating of deposits on the internal walls of the combustion chamber causes pre-ignition, so that it is not always practicable to work a gas engine continuously at its maximum output.

The idea of introducing water into an internal-combustion engine is not new. It is a common practice in oil engines to introduce water along with the oil in order to permit the compression to be raised, and water has been injected into gas engines for the purpose of preventing pre-ignition. Proposals have also been made to introduce water for the purpose of cooling parts of the metal. None of the latter, however, have been practical, if indeed they have ever been more than just proposals on paper, apparently because their originators did not appreciate the conditions which must be satisfied with the injected water to act as an effective cooling agent. If the water be turned into steam before reaching the metal it will not exert any cooling effect, except indirectly by lowering the temperature of the flame, and such lowered temperature is accompanied by a considerable loss of efficiency. On the other hand, water which reaches the walls in liquid form and is there evaporated, absorbs out of the heat given to the walls by the gas the whole of its own heat of evaporation, and there is no loss of thermodynamic efficiency, because the heat used is waste heat, which, in a jacketed engine, would go to warm the cooling water.

The author claims that it is of no use to inject the water in a fine spray, or to introduce it into the gas or air pipe, so that it is carried in suspension in the incoming charge, or, as is often done in oil engines, to spray it in along with the oil. Although some of these devices have proved useful for the prevention of pre-ignition and for the softening of the explosion, none are effective for the purpose of cooling.

The author found, however, that by injecting water in comparatively coarse jets against the internal surface of the cylinder, and the head of the piston, the metal can be kept cool without materially cooling the gases, with the result that there is no loss of efficiency. The temperature of the parts can be perfectly controlled, and simple single-walled castings can be used for the cylinders.

Experiments of Dugald Clerk, the author, and others have shown that the rate of heat-flow from the gas into the metal is far more rapid at and soon after the instant of ignition than at any other time. It seems likely from these experiments that for practical purposes the heat flow into the barrel of the cylinder during the last three-fourths of the expansion stroke might be so small compared with that in the first period that direct cooling of this portion of the cylinder could be dispensed with altogether. This anticipation has been found correct, and it has been found necessary only to direct the spray against the walls in the combustion chamber, and the piston, the rest of the cylinder being kept cool by conduction. Cold water is injected through a hollow casting projecting into the combustion chamber and provided with a number of nozzles or holes about 1/32 in. in diameter, from which the jets are projected against the metal surfaces.

For the purpose of experiment, an 11½ x 21-in. Crossley engine, rated at 40 h.p., was fitted with a new cylinder consisting of a plain barrel without a water jacket. The injection rose is a hollow casting projecting into the combustion chamber and provided with 25 holes. The drip from the rose suffices to cool the exhaust valve. A simple plunger pump driven by a cam injects a charge of water once in a cycle, lasting from about 30 deg. before to 30 deg. after the point of the sliding surface of the barrel is covered by the piston. The quantity of water used was about 2.4 lb. per brake horse-power-hour, and the temperature of the engine ranged from 150 to 180 deg. C. The engine consumed about 15 cu. ft. of coal gas per brake horse-power-hour, both when it was water-jacketed and after being fitted with the new cylinder.

Tests at other loads showed that with a weak mixture the gas consumption is slightly increased by the water injection, but with very rich mixtures it is a trifle less. The difference, however, does not exceed 5 per cent. either way, and on the average it may be said that the economy is unaffected by the use of this method of cooling.

This engine was set to work driving a dynamo, and its speed was increased from 180 to 195 r.p.m., when it was found capable of developing 50 b.h.p. for many hours, an increase of 25 per cent. on its original maximum safe load. It has now been running for a total period of 5,000 hours on regular work, giving no trouble at all, and the combined wear on both cylinder and piston is less than 0.01 in.

To regulate the water supply in accordance with the load the pump is connected to the governor, which is of the hit-and-miss type, so that the pump only takes a stroke when the engine takes gas.

With a throttle governor a corresponding regulation is easily provided. A simple thermostat has also been devised, which automatically controls the supply of water during starting, and when the engine is running, quite satisfactorily.

In case of failure of the water supply, nothing happens except that the engine slowly heats up, and after ten minutes or so, pre-ignitions occur, bringing the engine to a standstill. No damage results from this, but to guard against any possible danger a fusible safety plug is screwed into the combustion chamber, which melts if the cylinder gets too hot, and the noise of the escaping gases warns the attendant.

The system has also been applied to an engine of 105 h.p., and to one of 1,000 h.p.; in each case the original cylinder was used, without water in the jacket. The large engine was run under load 30 hours without a stop; after a short stop for adjustments, it ran for 70 hours without a stop, driving a factory, and developing an average of 800 h.p. The whole of the injection apparatus for the 1,000-h.p. engine cost only $100, and within a few hours of putting it on the engine it was doing all the work of the cooling tower, centrifugal pumps, etc., previously used. An 18 x 24-in. two-stroke-cycle single-acting engine has been built for use with the new system, and is now undergoing trials.

