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MISSING

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Reconstruction of the Eaton "Model Highway"

Change in Traffic Conditions in Eight Years Necessitates Substitution of Hot Mix Bituminous Concrete for Water Bound Macadam—Motors Now Over 70% of Traffic on Road Instead of 10% as in 1909

IN 1909 Sir John Eaton, president of the T. Eaton Co., Limited, of Toronto and Winnipeg, set aside $20,000 for the purpose of demonstrating the benefits to be derived from a properly constructed macadam highway. This money was applied to the construction of about 3¼ miles of waterbound macadam west of the C.P.R. tracks on Dundas Street, near Lambton, Ont., the work being under A. W. Campbell, then Deputy Minister of Public Works for the Province of Ontario, and W. A. McLean, who is now Deputy Minister of Highways of Ontario. The road became known locally as the Eaton Highway, or the Eaton Model Road, and Sir John Eaton also paid the maintenance expenditures, amounting to about $10,000, up to the end of 1913, when the Toronto and York Highway Commission assumed jurisdiction over this road and a treatment of Tarvia A, which had been previously applied, was followed at the commission's expense by annual treatment with Tarvia B.

For eight years this road proved a great boon to a large portion of Etobicoke Township and also to a considerable part of Peel County, as it was the chief means of access to the city of Toronto for the traffic from a big agricultural district. At the time the road was built, steel-tired, horse-drawn traffic constituted 90 per cent. of the traffic carried by the road. By 1917, traffic conditions had changed to such an extent that rubber-tired, self-propelled vehicles were found by a traffic census to be about 70 per cent. of the total traffic on the road. The census

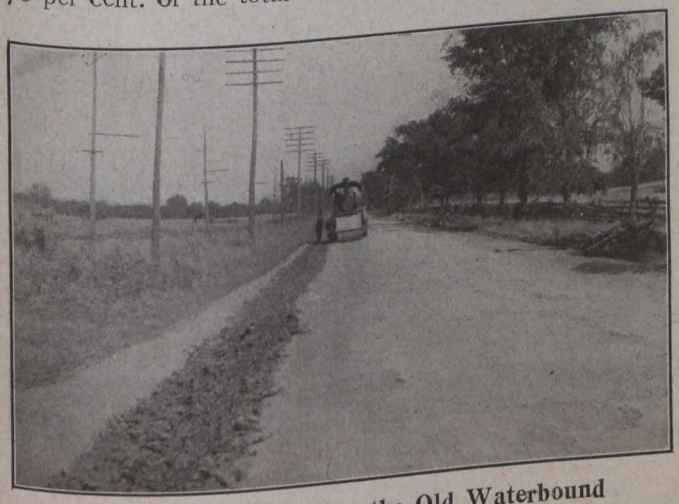


Fig. No. 1.—Scarifying the Old Waterbound Macadam Road

also proved that the road carried heavy traffic. Although the old road was still in fair shape, the change of traffic conditions required such heavy maintenance that a more expensive type of construction was considered economical, so Sir John Eaton offered to reimburse the Toronto and York Highway Commission for their portion of the expenditure on a new road, provided that a modern type of asphaltic concrete road would be built in such manner as to entitle the county to the 40 per cent. provincial subsidy authorized by the Ontario Highway Improvement Act.

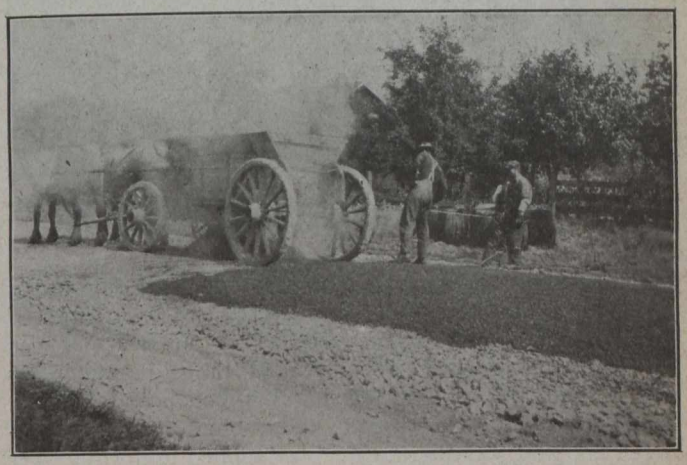


Fig. No. 2.—Unloading the Hot Mixed Material for the Top Course

It was later decided to extend the rebuilt Eaton road westerly to the Summerville Bridge, making a total length of 21,290 feet, or slightly more than four miles, and Peel County is now seriously considering the extension of the road for about another three miles to Cooksville.

The Eaton road was reconstructed during the summer of 1917, the contract being awarded to the Asphaltic Concrete Co., Limited, who scarified and prepared the old surface and then sublet the construction to the Constructing and Paving Co., Limited, of Toronto. The work was under the supervision of E. A. James, engineer of the Toronto and York Highway Commission, and under the inspection of the engineers of the Ontario Department of Public Highways. The actual construction was under the direction of F. B. Neeve, general manager of the Constructing and Paving Co., Limited; Arthur A. Ridler, general superintendent of that company; and Andrew Kinghorn, manager of the Asphaltic Concrete Co., Limited.

The new road is asphaltic concrete, hot-mix method. Crushed limestone was used from various Ontario quarries. Four hundred tons of Mexican Eagle asphalt were supplied by the Asphalt and Supply Co., Limited, of Montreal, fifty tons of Imperial asphalt by the Imperial Oil Co., Limited, of Toronto, and eight tons of Trinidad asphalt by the Barber Asphalt Paving Co., of Philadelphia. All flux used was Fluxphalte, supplied by the Asphalt and Supply Co., Limited, of Montreal, excepting for the Imperial asphalt, which was supplied already fluxed.

The road is 18 ft. wide, with a 3-ft. asphaltic macadam (penetration method) shoulder on each side, making a total width of 24 ft. The contract price was $1.10 per square yard for the asphaltic macadam mixed method, and 90 cents per square yard for the asphaltic macadam penetration method, or a total of $14,784 per mile.

Before the work was begun, adequate side ditches were opened and properly graded so as to carry all water

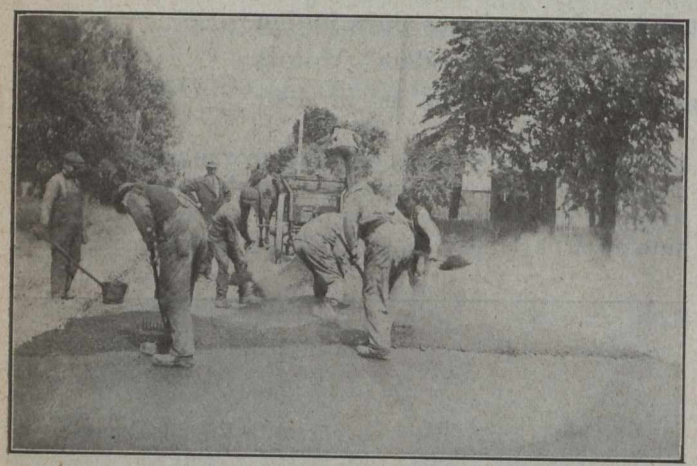


Fig. No. 3.—Raking the Hot-mixed Material with Hot Rakes. Material in Foreground Has Been Rolled

from the road allowance. The old road was thoroughly scarified for its full width and length and to a depth of about 4 inches. The loose stone left by the scarifier was harrowed and graded, the crown of the old road being lowered and the road widened. A 2-inch layer of fresh, clean stone was then spread, and asphalt (heated to between 200 and 300 degrees F.) was applied uniformly over the surface by hand sprinklers as a binder course, using between ½ and ¾ Imperial gallons of asphalt per square yard of surface. While the asphalt was still hot and plastic it was rolled with a 10-ton three-wheel steam roller until the course was thoroughly compacted and the surface true and even, conforming to the established grade and contour of the finished surface of the road.

The top course was laid so that when finally compressed and completed it had a uniform thickness of not less than 2 inches. The top course consists of a mixture of crushed stone, sand and limestone dust, to which was added asphaltic cement in sufficient quantity to coat thoroughly the particles composing the mixture and so as to fill all voids and produce a slight excess on the surface of the pavement after being thoroughly rolled. The materials composing the top course were mixed in the following proportions by weight:—

Stone (½-inch), 48 to 60 per cent.
Sand, 36 to 20 per cent.
Dust, 6 to 12 per cent.
Asphaltic cement, 10 to 8 per cent.

The stone and sand were heated to a temperature between 300 and 400 degrees F., and were thoroughly mixed with the mineral dust in a standard portable one-car asphalt plant, which was operated first at Lambton, at the east end of the work, and later moved to a C.P.R. siding at Islington, a distance of about one mile from the easterly end of the work and about three miles from the westerly. The mixture of stone, sand and dust was further mixed with asphaltic cement heated to about 250 degrees F. so as to produce a thoroughly homogenous mass, with all of the mineral aggregate covered with asphaltic cement. This mixture was immediately carried to the road in wagons properly protected from radiation and was applied at a temperature of about 300 degrees F. It was found that the temperature of the mixture did not at any time drop more than 10 degrees between the plant and the job. After being unloaded on the road, each load of the mixture was shovelled into place in such manner that the whole of it was moved promptly from the pile into which it was unloaded. It was then spread with hot rakes, great care being taken that all lumps were thoroughly broken up and the whole surface carefully spread to such depth as would insure a thickness in all places of at least two inches when ultimately compressed. The rolling was started at the side and continued towards the centre until there was no more movement of the bituminous surfacing ahead of the roller. Care was taken that no more of the binder course was laid at any time than would be covered with the top course within an hour.

After the surface of the pavement had been well rolled so that it was even and true without waves or depressions, a thin coat of asphaltic cement (from 1/5 to 1/4 Imperial gallon per square yard) was squeegeed over the entire surface, including the inner six inches of each shoulder. While this coat was still hot it was evenly covered with a thin layer of clean, sharp, hot sand, rolling then being continued.

New stone was used for the shoulders, about 1½ Imperial gallons per square yard of asphaltic cement being applied by hand sprinklers just before the squeegee coat was applied. The same asphalt was used for this penetration work as for the mixed method, but it was fluxed to a higher penetration. The shoulders were first rolled at the same time as the top course, and were rerolled together with the remainder of the road after the application of the squeegee coat and sand. The shoulders were sanded to the outer edges.