COAST TO COAST.

Calgary, Alta.—The G.T.P. is erecting a temporary station, pending the conclusion of negotiations for permanent terminals.

St. John, N.B.—Two of the longest branches of the branch railways projected are now in operation, while the other three are in process of construction.

Toronto, Ont.—The date of the completion of the Dominion Government's harbor contracts has been set at four years hence.

Victoria, B.C.—The Daily Times contains an editorial calling attention to the uncertain suspension in the plans for the terminals on the reserve and magnificent bridge that was to span the harbor from Johnson Street. The government announced this construction about a year ago.

Vancouver, B.C.—Eighty miles of double track have been completed from Vancouver west to Ruby Creek, and have been inspected by the Railway Commission Engineer. Formal approval for the operation of the second track is expected shortly.

Toronto, Ont.—It will be requested before the Ontario Railway Board that the Toronto Railway Company be compelled to extend their line west along Bloor Street from Dundas Street to Quebec Avenue, instead of constructing the projected Toronto suburban line along Annette Street and Pacific Avenue.

Ottawa, Ont.—The question of pollution of navigable streams and their tributaries, upon which a special committee of the House of Commons heard last season a great deal of evidence and gave a report, will likely furnish food for a conference between the provincial and federal authorities this autumn. The report recommended the calling of an interprovincial conference, and it is understood that all provincial governments will be called upon to send delegates to a gathering of experts to be held in Ottawa in November.

Winnipeg, Man.—Mr. George Bury, vice-president of the C.P.R., has stated that the program mapped out by the company for 1913 will be completed to the last detail, and that all the grading and steel work planned to be done will be finished this year. Concerning the double tracking, he said that more of it would be in operation before the close of the year.

Edmonton, Alta.—It was stated by Sir William Mackenzie on his return trip from inspecting the western progress of the C.N.R., that construction was now 74 miles beyond the British Columbia border, and that the company hoped to have the road to the coast completed by the end of 1914. He added that 300 miles of branch lines have been laid through the prairie provinces this year, and that, taken in all, the C.N.R. has laid 840 miles of new track since the beginning of the year.

Toronto, Ont.—Hydro power has enabled the farmer of Western Ontario to chop ensilage, thresh grain, and stock his barns by electrical energy. This revolution of the system which handles the annual harvest will, according to present indications, branch out beyond Ontario boundaries. Negotiations are now under way, it is understood, between Detroit and Windsor for the sale of power to the American city for like industrial purposes. The Hon. Adam Beck has stated that, though this is the first instance where power has been sought in this way, all municipalities agree that such disposal of power could be arranged under certain restrictions. A town could sell of its surplus to the extent of 7,500 horsepower, and anything in advance of that should be returnable from time to time as required, on a year's notice. Thus, municipalities might be aided by the payment of fixed charges until they require the full voltage for their own industries. Where a permanent disposal of power would be desired, the matter would have to come before the commission.

Calgary, Alta.—Sir William Mackenzie made the statement on September 17th that he expected to see the C.N.R. in operation in Calgary within sixty days. It is the opinion of shippers that though the line is somewhat rough, it is in good enough condition for freight traffic.

Moose Jaw, Sask.—The shortage of the supply of cement throughout western cities is not being felt in this city. Owing to the renewed building activity of late, the supply on hand in city warehouses was taxed to keep up with the demand, but no serious hold-up in business operations was caused.

Ottawa, Ont.—At the instigation of the Canadian Manufacturers' Association and the Ottawa and other Boards of Trade, the railway board has asked the railways to extend their cartage system until January 1st. So far negotiations have been without result, but it is hoped that transportation interests will be strong enough to provide a reasonable agreement until the whole matter is finally settled.

Ottawa, Ont.—This is the first fall that the two conservation dams of the Upper Ottawa have been working to their full capacity and consequently there will be a great deal of interest particularly among power owners concerning the effect these dams will have on the volume of water available at the Chaudiere. So far it would seem that these dams are very effective in holding back the water for the low water seasons. This has been a very dry season and consequently the amount of water coming down to the Chaudiere would be expected to be very much reduced. However, it has held up remarkably well. At the very low water period a few years ago there were only 7,000 cubic feet of water per second flowing at the Chaudiere, while now the flow is about 24,000 cubic feet, or over three times as much. The two dams, at Kippewa and at Temiskaming, are both in operation this year. They hold back the water in the wet seasons and let it out in the dry seasons in order to keep the level of the river more nearly uniform all year. Then they begin about November to store up water again from the fall rains and let it out during the winter. The government is now building a third dam at Lake Quinze, which is farther up and will increase the storage capacity considerably. To give an idea of the vast amount of water these dams conserve, it is equal to a body of water with an area of 4,000 square miles and a depth of one foot. Besides making the water higher in the low water periods it will to a certain extent relieve the floods of the spring by holding back the water. The work has been conducted by the Dominion government and will cost about $1,000,000.

Saskatoon, Sask.—The Canadian Pacific Railway is contemplating the building of a direct line from Calgary to this city, which will make the second direct line of communication between the two cities. The Grand Trunk Pacific has already chosen its right-of-way into the city.

Toronto, Ont.—Prof. A. T. Laing, of the University of Toronto, has returned from his travels through Italy, Switzerland, France and Great Britain. During the four months of his absence he devoted most of his time to the study of roadway conditions. Prof. Laing stated that one, after travelling abroad, and particularly in Scotland, is impressed with the fact that there is still much to be learned or put into practice in Canada in order to keep pace with other countries, or to meet even in a remote way the economic requirements essential to development. The time has come, said he, when the older and more densely populated districts much have better transportation facilities. Prof. Laing remarked that, as Toronto was surrounded by the best of agricultural land, he could see no reason why she should not be served by the district within a radius of thirty or forty miles. But this he believed to be impossible with the present conditions of the roads. By the use of the motor truck produce can be carried fifty miles in the Old Land.

Kerrisdale, Point Grey.—A lighting experiment is being tried in Point Grey, which, it is said, has already been favored by delegations of ratepayers from Wards Two and Three who have examined it. Point Grey is the first municipality in the district to endeavor to determine what can be accomplished by a municipal lighting and heating plant, and other municipalities are stated to be keenly watching the progress of events. The light, which is very brilliant, and yet soft to the eyes, is obtained from gas manufactured from petrol, and is declared to be produced at a very low rate, the trial working out at a cost of about 69 cents per thousand cubic feet of gas. The plant works on an automatic principle, it being said to only require attendance about once in six months. The illuminant is now on trial, and if successful a proposal may be made for the municipality to undertake the lighting of the district. The gas can be used for a variety of purposes, street and house lighting, house heating and cooking purposes. If this principle is adopted, small plants will be erected in various parts of the municipality, this being a better method than having one large central plant, as it will not be necessary then to have large gas mains throughout the area, the small plants being able to supply each section through small pipes. No scheme, however, has yet been outlined, the matter still being in a tentative stage.

Montreal, Que.—The Harbor Commissioners, at a conference held recently with the Hon. J. D. Hazen, Minister of Marine and Fisheries, obtained an additional grant of $18,000 for the purpose of completing the new addition to the grain elevator, the original grant of $50,000 being found insufficient. The Commissioners hope that the only works contemplated in the harbor for the immediate future will be finished this year. On their return they expressed extreme gratitude for the liberality the Minister had shown in granting their requests. The question of a free port, which has been agitated here for some time, was also briefly discussed. In the opinion of Commissioner Robertson, Montreal was already a free port, and the Board of Trade and other commercial bodies were, therefore, asking for something they already had. Mr. Robertson stated that he was unaware where any port existed at which there were no tolls to correspond to all the harbor charges in Montreal. The report of the Royal Commission on Transportation in its last sitting, urged that Montreal be established as a free port; but this Mr. Robertson held had already been done, though without any special sanction from Parliament.

Montreal, Que.—An additional $20,984 for sidewalks is the request of the Board of Control from the City Council as a result of Superintendent Barlow's report, submitted at a recent meeting. It is found that more sidewalks than it was expected can be laid this year before cold weather sets in, and the supplementary amount of money is requested that as much work as possible can be done, especially on streets which have been paved, but on which sidewalks are not yet laid.

Ottawa, Ont.—About 1,000 tons of peat from the plant at Alfred, Ont., will be sold in Ottawa this winter. The price of this commodity to Ottawa people will probably be $5 per ton. The Government three years ago, as an experiment, installed a plant there that had proved most successful in Europe, and turned out thirty tons a day. Later, the Government sold their portion of the bog to private interests, who have installed improved machinery. Two years ago peat from this bog was sold here, and found a ready market. By analysis one ton of hard coal goes as far as one ton and three-quarters of peat, but by actual practice this is not the case; for much is lost in the coal by combustion and in the escaping of half-burned clinkers, whereas in peat the combustion is almost complete, and the substance is burned away to a fine ash. Canada has 37,000 square miles of known peat bogs, constituting a potential national asset of enormous value. Four bogs, within five miles of Ottawa, examined by Government experts, are estimated to contain over 25,000,000 tons of fuel.

Toronto, Ont.—The Toronto Hydro-Electric system made a profit of 13.19 per cent., or $71,000 during the first six months, ending July 1.