The contractor guaranteed the road for a period of three years from the date of acceptance by the Toronto and York Highway Commission, and agreed to make all necessary repairs and maintenance for that period.

Fig. No. 4.—Rolling the Top Course

Following is the specification which was used for the asphaltic cement for the penetration method:—

1. It shall be homogeneous and free from water, and shall not foam when heated to a temperature of 150 degrees centigrade.

2. It shall have a specific gravity at 25 degrees centigrade of not less than 0.98.

3. It shall have an open flash point of not less than 190 degrees centigrade.

4. It shall have a penetration (No. 2 needle, 100 grams, 5 sec., 25 degrees centigrade) of not less than 130 degrees nor more than 180 degrees.

5. It shall have a ductility at 25 degrees centigrade of not less than 75 centimetres.

6. It shall be soluble at room temperature in chemically pure carbon disulphide to the extent of not less than 99.5 percentum by weight in the case of oil asphalts, and native asphalts shall show a percentage of material soluble in carbon disulphide characteristic of the products of the fields from which they come.

7. Of the material soluble in carbon disulphide not less than 14 percentum nor more than 30 percentum by weight shall be insoluble at room temperature in 76 degrees Baumé paraffin petroleum naphtha distilling between 60 degrees and 88 degrees centigrade.

8. It shall show not less than 10 percentum nor more than 18 percentum by weight of fixed carbon on ignition.

9. It shall contain not more than 5 percentum by weight of paraffin scale with a chill point of 18 degrees centigrade when calculated on the basis of distillate.

10. Fifty grams of the material, when heated in a cylindrical vessel 5.5 centimetres in diameter and 3.5 centimetres deep, shall not lose more than 5 percentum by weight nor shall the penetration of the residue (No. 2 needle, 100 grams, 5 secs., 25 degrees centigrade) be less than 50 percentum of the original penetration.

Asphaltic cement for the hot-mix construction was prepared under the following specification:—

1. It shall be thoroughly homogeneous and the various bituminous ingredients contained in it shall be in a state of complete solution. It shall not be oily to the touch.

2. It shall have a penetration (No. 2 needle, 100 grams, 5 sec., 77 degrees Fahr.) of not less than 50 nor more than 75 degrees.

3. It shall not flash below 350 degrees Fahr. when tested in open cup.

4. It shall be soluble at air temperature in carbon disulphide to an extent characteristic of the material

Fig. No. 5.—Putting on the Squeegee Coat

obtained from the same source as that which it is proposed to use.

5. Its bitumen, as determined by clause 4, shall be soluble in carbon tetrachloride to the extent of not less than 98.5 per cent. by weight.

6. Its bitumen, as determined by clause 4, shall be soluble in 76 degrees Baumé paraffin petroleum naphtha to the extent of not less than 65 nor more than 85 per cent. by weight.

7. It shall yield not more than 16 per cent. by weight of fixed carbon on ignition.

8. Fifty grams of the material, when maintained at a uniform temperature of 325 degrees Fahr. for 5 hours in a cylindrical vessel 5.5 centimetres in diameter and 3.5 centimetres deep, shall not lose more than 5 per cent. by weight. The penetration of the residue remaining shall not be less than 50 per cent. of the original penetration.

Fig. No. 6.—Sanding Over the Squeegee Coat

9. It shall have a ductility (Dow Mould, 5 centimetres per min. 77 degrees Fahr.) of not less than 75 centimetres.

10. In this specification "bitumen" shall mean any hydrocarbon or hydrocarbons soluble in carbon disulphide.

The sand requirements of the specification were as follow:—

The sand shall be hard-grained, clean, moderately sharp and shall not contain more than 1 per cent. of clay or loam. On sifting, the whole shall approximate, as nearly as possible, the following grading:—

Percentage of sand	Pass	Retained on
20	8 mesh sieve	30 mesh sieve
27	30 mesh sieve	50 mesh sieve
30	50 mesh sieve	80 mesh sieve
15	80 mesh sieve	100 mesh sieve
7	100 mesh sieve	200 mesh sieve
1	200 mesh sieve	

Regarding the crushed stone and screenings used on the road, the requirements of the specification were as follows (NOTE: All stone used on the job fulfilled the requirements of Grade B):—

Crushed stone shall be bedded rock or boulders which have been broken by mechanical means into fragments of varying shapes and sizes. It shall not contain more than 10 per cent. by weight of soft or friable material. Material of which the particles are coated with dirt or have the edges worn off will not be accepted.

No crushed stone shall be accepted which shows signs of being disintegrated or reduced in quality by the action of the weather.

Crusher run shall be the product of the crusher, of which not more than eight per cent. by weight shall pass a one-quarter inch opening.

The following schedule of sizes shall be used, with the percentages of material larger than the maximum and smaller than the minimum openings respectively as shown. The sizes of opening shall mean the diameter of circular openings in steel or iron plates. The percentages shall be determined by weight.

The sizes of stone with the openings by which they are obtained are as follow:—

Name of size	Maximum size of opening in inches.	Max. per cent. retained by max. size of opening.	Minimum size of opening in inches.	Max. per cent. passing min. size of opening.
5-inch	5	3	4	8
4-inch	4	3	3	8
3-inch	3	3	2½	8
2½-inch	2½	5	2	10
2-inch	2	5	1½	10
1½-inch	1½	5	1	15
1-inch	1	5	½	15
½-inch	½	7	¼	15

Screenings shall be material all of which shall pass a one-quarter inch screen.

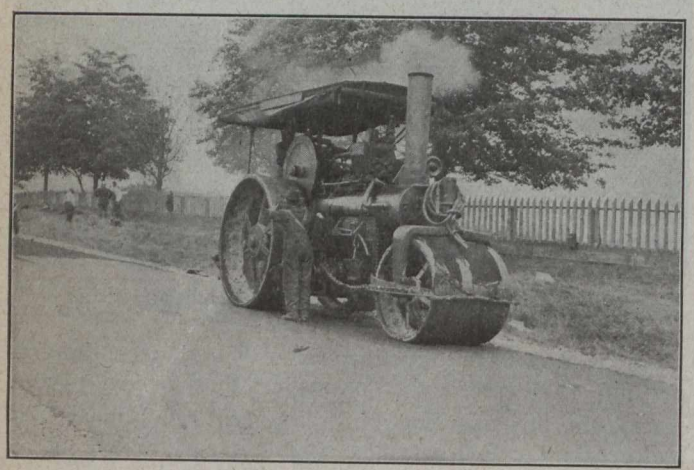


Fig. No. 7.—Final Rolling, Road Completed

Mineral dust shall be finely pulverized stone of which not less than eighty per cent. by weight shall pass a 200 mesh screen.

In addition to fulfilling the foregoing requirements, crushed stone shall be classed into three grades, according to qualities which shall be determined by tests conducted in a properly equipped laboratory. The properties determined shall be: Coefficient of wear, toughness, and absorption. Material meeting the requirements of any of the grades with respect to absorption may, on consideration of the engineer, be classed with the higher grade.

Crushed stone shall be classed under one of the following grades:

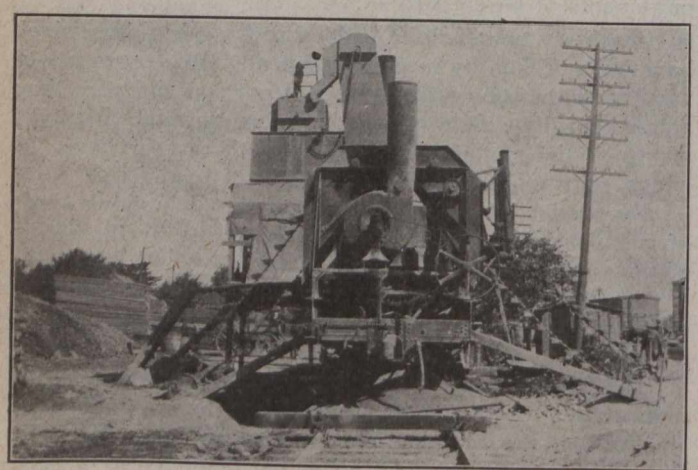


Fig. No. 8.—The Portable Asphalt Plant on Flat Car at Islington Railroad Siding

Grade "A" is a rock which has a toughness of not less than eighteen, a coefficient of wear of not less than fourteen, and an absorption of not more than six-tenths pound per cubic foot.

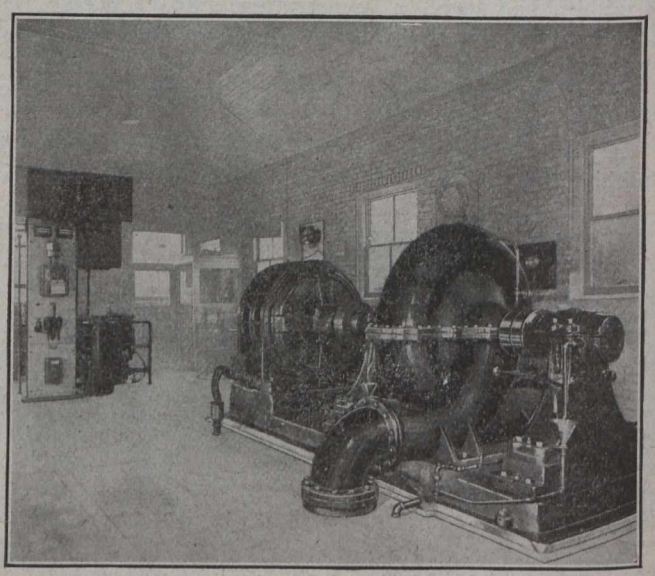
Grade "B" is a rock which has a toughness of not less than ten, a coefficient of wear of not less than seven and an absorption of not more than one pound per cubic foot.

Grade "C" is a rock which has a toughness of not less than seven, a coefficient of wear of not less than five, and an absorption of not more than one and five-tenths pounds per cubic foot.

SINGLE STAGE PUMPING UNIT OPERATES AT HIGH EFFICIENCY UNDER UNUSUAL VARIATIONS OF HEAD AND CAPACITY

THE motor-driven centrifugal pumping plant recently completed at the Riverdale station, Toronto, was designed to deliver five million Imperial gallons in twenty-four hours, against a head of 170 feet and running at a speed of 720 r.p.m., but owing to probable variation in pressure and consumption, the city required the unit to deliver either three million gallons or one million gallons against a lower head, varying from 130 feet to 70 feet. This requirement called for great flexibility of the unit in both speed and capacity.

Under such conditions, it is usual to install two pumps, but the contractors, Canadian Allis-Chalmers, Limited,



Motor-driven Pump at Riverdale Station, Toronto

designed and built one single-stage pump which has fulfilled all the guarantees required by the city. The usual practice also is to supply constant speed induction motors for centrifugal pumps, but as the speed to fill the above requirements must vary from 720 r.p.m. down to 350 r.p.m., the Canadian General Electric Co., Limited, built a special 250 h.p. variable speed motor which fulfils the requirements of the city.

The pump has a specially designed and constructed cast-iron spiral casing, with discharge and suction inlet cast on to the lower body. This casing is split on a horizontal centre line, so as to facilitate inspection without dismantling pipe or any other part of the unit. A set of

removable diffusion guide vanes has been provided so as to guide the water from the impeller to the casing in the most efficient manner. The impeller is made of cast bronze and is polished so as to eliminate unnecessary friction.

Special neck rings have been provided so as to decrease the leakage water from the pressure side to the suction side. The impeller is of double suction type. Proper stuffing boxes are arranged on each side of the extending shaft, and bronze sleeves are provided so as to eliminate rust and undue wearing. The shaft itself is made of hammered steel and of ample design to prevent any vibration.

Separate outboard pedestal bearings are provided in order to carry the shaft, and one of these bearings is arranged with forged collars which act as a thrust bearing in order to take care of any unbalanced thrust which might occur occasionally. All bearings are arranged for water cooling and are of the self-aligning, ring-oiling type. Separate sub-bases are provided to facilitate dismantling and direction. Both bearings are tied up to the main pump casing by means of stay bolts, so as to make the whole unit as rigid as possible.

A flexible pin type coupling is arranged for connecting up the pump with the motor. The whole unit is set upon a heavy cast-iron base plate which is grouted in to the foundation. The unit has proven to be exceedingly quiet during operation, a point insisted upon in the specification, and to be well over 70 per cent. in efficiency at the various tests and operating at the various speeds, which is remarkable for a single-stage pumping unit operating under such conditions.

LIEUT.-COL. MONSARRAT DELIVERS ADDRESS ON QUEBEC BRIDGE

Before the Canadian Society of Civil Engineers at Montreal last Thursday, November 22nd, Lieut.-Col. C. N. Monsarrat, chairman of the Board of Engineers of the Quebec Bridge, delivered an address in which he described the Quebec Bridge in a most interesting and instructive manner.

It was the first of a series of talks on the Quebec Bridge, the next one to be given on December 6th, when Geo. F. Porter, M.Can.Soc.C.E., will follow up the discussion commenced by Lieut.-Col. Monsarrat last Thursday.

The speaker of the evening was introduced by Walter J. Francis, chairman of the Papers and Meetings Committee.

The attendance was the largest in the history of the society—the assembly hall being crowded, many having to stand in the aisles.

In introducing the speaker of the evening the chairman referred to the wonderful achievement of Canadian engineering as represented by the successful completion of this enterprise with which success the name of Lieut.-Col. Monsarrat is so intimately linked.

Lieut.-Col. Monsarrat in opening his remarks referred to the difficulty of covering in so short a time so important a piece of engineering work. Nevertheless, in spite of that fact, the address, supplemented by lantern slides, was exceedingly interesting to the large audience present.

The speaker described the sinking of the huge caisson, 188 feet long by 55 feet wide, which was eventually used for the southern pier, and two smaller ones for the northern pier. By these changes the centre of the new bridge was made to coincide with that of the original structure, the span being increased to 1,800 feet.

With a series of slides Lieut.-Col. Monsarrat explained the construction and gradual sinking of these enormous caissons to their final resting place. At one spot, 20 feet below the bed of the river, they encountered a large steel plate from the original bridge, which could not be cut, so had to be carried down to the bottom.

The speed with which such vast plans could progress was shown by the fact that the average rate of sinking these caissons ran from 4½ to a little over 5 inches a day, at the lower levels the "sand hogs" working under 45 pounds pressure, and being only able to take two turns of an hour each daily.

Lieut.-Col. Monsarrat then gave a description of the immense masonry anchor piers on which the steel superstructure is built and held in position. These were 136 feet long by 29 feet wide, built of masonry, whose cyclopean proportions were evident in the views, especially when compared with the workmen, while the immense stones, some of them of five cubic yards, had to be dressed to the most exact proportions. While little of it was visible, Lieut.-Col. Monsarrat said that the pier itself was 136 feet high from the ground.

To carry the bridge these huge stones, 4 feet deep and many of them 8 ft. long, which carried the bridge shoes with a pressure of 55,000,000 pounds, had to be beveled to within 1/100 of an inch, but the result showed that a good job had been achieved. The extreme delicacy of this part of the work was shown by the fact that about six weeks' work was required with machines and masons for each of the four beds on the main pier.

Another problem to be considered was wind pressure, and Lieut.-Col. Monsarrat explained ingenious devices by which the average direction and pressure of the wind to be met by the bridge had to be dealt with, and showed the various huge chords and trusses which are now doing the work.

Lieut.-Col. Monsarrat then dealt with the metal work, and illustrated the enormous chords, running into many tons, whose accuracy had to be 12/1,000 of an inch in 50 feet.

Another interesting series of views showed the completed structure from the interior, with the ponderous floor arrangement, giving a splendid idea of its strength.

At the conclusion of the address Sir John Kennedy moved a hearty vote of thanks. Sir John said that he could appreciate the joy with which his fellow engineers would follow the progress of this tremendous structure, as he had not been able to do, owing to his loss of sight.

Following the description given, including the substructure, the quality of material, the workmanship, everything from the caissons to the top of the towers, seemed to be perfect, and an achievement of which Canada might well be proud, Sir John particularly emphasized the progress of metal bridges during the last century as exlasting and contrasting memorial should be prepared to illustrate what had been accomplished.

The vote of thanks to Lieut.-Col. Monsarrat was carried with loud applause.

In our issue of October 25th, 1917, page 357, it was stated that Messrs. W. W. Patterson Co., of Pittsburg, had furnished some wire rope block for use in connection with the erection of the Quebec Bridge. This firm also furnished some manila rope blocks in connection with this work.

OPENING OF TORONTO-HAMILTON HIGHWAY

LAST Saturday, November 24th, witnessed the official opening of this important highway, which has been practically completed with the exception of the building of several bridges and the approaches thereto which it is proposed to construct as early as possible next spring.

About two hundred people were present at the Humber when Sir William Hearst cut the ribbon which was stretched across the pavement at that point and declared the roadway open to the public. Following this ceremony public officials, road officials and guests to the number of about two hundred motored to Hamilton, the other end of the highway, and there sat down to a luncheon at the Royal Connaught Hotel.

Mr. George H. Gooderham, chairman of the commission, occupied the chair and among others seated at the head table were Sir William Hearst, Hon. Finley McDiarmid, Mark Irish, M.P.P., Messrs. Hugh Bertram, E. Duffy, commissioner of highways for the State of New York, W. D. Flatt, of Hamilton, to whose untiring efforts during the years 1912, 1913 and 1914 much of the success of the highway is undoubtedly due.

Mr. Gooderham, the chairman, presented a paper from which the following abstracts concerning the origin, history and development of the work are taken:

"In the Public Archives of Canada, Series Q, Vol. 283, 1798, we read it is ordered 'that roads be opened, with bridges, between the Humber and the Credit and from the Credit to the head of the lake, the work to be done by the Queen's Rangers.' By this action the Toronto and Hamilton Highway originated. The diary of the provincial land surveyor, Mr. Augustus Jones, for May 19th, 1798, contains this entry: 'Saturday, 19th May, '98—Busy marking the most eligible ground for a road from the mouth of the Humber to a creek called Lamabinecouce. Struck it above the pond and marsh—fine weather.' If we follow in detail the record made by Mr. Jones it is evident that even at that early date the construction of this highway presented many difficulties, especially the portion included within the County of York. No one can sympathize with these early road builders more fully or more knowingly than the members of the present commission. There are those who say with the firm conviction born of a trip between the two cities on a rainy day that for the 116 years following 1798 no attempt was made to improve upon the work of the Queen's Rangers.

"That these conditions do not exist to-day is due primarily to the efforts of Mr. W. D. Flatt to whom the blazing of a trail has ever been a work of love."

In February, 1913, a delegation representing the Toronto Board of Control and Council, Toronto Board of Trade, Toronto Manufacturers' Association, Ontario Motor League, Hamilton Board of Control and Council, Hamilton Board of Trade, as well as the intervening township councils, waited upon the provincial government. Later, another deputation waited upon the government. The sentiment in favor of the building of such a road crystallized into action in August, 1914—the month in which the war broke out.

"In the highway as constructed, a roadway of from 12 to 15 feet has been graded to a minimum width of 26 feet. Many hills and hollows have been improved. The maximum grade has been reduced from 10 per cent. to 4 per cent. More than 50 bridges and culverts with spans up to 50 feet have been reconstructed or enlarged. More than 35 miles of tile drains have been laid. Many improvements in location have been introduced—bad curves have been eliminated or improved—telephone, telegraph and hydro poles, radial tracks and other obstacles have been removed. The cost of the road surfacing represents approximately only 50 per cent. of the total cost. In fact much of the work done should be considered as done for all time to come. The increase in width of pavement from 16 to 18 and 24 feet has increased the total yardage by almost 20 per cent. The statement was based on the completion of the work in 1915, and the commission's contracts were placed with that idea in mind. The work has been done by day labor and the commission has had to increase its hourly rate for labor by 75 per cent. The market price of the most important materials has increased by nearly 60 per cent. The cost of commissary supplies has almost doubled. Some of the other supplies have cost nine times as much as in 1914. None of us have ever seen a similar change in conditions in such a short period.

Progress of Work During 1916

"The spring of 1916 was cold and wet, the weather not settling until June 21st. Sufficient stocks of sand and stone were on hand, however, and the work west of the Etobicoke would have been completed earlier in the fall if labor shortage had not interfered seriously with the regularity of the cement shipments. Late in the fall of this year the highway was opened for traffic from the Etobicoke bridge westerly to the limits of the city of Hamilton.