Fort William, Ont.—The Board of Railway Commissioners for Canada, at a sitting in Ottawa, September 16th, granted permission for the Grand Trunk Pacific Railway Company to construct a double track branch line from its main line at Empire Avenue, Fort William, northward on what was formerly known as James Street, thence easterly along the city limits to Thunder Bay. The new spur track will be over three miles in length and will open up and serve a large industrial area as well as giving the Grand Trunk Pacific Railway access to the new Government elevator.

Winnipeg, Man.—Track laying on the main line of the G.T.P. Railway is progressing towards Prince George at a rapid rate. Steel is at mile 1,200 from Winnipeg. While the steel bridge across the Fraser River was being completed, a short check was experienced at mile 1,197, where the railway for the second time crosses the Fraser River. This obstacle has now been successfully passed, and the track laying machines are steadily pushing their way forward. The Fraser River is crossed for the third time about 40 miles west of the second crossing, but the bridge here will not be allowed to delay track laying, and a temporary trestle will be erected to get the steel across the river. The steel bridge will be put in place shortly after, and towards the end of November the track should reach Prince George. One hundred and four miles of branch line in the province of Saskatchewan have just been opened for traffic by the G.T.P Railway, with the inauguration of a mixed train service on a part of the Biggar-Calgary branch. This line has been completed to Loverna, on the boundary line between Saskatchewan and Alberta, 104 miles from Biggar. Track laying on the Regina-Moose Jaw and north-westerly branch of the G.T.P. Railway has just been completed to mile 91, a short distance beyond Mawer, Sask., and within a couple of miles of the Saskatchewan River. Permission has just been granted by the Board of Railway Commissioners for operation of this line, and it is probable that a considerable amount of wheat will be shipped over it this year.

Montreal, Que.—Mr. H. S. Holt, president of the Royal Bank, and of the Montreal Light, Heat and Power Company, made some interesting observations on tne progress of the work of the C.P.R., throughout the past year. He states that the company is spending in the west on extensions, terminals, and double-tracking, as much as, if not more than, it spent on the original system; that 1,100 miles of new trackage are under way at present and thousands of men at work on their construction; that over $30,000,000 is being expended this year in the west, and in no part of the system is finality disclosed; and concerning the Windsor and Place Viger stations, that before the company has finished their construction with the offices and the slow and tedious system of trackage involved, there will have been an expenditure of about $8,000.000.

PERSONAL.

A. P. LOW, Deputy Minister of Mines, Ottawa, will retire shortly.

H. C. QUAIL, B.A.Sc., has received an appointment to the staff of the Midland Construction Co., at Healey Falls, Ont., and assumes his duties this week.

CHAS. B. GORDON, of Montreal, was elected president of the Canadian Manufacturers' Association at its recent convention in Halifax.

FRANK S. STREETER, one of the United States members of the International Joint Commission has resigned and OBADIAH GARDNER, ex-Senator, Maine, has been appointed in his stead.

CHARLES T. MILLER is a name which we inadvertently omitted from the list of directors of the Maritime Bridge Co., published in our issue of September 11th. Mr. Miller is secretary of the Canadian Bridge Co., Limited, Walkerville, Ont.

W. A. EVANS, recently Public Health Commissioner of Chicago, has been touring the cities of the Canadian West, and has delivered a number of instructive addresses on the subject of public health. Winnipeg, Regina, Moose Jaw, Medicine Hat and Saskatoon were among the places visited by Dr. Evans on his trip.

H. F. MEURLING, C.E., of the Columbia River Hydrographic Survey, is in charge of work near Burton, B.C. The river is undergoing measurement and soundings to find out whether a dam and locks can be built below the narrows at Caribou Point, to raise the water sufficiently for navigability throughout the entire year.

OBITUARY.

DONALD J. McLACHLAN, a well-known contractor of Calgary, died on September 22nd.

AUSTIN BARRETT, in charge of a survey party in British Columbia, was accidentally shot and killed last week. Mr. Barrett was a native of Puslinch, Ont.

E. GRAHAME-JONES, a young engineer connected with a construction party of the Canadian Northern Pacific Railway, was drowned in the Fraser River, near Lytton, B.C., by the upsetting of a small boat. Mr. Grahame-Jones' home was at Stanstead, Surrey, Eng.

COMING MEETINGS.

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

UNITED STATES GOOD ROADS ASSOCIATION.—Convention will be held at St. Louis, Mo., November 10th to 15th. Secretary, J. A. Rountree, L021 Brown-Marx Building, Birmingham, Ala.

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

AMERICAN CONCRETE INSTITUTE.—Tenth Annual Convention to be held in Chicago, February 16th to 20th, 1914. Secretary, E. E. Krauss, Harrison Building, Philadelphia, Pa.