Progress of Work During 1917

"Weather conditions in the spring of 1917 were again very unfavorable to outdoor work. Rain fell almost every day until July 19th. The wet weather in combination with the heavy clay soil and the network of newly filled trenches interfered very seriously with the progress of the grading. In addition, the work on the New Toronto sanitary sewer moved along very slowly, and as the portion undone was just opposite the commission's yard the commission itself finally completed the backfilling of the trench in order that concreting materials could be hauled to the roadway and the laying of the concrete begun.

"The first mixer was started July 18th. The weather now settled, and good progress was being made, until like a bolt from the blue sky came the order restricting the use of cars in the stone trade. The commission urged the necessity of its finishing up the roadway this season, but could not urge its claim in opposition to that of the people of Canada for coal. Three weeks of ideal weather was lost before stone shipments were resumed, and the opening of the roadway delayed for at least that period.

"In presenting its estimates in connection with the application made to the Railway Board to widen the roadway, the commission included items covering the cost of storm sewers, catch basins, boulevard grading and curb work. It was held, however, that this work was optional with the municipalities. Mimico and New Toronto requested that this special work be done, but in Etobicoke township, east of the town of Mimico, the commission found itself in the position of having to acquire land at considerable cost, utilize a large portion of it for an undesirable open ditch construction and place the concrete roadway in such a location as to make it extremely likely that it would have to be torn up within a few years if that section should develop to the extent that the commission anticipates. Many meetings were held with the township council and the ratepayers in that section, but it was not until September 13th that an agreement was reached

(Concluded on page 464)

INFLUENCE OF WAR ON BRITISH ROAD WORK

THE following extract dealing with the influence of the war on road work in Great Britain is taken from "The Surveyor," of London:

Since the outbreak of war great advantage has been derived from the improvements effected in important roads throughout the country with the assistance of grants and loans from the Road Improvement Fund. But the heavy motor traffic directly or indirectly connected with military movements and the transit of warlike stores has caused a great deal of damage to many miles of road, and, notwithstanding the expenditure of nearly £1,500,000, which represents the cost of special work on public roads paid for out of army funds and other government contributions, an extensive road mileage, used by the special traffic referred to has greatly deteriorated in condition.

Large Expenditures After War

No doubt is entertained by the board that a considerable amount of expenditure will have to be incurred on these roads after the war. Many other roads have also suffered damage by the substitution of motor traffic for horse-drawn traffic in connection with agricultural operations in some counties. Concurrently with these things, the expenditure of highway authorities on maintenance has been reduced, partly for financial reasons and partly owing to shortage of labor and materials. There will, therefore, be a considerable leeway to be made up after the war before roads can be restored to their pre-war condition.

Meanwhile, the policy of the board in regard to making grants and loans has been continued on the lines laid down by the treasury. During the current year the board is distributing, with treasury sanction, a sum of £200,000 out of the Road Improvement Fund, mainly in the form of assistance to expenditure on tar treatment of main county roads in Great Britain which are in a suitable condition for tar treatment, and in doing so they are endeavoring to secure that sections of road which were improved with the aid of Road Board grants prior to the war shall be preserved, as far as possible, in a condition which will prevent the benefit of improvements already made being lost.

Apart from the question of deferred maintenance expenditure and special damage caused to roads by heavy motor traffic in connection with the war the question of expenditure required in the near future for the improvement of roads has been considered by the board, and its views on this matter are set forth in a letter addressed to the secretary of the reconstruction committee.

In this communication the board states that the works of road construction and improvement which are required, and, if funds were forthcoming, might be available for execution after the war, may be divided into four classes:

(1) Works of (*a*) strengthening and resurfacing, and (*b*) drainage reconstruction, and resurfacing, which are of first importance, and should be proceeded with as soon as finance, labor, and materials can be provided.

(2) Works of road widening and new construction which have been approved, but the execution of which was postponed owing to the war, on financial considerations.

(3) Reconstruction of bridges on important roads which are unable to support heavy motor traffic, including bridges owned by railway and canal companies.

(4) Schemes for the construction of new roads and bridges, widenings in urban areas involving the purchase of buildings, and widenings and improvements of important country roads involving the purchase of property. These schemes represent desirable improvements, but their value in relation to their cost can be determined only by investigation and consideration of each scheme by the local authorities concerned in conjunction with the Road Board.

Reconstruction

The most urgent need at the present time, the board continues, is the reconstruction of important roads which are too weak to carry modern traffic. The urgency of this reconstruction is twofold—(1) To provide for the traffic of heavy motor vehicles which is expected to expand rapidly after the conclusion of the war, and if not provided for in advance will cause serious deterioration of roads and consequential damage and expenditure; and (2) experience has shown that it is less costly to highway authorities, in the long run, to construct roads of a type suitable for the traffic, rather than to continue the use of methods and materials which have become antiquated.

Conditions in England and Wales

The total mileage of roads in England and Wales is 152,000. It may be assumed that 10 per cent. of the total, or about 15,000 miles, stands in need, more or less urgent, of reconstruction or strengthening, as distinguished from resurfacing in the course of ordinary maintenance, in order to enable the roads to carry the growing motor traffic. The cost of reconstruction may be estimated at from £1,000 to £4,000 per mile, or at an average of £2,000 per mile. The total cost of dealing with 15,000 miles may be estimated therefore at approximately £30,000,000 over and above the normal expenditure of the local authorities on current and deferred maintenance.

The annual expenditure of highway authorities in England and Wales on maintenance and improvements, including loan charges, is about £16,000,000. This sum is provided out of the local rates, with some assistance from the Exchequer Contribution Account. For practical purposes, £16,000,000 may be regarded as the maximum which highway authorities will spend on road services under existing conditions. There is no practical prospect of these authorities providing, without express statutory direction or considerable financial assistance from central funds, the capital sum which is necessary to reconstruct the more important roads of the country, even though the expenditure of that capital should be shown, not only to effect large savings in the wear and tear of vehicles, but also to arrest the increase in annual maintenance expenditure, which has been growing at a very serious rate, and which is certain, unless large capital expenditure is incurred, to continue to grow, if deterioration of roads is to be prevented.

Road Improvement Fund

Apart from the local rates and imperial subventions, the only public revenue available for road purposes is the Road Improvement Fund. The income of this fund, for the financial year ended March 31st, 1915, was £1,621,000. Of this sum, £898,000 was the proceeds of the motor spirit duties, £630,500 arose from carriage licenses and £92,500 from interest on investments. The revenue from the motor spirit duties and carriage licenses has since August, 1916, been diverted from the Road Improvement Fund to the exchequer. The proceeds of the motor spirit duties were the result of a tax of 1½d. per gallon on petrol used in commercial and public service vehicles.

Since that date the duties and license charges on petrol used in private cars have been increased to 1s. per gallon and in commercial and public service vehicles to 3d. per gallon. The proceeds of these increased duties are not known to the Road Board.

The restoration of the proceeds of the duties, either on the old or an enlarged scale, to the Road Improvement Fund would enable the Road Board to make some contribution to the £30,000,000 required, but such contribution would represent but a small proportion of the total.

Classification of Roads

In this connection it may be mentioned that shortly before the outbreak of war proposals were under consideration by the government for the classification of the roads and a revision of the exchequer grants to local authorities in respect of their expenditure on various semi-national services, including roads. The Road Board, at the request of the Local Government Board, had undertaken to classify the roads in England and Wales, as such classification was an essential preliminary not only to a sound scheme of State aid, but also to any general scheme of reconstruction. The classification was nearing completion on the outbreak of war, when the work was suspended. It will be practicable, however, to continue the work from the point at which it was broken off as soon as the board receives authority to proceed.

Although, as a class, all such works as new roads, widenings, etc., are of secondary importance, as compared with the reconstruction of the road crusts of important roads, there are some which are of considerable value, and should be carried out side by side with road crust improvements. Applications in respect of such works have been received by the board, and a number have been approved by them as suitable for assistance from the Road Improvement Fund and as works which may be carried out as soon as circumstances permit, the total estimated cost in England and Wales being £1,314,152. It must be understood, however, that this includes only such works as have been made the subject of an application to the board.

There are similar works which would be deserving of assistance as soon as the urgent works of reconstruction are completed or funds are available. The cost of works in this class which may have to be taken in hand at some time or other would probably not be less than £5,000,000.

Bridges

There are a very large number of bridges in all parts of the country which require reconstruction. The Middlesex highway authorities, for example, have made an application to the Road Board for grants toward the reconstruction or widening of twenty-two bridges, the cost of which is estimated by the councils at upward of £150,000. In every county there are a large number of bridges vested in highway authorities or owned by railway and canal companies which are scheduled as capable of carrying vehicles of only a limited tonnage, with the result that a very large mileage of roads—often important roads—are closed to traction-engine and heavy motor-car traffic, until such time as these bridges can be reconstructed.

A recent decision of the House of Lords will have the practical effect of throwing, in most cases, upon highway authorities the cost of the reconstruction of weak bridges carrying public roads over railways and canals. It may be roughly estimated that the expenditure necessary to reconstruct bridges on important roads so as to support the motor traffic legalized by parliament will not be less than £7,000,000. This is a very conservative estimate.

Suggestions have been put forward from time to time for schemes for the construction of new roads and various improvements, but the consideration of which has not been entered upon in detail in the absence of any prospect of financing them while the more urgent work of road-crust improvement was in progress. These schemes may be grouped into the following classes:

(*a*) New approach roads to large towns.
(*b*) New bridges giving additional communication.
(*c*) New roads to connect county boroughs.
(*d*) New by-pass roads to avoid narrow villages.
(*e*) Improved communications and widenings in urban areas, involving high cost due to the purchase of buildings.
(*f*) Improvement and reconstruction of important through routes, involving the purchase of property and costly work.

These and similar schemes, the aggregate cost of which would amount to many millions, have not been examined or estimated in detail by the Road Board in conjunction with the local authorities, nor has the relative public value and cost been appraised, a work which would involve a large expenditure of time and money, for the reasons already mentioned. It may be assumed that, in almost every case, the local authorities affected would not be prepared to accept financial responsibility for schemes of the character under discussion, and that their contributions toward them, except in the case of some urban widenings of only local importance, would represent but a very small fraction of the cost. For this reason very few of such schemes can be regarded as being within the range of practical consideration at the present time, especially while the really urgent work of road-crust improvement remains to be undertaken when funds are available.

Of a somewhat similar nature are the proposals of the recent Metropolitan Arterial Road Conferences for the construction of about 130 miles of approach roads to London, 70 miles being entirely new. The Local Government Board has requested the Road Board to examine these schemes, which, taken altogether, if their execution were proceeded with continuously, might involve an expenditure by all parties concerned of considerably over £10,000,000, and it might approach £15,000,000. The highway authorities concerned have made it clear that they are not prepared to provide any considerable proportion of the expenditure. No possible source of revenue is, therefore, in sight. The proportion of the Road Improvement Fund, as now existing, which the board can regard as available for grants toward road improvement schemes in Greater London, with the exception of a few thousand pounds, have already been pledged to works in progress, but most of which have been held up during the war. The board has pointed out to the Local Government Board that its examination of the schemes cannot be of a very practical character if it is conducted on the assumption that no money assistance is likely to be forthcoming beyond any possible grants from the Road Improvement Fund.

Scotland and Ireland

As regards Scotland, the mileage of roads requiring reconstruction and strengthening over and above the mileage that can be dealt with by the local authorities themselves out of their own resources may be taken at about 2,000 miles, at an average expenditure of £1,500 per mile, or a total of £3,000,000.

No estimate can be given as regards Ireland, but it may be mentioned that the special circumstances which have caused the great increase in road expenditure in England and Wales, and in some parts of Scotland, due to the large volume of motor traffic, have not hitherto pressed with any severity upon the highway authorities in Ireland.

The board has continued the special work which it undertook after the outbreak of war at the request of the Army Council, namely: (1) To supervise and arrange for the construction and maintenance of new roads, and the improvement of certain private roads in several districts for military purposes in connection with camps and otherwise, and to carry out such work, where required, by direct labor; (2) to arrange with highway authorities for improvements, mainly at the cost of the Army Council, on public roads required for military purposes, and to supervise, or to carry out by direct labor, the execution of the improvements; (3) to settle by negotiation with highway authorities the amounts payable by the Army Council in respect of damage caused by extraordinary traffic in connection with military purposes. Similar work has, with treasury approval, been undertaken for the Admiralty, Minister of Munitions, and Timber Supply Department of the Board of Trade.

INTERESTING MUNICIPAL INSTALLATION OF ULTRA-VIOLET RAY STERILIZER

ONE of the first cities to install the pressure type of ultra-violet ray sterilizer for use in connection with municipal waterworks was Henderson, Ky., on the Ohio River, about twelve miles below Evansville, Indiana. Since the installation of the plant it has been in continuous operation and has proven its reliability, both from an operating and bacteriological standpoint.

Henderson, Kentucky, is a city of some 17,000 people, and its water supply is secured from the Ohio River. Until 1916 it had been the practice to take the water directly from the river by pumping it to a reservoir on the summit of a hill, the reservoir having a capacity of something like four million gallons, which was equivalent to a little over one day's supply, the daily average hovering around two and a half million gallons. The municipal authorities of Henderson entered into negotiations with the R.U.V. Company, 50 Broad Street, New York, and the Pittsburg Filter Manufacturing Company, of Pittsburg, Pa., jointly, and it was decided that a complete sedimentation, filtration and sterilization plant with a capacity of three million gallons per day be designed and so arranged that it could be increased to double that capacity without in any way affecting the existing structures.

The water delivered to the sterilizer is first passed through sedimentation and coagulating basins and filters at the pumping station and delivered to the sterilizer practically clear. The design called for two coagulating basins each 95½ ft. long, 30 ft. wide and 16 ft. deep; two baffled mixing chambers 25 ft. long, 7½ ft. wide and 17½ feet deep. On a capacity of 3,750,000 gallons per day, the detention period in the coagulating basins is four hours, and the capacity of the settling basins is 620,000 gallons divided into two basins. The design also called for six reinforced concrete filter units, each 17 ft. long by 13 ft. 4 ins. in width, with a normal capacity of 625,000 gallons. The designs were submitted to and passed upon by J. W. Ellms, consulting engineer, of Cincinnati.

Reinforced concrete construction was used throughout except in the case of the filter and head house, which were built of brick. Below the filter units and pipe gallery there is provided a clear-well covering the entire area

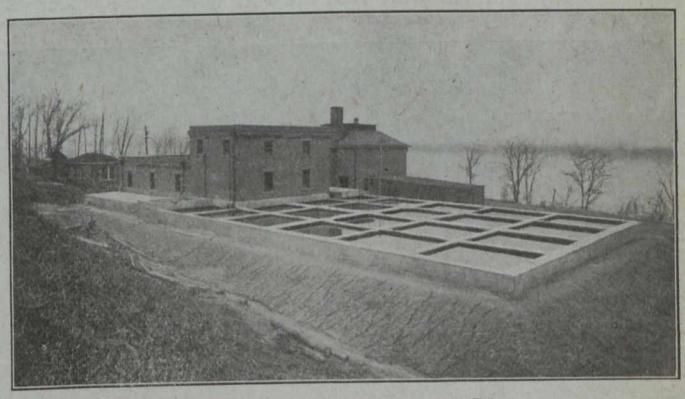


Fig. 1.—Exterior View of Plant

below the filter units and pipe gallery and near to this on the outside is erected a reinforced concrete building or basement which is used for housing the sterilization apparatus.

The sterilizers consist of three legs, each of which comprises five units, these legs being connected in series with the pipe line that leads from the clear-water basins to the sump from which the pumps secure their supply. Inasmuch as the sterilizer units are 30 inches in diameter,

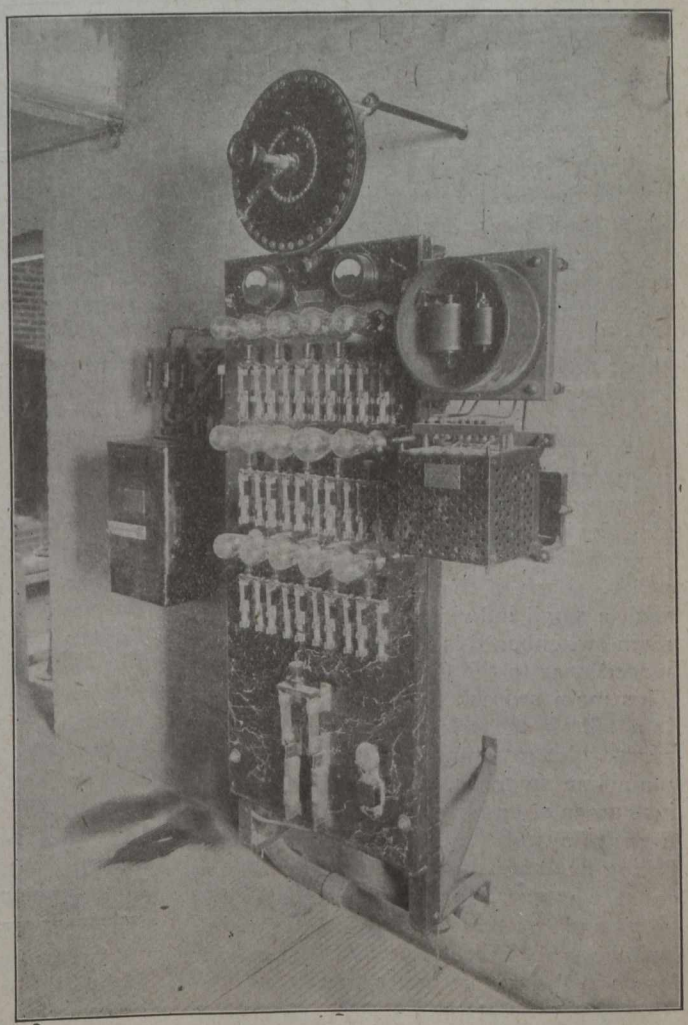


Fig. 2.—Operating and Indicator Board

valved increasers and reducers are provided for the purpose of connecting the sterilizer with the service pipe line. Inserted in the side of each of these units is a lamp box, fitted with a clear quartz U-shaped tube, which projects into the body of the unit and around which the water is forced to flow in a thin film by means of a baffle which is placed at 90 degrees to the long axis of the sterilizer. In this baffle there is a slotted opening made to receive the U tube and to provide for the passage of the water.

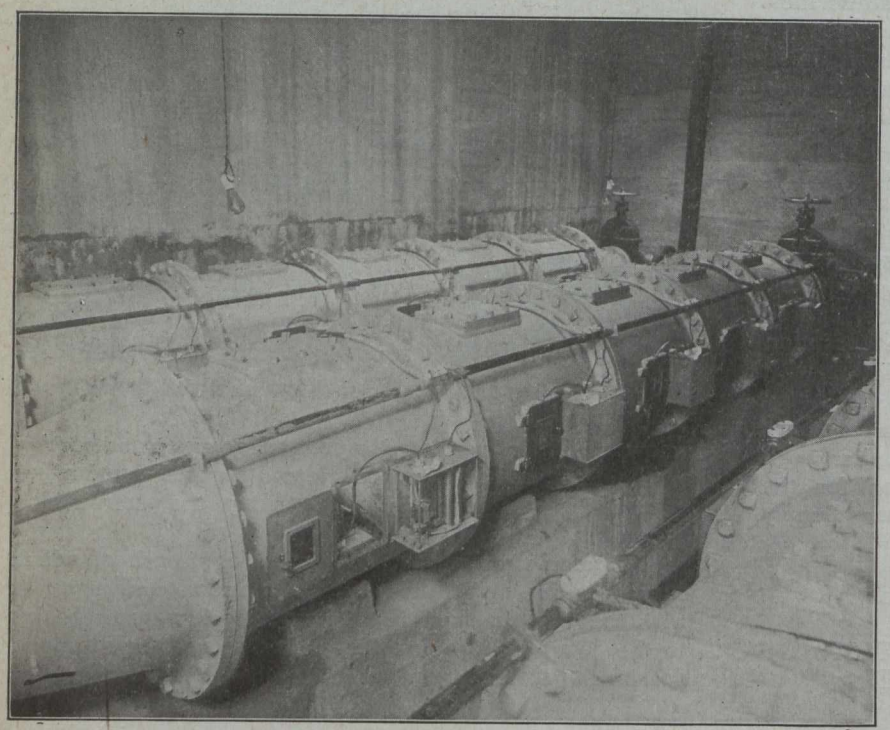


Fig. 3.—Ultra-violet Ray Sterilizers

A 220-volt direct current ultra-violet ray lamp, consisting of a mercury vapor arc encased in clear quartz, is placed inside the quartz tube and properly held in place and automatically tilted by a tilting device which is located in the lamp box.

In order to agitate the water and to insure effective striking of each particle of water by the ultra-violet rays, a stirring device is used. This consists of an iron casting shaped like a ship's propeller. Each of these lamps is provided with a small individual switchboard. A main switchboard is also provided and is placed near to the filter operating room. This main switchboard has mounted on it a telltale incandescent lamp for each ultra-violet ray lamp in the sterilizer, main line switches, electrical indicating instruments, and a warning bell. In the event of any of the ultra-violet ray lamps failing or diminishing in power from any cause whatever, the bell automatically rings and the telltale lamp on the main switchboard indicates which lamp or lamps in the system are in trouble.

The sterilizer calls for 220 volts direct current, and in order to most economically transform the available alternating current to suit that requirement, a motor generator set is provided for that purpose.

The apparatus sterilizes the water without raising its temperature and without using chemicals, and is entirely automatic and effective in action, irrespective of the bacterial count, nature of the bacteria or the manual control.

As indicating the effectiveness of the apparatus, the accompanying tabulated results, which were secured over a two months period and are taken from actual daily tests, are illuminating.

The bacteriological work was done in accordance with the standard methods of the American Public Health Association's laboratory section, and the average results were closely checked by the maximum and minimum obtained, and vary little from the average results.

The plant was put in operation towards the end of 1916, and the daily capacity of the plant has run from 2,250,000 to 3,000,000 gallons a day.

An estimate of the cost of sterilization by this method can be made from the consumption of current which is 92.5 kw.h. per million gallons.

As will be seen from the accompanying table, the guarantee of the R.U.V. Company to produce water free from pathogenic bacteria as indicated by B. coli as tested along the standard methods as referred to has been met. The current consumption guarantee of .77 kw. per lamp was also met.

Sample.	Total No. of Samples.	Total bacteria per 1 cc. 24-hr. incubation Maximum count.	Total bacteria per 1 cc. 24-hr. incubation Average count.	Total B. coli per 1 cc. 48-hr. incubation Maximum count.	Total B. coli per 1 cc. 48-hr. incubation Average count.
Raw	25	190,000	85,000	1,000.0	276.0
Coagulated	25	1,200	720	100.0	45.0
Filter	70	320	80	1.0	.35
Influent leg No. 1	52	95	32	1.0	.260
Burner No. 1 ..	48	30	16	.8	.215
Burner No. 2 ..	48	20	8	.8	.200
Burner No. 3 ..	48	16	6	.2	.136
Burner No. 4 ..	48	6	2.1	.1	.09
Burner No. 5 ..	54	3	.31	0.0	0.0
Influent leg No. 2	53	75	36	1.0	.310
Burner No. 1 ..	47	50	12	.6	.273
Burner No. 2 ..	47	20	6	.8	.18
Burner No. 3 ..	47	7	5.2	.4	.117
Burner No. 4 ..	47	6	1.8	.1	.07
Burner No. 5 ..	54	3	.38	0.0	0.0
Influent leg No. 3	54	95	25	1.0	.326
Burner No. 1 ..	47	55	14	.8	.240
Burner No. 2 ..	47	19	9	.8	.21
Burner No. 3 ..	47	12	4	.4	.110
Burner No. 4 ..	47	6	1.6	.1	.06
Burner No. 5 ..	54	3	.42	0.0	0.0
Tap at pumps ..	34	11	.39	0.0	0.0

Rate of pumping 2,200,000 gallons per day to 3,200,000 gallons per day with little or no variation in results.

Turbidity of raw water varied from 130 to 880 p.p.m.

Filtered water usually clear with maximum turbidity of 5 p.p.m.

FALLACIES IN INVESTIGATION OF WATER SUPPLIES*

By H. A. Whittaker
Director, Division of Sanitation, Minnesota State Board of Health.

FOR many years laboratory workers have been developing analytical methods for the detection of pollution in water, and these investigations have resulted in the establishment of standard methods for this purpose. It is a well-known fact that these methods, when properly applied, form an important part of a routine water supply investigation. It is also recognized that a thorough field survey is absolutely essential before a reliable opinion can be offered regarding the safety of a supply for drinking purposes. Unfortunately, certain health departments have been depending largely on an analysis of the water, without obtaining first-hand information regarding the environmental, structural and operative features of the water supply. A common practice is to leave the field work to untrained individuals in the local communities. Data sheets and sampling equipment are often furnished to local authorities and private citizens, who collect the field data and water samples on which the safety of a water supply is determined. There are several points in connection with this practice that are dangerous to public safety. By this method, the field survey, which is one of the most essential parts of the investigation, is placed in the hands of an untrained observer who is often incompetent to undertake the work. The same unskilled individual is entrusted with the duty of securing samples of water that must be properly collected if satisfactory analytical results are to be obtained. These samples are then shipped to the laboratory and subjected to most careful examination by skilled technicians when there is no assurance of the accuracy of their collection. This method makes it necessary for the skilled worker to accept facts from an untrained person on the fundamental features of an investigation on which the safety of a water supply is to be judged.

This practice is often the result of a desire on the part of health departments to extend their services to the public, without considering the dangers associated with this method. Frequently these departments are short of funds to carry on field surveys, and this method is provided as a substitute for more thorough work. After the public is educated to such procedure, it becomes very difficult to refuse the examination of samples collected by anyone and from every conceivable source.

In 1903 the Minnesota State Board of Health recognized the fallacy of attempting to investigate water supplies by this method, and since that time has required that the field and laboratory work in connection with these investigations be undertaken by trained representatives of the board.

The 569 investigations undertaken represent both surface and underground water supplies from a variety of sources, including wells (dug, bored, drilled, driven), springs, lakes, rivers, creeks, etc. The need for water supply investigations in this state is shown by the fact that 344, or 60 per cent. of the samples examined, were found to be unsatisfactory in their existing condition. An analysis of the results of these unsatisfactory supplies brings out the fact that 180, or 52 per cent., were shown to be unsafe by both the field survey and analytical results; 136, or 40 per cent., by the field investigation alone, while the analytical results on the date of the investigation were satisfactory; and twenty-eight, or 8 per cent., by the analytical results alone, where the field investigation did not show the possibilities of pollution at that time, and further investigation was required. These results show that the field survey was corroborated by the analytical results in 52 per cent. of the cases; that the field survey was the only index of danger in 40 per cent.; and the analytical results the only index in 8 per cent.

These results bring out very forcibly the importance of thorough field work, for had the analytical results been accepted as the only index, 40 per cent. of the unsatisfactory supplies would have been approved. It is also true that had the analytical work been omitted, 8 per cent. of the unsatisfactory supplies would have been overlooked. It is evident from these results that both a field and analytical investigation should be made before an opinion is given as to the safety of a water supply from a sanitary point of view. The field survey should give an accurate idea of the possibilities of present and future pollution, while the analytical results should provide information on the sanitary condition of the water at the particular time the investigation is made, and may furnish some information on the past history of the water. The field survey and analytical results together should afford information on which recommendations can be made for the protection or abandonment of the supply.

It should be thoroughly appreciated that the use of any method in the investigation of water supplies which provides for the collection of haphazard information by untrained individuals is a dangerous practice. Judging from the published material of various health departments, there appears to be little uniformity as to the collection of data on which opinions are offered regarding the safety of water supplies. It would seem that a comprehensive survey of the methods of all state departments, at least, would be desirable at this time. These data would provide information on which recommendations could be made with the view of unifying the irregular procedures now in use. It is appreciated that a variety of conditions attend the work of public health departments in different sections of the country, but a standard procedure could be outlined toward which all could work.

*American Journal of Public Health.

An asbestos-cement composition is being manufactured in England as a substitute for sheet steel for various purposes. Ground asbestos is mixed in the proportion of one to six with Portland cement and worked into a paste with water. A machine something on the order of those used in making paper forms it into sheets, which are trimmed to size and if desired corrugated for roofing purposes. After seasoning the material is ready for use. It is durable, resistant to climatic conditions, particularly acids in the atmosphere, fireproof and also a non-conductor of heat.

Northern Lincolnshire, England, where there are large beds of ironstone and a good number of blast-furnaces, is rapidly becoming a centre of steel manufacture, and sanguine prophets are already saying that in the course of time the district will rival Middlesbrough in this respect. Following the establishments of the Frodingham Iron and Steel Company and of Lysaghts, the Redbourne Hill Iron Co. is building a steel works plant at Frodingham, capable, it is said, of producing several thousand tons of finished material per week. John Brown and Co., Ltd., of Sheffield, also have begun to erect a steel foundry in connection with their Trent blast furnaces in the same district, and will probably carry on other steel processes there eventually. Several other large steel concerns are prospecting the district with a view to establishing works near the Lincolnshire ore field.

LONG POWER CABLE SPAN ACROSS ST. LAWRENCE RIVER

OWING to the unprecedented demand for power in the province of Quebec and in a desire to supply that demand, the Shawinigan Water and Power Company has been forced to erect an unusual piece

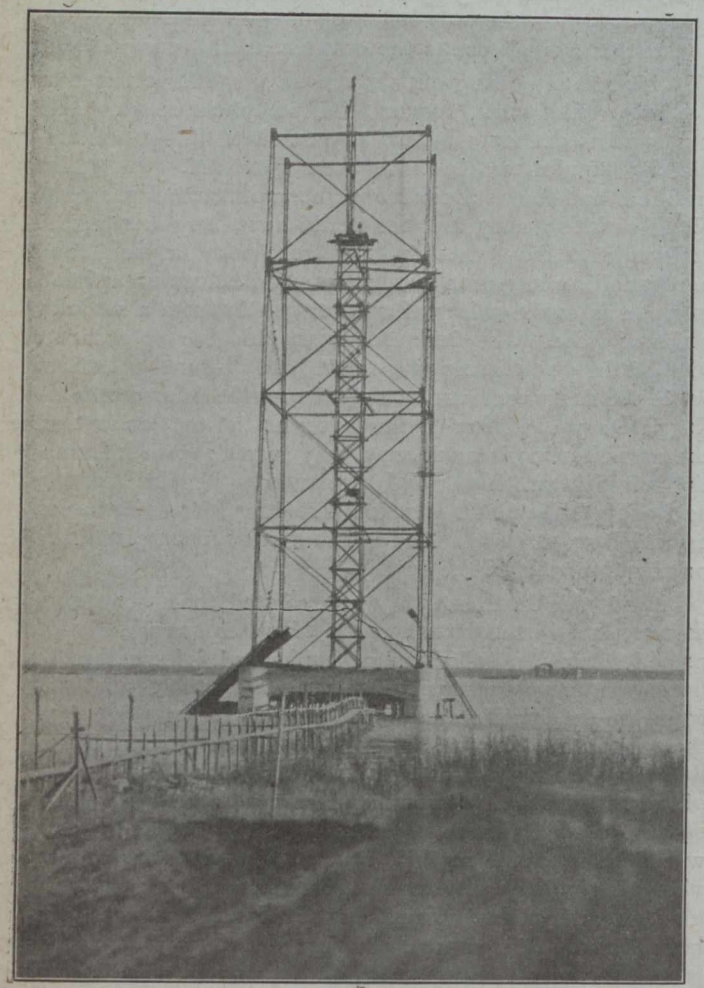


Fig. 1.—Steel Tower on North Side of St. Lawrence River

of engineering work. In order to furnish power to the district south of the St. Lawrence River, it has been found necessary to construct two towers, one on either side of the St. Lawrence River for the purpose of carrying a transmission line across the river. Each of these towers will be 350 feet high (which is the same height as the top of the cantilever arms of the Quebec Bridge).

Fig. 1 shows the northern tower. The height of the towers is governed by the requirements of navigation, the lowest point in the cable having to clear the water by 160 feet. The width of the river at this point is about one mile.

These towers will support a 5,000-foot span of three steel cables.

The towers rest upon concrete foundations which are built about 500 feet from each shore. The circular concrete columns constituting the foundations are 11 feet in diameter and go to a depth of 40 feet below the river bed. The four piers are tied together above the water by arched concrete structures.

The cables are carried over to the back of the towers and fastened to an anchor in the ground some distance behind the towers. (See Fig. 2.)

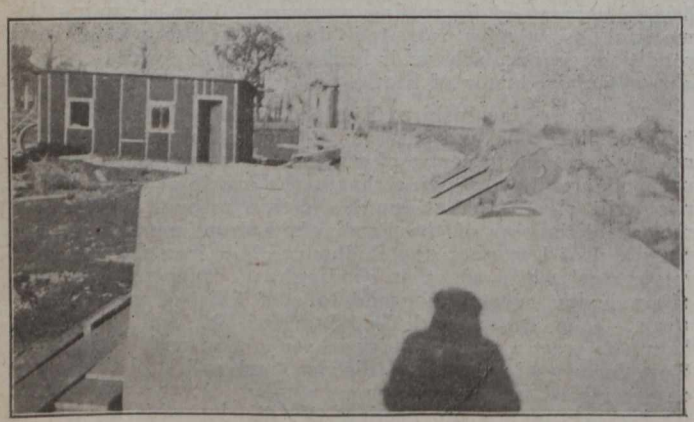


Fig. 2.—Anchor Piers, Behind Steel Towers

MANUFACTURERS OF CANADA

The postal census of the manufacturers of Canada, taken in 1916, for the calendar year 1915, just issued, shows a general expansion in the manufacturing business of the Dominion. The number of establishments in operation was 21,306, representing an invested capital of $1,994,103,272, employing 52,683 persons on salaries and 462,200 persons on wages, and producing goods to the value of $1,407,137,140 from raw materials valued at $802,135,862.

During the decade 1905-15 the number of establishments increased by approximately 34 per cent.; capital, 135 per cent.; employees on salaries, 44 per cent.; employees on wages, 29 per cent.; salaries, 96 per cent.; wages, 70 per cent.; and the value of products, 95 per cent.

The value of the products of factories in 1915 was $1,407,137,140, as compared with $718,352,803 in 1905, an increase of $688,537, while wages paid totalled $229,456,210, an increase of $95,080,285.

There were in Canada during the year covered by the statistics 65 establishments employing over 500 hands; 25 employing over 1,000; nine employing over 2,000; five employing over 3,000; and three employing over 4,000. Of these three establishments two employed over 5,000 hands.

During the five-year period, 1910-1915, the capitalization of Canadian industrial enterprises increased by $746,520,663, or about 60 per cent.

TUNGSTEN PRODUCTION IN NEW BRUNSWICK

A very interesting development of wolframite or tungsten is in progress at Burnt Hill on the South West Miramichi, New Brunswick. This metal is extensively employed in the manufacture of high-speed steel and armor plate. As the Imperial government has commandeered for its own use all of the metal of this kind in the empire, the successful development of this provincial prospect possesses more than local interest. The company has erected a concentrating mill at the water's edge of the Miramichi River, for the treatment of the ore as it is taken from the mine. A shaft 65 feet deep has been opened up to follow the vein in two directions. The mine is equipped with steam hoisting apparatus, and air compressor for the drills. The vein of ore is about four feet in thickness and is nearly vertical.

The Liverpool Tramways have carried nearly ten million more passengers during the past nine months as compared with 1916, and, although therewas a decrease in the mileage run of 90,303 miles, the receipts, which were £603,317, showed an increase of £53,417 upon those of the corresponding period of last year. The earnings per car-mile were 1s. 3.43d., as against 1s. .88d. Some 2,200 employees have joined the Forces, and this fact, with the difficulty of obtaining supplies, has involved strenuous conditions.

The Engineer's Library

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

CONTENTS

BOOK REVIEWS

Practical Road Building. By Chas. E. Foote. Published by David McKay, Philadelphia. 295 pages, 40 illustrations, 5 x 7½ ins., cloth. Price, $1.25 net. (Reviewed by W. A. McLean, Deputy Minister of Highways for Ontario.)

"Practical Road Building" is a breezy talk on road construction which would serve as a primary text book on the subject for the use of students; also as a primer for councillors, road overseers and contractors who may wish to become conversant with the general practices in modern road-building.

Road-building is a matter of principles, rather than of specific rules. The author, writing from the viewpoint of a free lance, has evidently observed closely, and has approached the subject from the standpoint of principles, rather than that of limited experience in dealing with specific construction. The subject is approached in the common but logical manner, dealing in sequence with road history, road location, road grades, drainage, foundation, road surfaces, bridges and culverts, road traffic, and road finances.

The second part of the little volume deals more definitely with various types of construction, but in no sense is it technical. It is just a book on roads, written by a practical observer, and for popular consumption.

Memorandum on Chains and Other Lifting Appliance. By G. S. Taylor, H.M. Inspector of Factories. Home Office publication. Published by Wymann & Sons, London, Eng., Canadian selling agents, T. Fisher Unwin. 50 pages, 13 ins. x 8 ins., 4 appendices, tables and 8 illustration plates. (Reviewed by A. L. Haas, London, England.)

It is not too much to say that a copy of this book should be in the hands of every thoughtful engineer. Nor does it overstate the case to observe that the publication is a vital necessity to everyone in responsible control of lifting tackle. Also, it is more than probable that so much digested information on a technical subject of a safety character has never before been placed on sale at so moderate a price.

From time to time in the columns of the technical press appear articles dealing with matters of slinging work, annealing chain, dangerous stress set up by inclination of sling, care of lifting tackle, the effect of surging loads, etc. In this memorandum, without any verbiage, every matter of the kind obtains adequate notice and treatment. Formulæ, tabular matter, illustrations, all are excellently done and cross reference to a bibliography of 40 authorities prove the research made by its author, who may be congratulated upon an addition to technical literature in a field in which information is scarce and not generally available.

The only criticism which suggests itself as to alteration or reprint is that each paragraph of text should bear a marginal note for easy reference and that a properly compiled index for which the contents page is no substitute might be added.

Since E. J. Taylor, of Messrs. Baylie & Co., Stourbridge, manufacturers of high-class crane chains, gave his paper before the Manchester Association of Engineers in 1899, a deal of research has been made, but little from a practical standpoint has been written or published. The present memorandum was badly wanted to incorporate and get together the widely separated information on so important a subject.

The memorandum is obviously compiled with a view to the prevention of accident and to minimize danger. It is, therefore, of great value in connection with the "safety first" movement.

In connection with eyebolts, for example, it is duly proved mathematically that any load not in an axial direction very seriously diminishes the safe load.

In connection with the injury imparted to chain slings by the sharp corners of the load corresponding with a nicked test bar, it is observed that in one works grooved wooden blocks (of circular section, with one quadrant removed) are extensively used on corners instead of wood packing. Overload detectors are advised for use on all cranes. The importance of records in connection with all lifting tackle and means for their identification with such method of record is advised. It must be in all respects more comfortable to those responsible to be able to plead reasonable precautions and definite data as to source of supply and annealing if accident should result.

Shackles and hooks are dealt with at length both in practice and theory and virtually every type and kind of chain appliance receives adequate notice.

In review of the authorities and the tabular statement which shows wide divergences in formulæ for calculation, the author asks for greater uniformity. The differences are very considerable and in themselves constitute a danger point. The results of the use of the highest and lowest safe loads by the formulæ given would result in large difference in dimensions for similar purposes. Added to this there are at least four grades of chain dependent upon material and workmanship.

Railways, government departments and harbor boards exercise extreme care in the matter of chain, both with regard to purchase and inspection and the vital question of annealing. It is, however, to be feared that the average user is without much safeguard other than the reputation of the manufacturer

The present reviewer, who has had many years' experience in the inspection, purchase and use of high-class crane chains, is strongly of the opinion that a copy of this memorandum should be in the hands of every engineer, than which there is little more to be said; unless the final word is added that in most instances where chain is employed or overhead lifting tackle its default may lead to fatality. In such wise the extra expense incurred for a first-class, reliable article represents a gilt-edged investment, as it is out of all proportion to the safety insured and the inconvenience avoided.

Empirical Formulas. By Theodore R. Running, Associate Professor of Mathematics, University of Michigan. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Limited, London; Canadian selling agents, Renouf Publishing Co., Montreal. First edition, 1917. 144 pages, 20 figures, 6 x 9 ins., cloth. Price, $1.40. (Reviewed by Prof. R. W. Angus, University of Toronto.)

This book is No. 19 of the Mathematical Monographs edited by Mansfield Merriman and Robert S. Woodward, and is intended to show how to find the constants in an equation of a form suited to a given set of observations. It has been prepared with a special view to engineers, as stated in the preface.

There is undoubtedly need for books along this line. In the course of his experiments and ordinary practice the engineer frequently takes simultaneous readings on different parts of the same plant or machine and it is often very desirable to know whether any regular law connects these readings, and if so to find out its general form. Such is the case, for example, when the frictional loss in a pipe at different velocities is measured and the law connecting the two is desired.

In so far as the book helps along these lines it is very useful, and the author has assumed a very general lot of equations and has shown how to obtain the constants in each case, and illustrated many of these cases by examples, more or less common, selected from engineering practice or research. A chapter is also given on the application of least squares to the formation of normal equations and another one on numerical integration. The author has evolved methods of representation of such a nature that the constants in the formulas are obtained from straight lines, which is a great advantage from the point of accuracy and simplicity.

It would seem that a larger number of the more common engineering illustrations might have been used, and further, that the author might have suggested somewhat better the kind of formula which would probably fit a given series of observations; that is, the method of procedure in trying to find a formula which is of the best for a given case.

The book should be found of value by those desiring to make up empirical formulas in given cases.

Elliptic Integrals. By Harris Hancock, Professor of Mathematics, University of Cincinnati. Published by John Wiley & Sons, Inc., New York City; Canadian selling agents, Renouf Publishing Co., Montreal. First edition, 1917. 104 pages, 20 figures, tables, 6 x 9 ins., cloth. Price, $1.25 net. (Reviewed by Prof. Alfred T. DeLury, University of Toronto.)

This little book, by Professor Hancock, who is the author of a comprehensive work on the larger subject "Elliptic Functions," sustains the high level of excellence of the series of mathematical monography of which it is number eighteen. In the brief compass of one hundred pages the author gives a treatment of these important integrals reasonably complete for the practical man, and has shown marked skill in selecting from a great body of classical work just what is essential, and in arranging it effectively. Numerical computation is emphasized and five place tables of the integrals of the first and second kinds are given. The tables allow the author to propose a number of problems calling for numerical results, an important thing, above all to the busy man, in relation to any mathematical theory. The book is one that should appeal to the student of engineering and to the engineer who needs to employ these integrals, or who, finding his calculus growing dim through disuse, would like to brighten it up through a fresh interest.

Water Supply Engineering. By A. Prescott Folwell. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Limited, London; Canadian selling agents, Renouf Publishing Co., Montreal. Third edition, 1917. 469 pages, 121 figures, 6 x 9 ins., cloth. Price, $3.50 net. (Reviewed by R. O. Wynne-Roberts, consulting engineer, Toronto.)

Prof. A. Prescott Folwell, besides being a member of various societies, is the editor of "The Municipal Journal" and well known among municipal officials. The first edition of this book appeared about eighteen years ago and now the third edition appears—rewritten and up-to-date. It is well printed and contains about 121 good illustrations of different items in connection with waterworks.

This book is divided into sixteen chapters which deal with quantity, quality and purification of water, source, rainfall, surface water, rivers and lakes, ground water, gravity schemes, pumping systems, pumps, dams, designing, etc., etc.

The examples and sources of information are those of American cities, with few exceptions, and whilst these are useful for reference and comparison, waterworks engineering is nevertheless international in many respects, and develops interest as the work of other nations is described. In some matters, American and Canadian waterworks afford striking differences to European practice. For example, Table II. gives statistics relating to water consumption in American cities, which range from 57 to 334 gallons per capita per day. Even in cities where about 100 per cent. of the services are metered the quantity of water consumed was from 57 to 121 gallons per capita daily. General metering of domestic connections in European cities is exceptional and yet the average daily consumption for all purposes would probably be about 35 gallons per head. The author of this book states that "where domestic consumption exceeds 30 or 40 gallons the surplus is generally waste."

Prof. Prescott Folwell on page 17 rightly states that if the supply of water is pumped waste "means increased expense for coal consumption and enlargement of pumping plant; if the supply is from wells or reservoirs it hastens the day when new wells must be sunk or new drainage areas sought; and in any case it means that either the mains must be unnecessarily large or the pressure will be decreased below that desired." The author further states that millions of dollars are being spent by many of our "larger cities to increase their supply in order that two-thirds of it may be wasted." There are also some Canadian cities where this occurs.

The conservation of life by filtering public water supplies is well shown on page 35. Typhoid fever death rates which prevailed in certain cities during the five years before installing filters were reduced during the succeeding five years, in Albany, 74 per cent.; Cincinnati, O., 80 per cent.; Columbus, O., 78 per cent.; Pittsburg, Pa., 85 per cent., and so on. It is therefore remarkable that the public do not more readily appreciate the value of pure water and insist upon effectual treatment.

The treatment of water is described in the chapter on purification. On page 62 the question of the size of tanks for the sedimentation of water is discussed and some interesting deductions are made on the assumption that the mean velocity of flow through a tank must not exceed three times the settling velocity of the limiting particles. The author states on page 72 that where air is not used in connection with the washing of filters it is customary to place a brass screen between the gravel and sand in filters to prevent the gravel rising. The experience at Cincinnati and elsewhere appears to controvert this assertion. The screens are now frequently omitted, provided the depth of gravel is increased. It would have been an advantage if the author had dealt more fully with pressure filters. Recent improvements in the design and arrangement of such filters appear to make them as adaptable for certain conditions as gravity types. The "drift sand" filter is not described.

A good gasoline engine will generate a horse-power hour on ⅛ gallon of gasoline. Small steam pumping plants do well to secure a pump horse-power on 4 or 5 lbs. of coal (see page 252). With gasoline at 24 cents per gallon and coal at $6 per ton the cost of one horse-power hour is estimated at 3 cents and about 1.4 cents respectively. The attendance and capital charges, however, are greater for steam than for gasoline plants.

This book will be found very serviceable to waterworks men. It is written in a simple, clear and concise manner.

Stresses in Structural Steel Angles. By L. A. Waterbury, University of Arizona. Published by John Wiley & Sons, Inc., New York; Canadian selling agents, Renouf Publishing Co., Montreal. First edition, 1917. 77 pages, illustrated, 5¼ x 8 ins., cloth. Price, $1.25 net. (Reviewed by A. H. Harkness, of Harkness & Oxley, consulting engineers, Toronto.)

Perhaps no structural shape is more generally used than steel angles. The usual practice in the engineering profession has been to assume that the stresses due to loading are the same as for symmetrical sections, similarly loaded, whether in binding, direct tension or compression, or bending combined with tension or compression. It has generally been recognized that such method of treating them is only approximate in its result. With the information and the tables available, however, it has been considered impracticable to give a close analysis of the actual stresses produced by any particular condition of loading.

The author, in this small book devotes the first 27 pages to the theory and a discussion of the stresses in angles. In the first 13 pages the questions of section modulus, with section modulus polygons, product of inertia, plane of loading and bending stresses, are treated. The balance of the text considers combined stresses, with special attention given to the effect of end connections.

The last 47 pages give tables to make possible the convenient application of the theory to practical problems. Tables I. and II. give the elements of angles including the products of inertia. Table III. gives the co-ordinates of section modulus polygons for angles referred to rectangular axes through the centre of gravity so that the modulus diagram may be drawn for any angle. Tables IV. and V. give the efficiency and allowable tension for angles in pairs riveted through one leg to a rigid connection plate.

The author, on page 26, makes a comparison of the results of his calculation as given in Tables IV. and V. with the results of some actual tests, and concludes that the usual clause in specifications which allows only the connected leg of the angle to be figured in tension is much more conservative than necessary.

Diesel Engine Design. By E. Mortimer Rose, M.Sc., Assoc.M.Inst.C.E. Published by Emmott & Co., Limited, Manchester, Eng. 1917 edition. 203 pages, 5 plates, 18 tables, 87 figures, 5¾ x 8¾ ins., cloth. Price, $1.50 net. (Reviewed by H. H. Williams, manager, General Machinery Company, Toronto.)

The professed object of the author, which, as is stated in the preface, is to give prominence to the details of design leading to successful manufacture, is very ably carried out.

Many books have been published on the subject of the Diesel engine, but more with the apparent object of broadening the general knowledge of the uses to which the engine has been and may be applied than with a view to assisting the designer in a knowledge of the necessary principles governing the design of its parts.

In this book, history is but slightly touched upon and the exhaustive and often cumbersome descriptions, drawings and cuts of various types and sizes of engines now being produced, are to an unusual degree omitted.

The very lucid chapters on "Thermodynamics" develop this subject in a simple and practical manner, which aids greatly in an intelligent understanding of the theoretical principles underlying the subject matter to which the book is devoted. Under "The Working Fluid of Internal Combustion Engines" are cited examples of interesting experiments and research work, the results of which are practically discussed in their relation to the design of the parts affected.

From this point, through succeeding chapters, the essential features of the design of the various parts are taken up in sequence and treated in a clear and concise manner, which will render the book one of particular value to the designer. Although this, primarily, is the object of the author, the book is extremely well adapted to the requirements of the operating engineer and station manager, to whom a somewhat detailed knowledge of the apparatus in his charge is essential, but who, naturally, wishes to arrive at this information in the most direct and practical way.

PUBLICATIONS RECEIVED

The Cochrane Precision Meter.—Bulletin No. 21 issued by the Harrison Safety Boiler Works, Philadelphia, Pa.

Province of Ontario.—Report of the Minister of Public Works for the twelve months ended October 31st, 1916.

Year Book of the Bureau of Mines, 1916.—By Van H. Manning Published by the Government Printing Office, Washington, D.C.

Queen Victoria Niagara Falls Park.—Thirty-first annual report of the commissioners for the Queen Victoria Niagara Falls Park, 1916.

Belts.—Pamphlet issued by the Federal Engineering Co., Limited, 172 John Street, Toronto, containing information for users of belts.

Test of Some Canadian Sandstones to Determine Their Suitability as Pulpstones.—By L. Heber Cole. Bulletin No. 19, Department of Mines, Ottawa.

Scientific Treatment of Boiler Feed Water.—Cochrane Engineering Bulletin No. 20, issued by the Harrison Safety Boiler Works, Philadelphia, Pa.

Rails, Locomotives, Cars, Machinery, Tanks, Etc.—Bulletin No. 226 issued by the Walter A. Zelnicker Supply Co., 325 Locust Street, St. Louis, Mo.

RF Adjustable Speed Motors.—Illustrated leaflet issued by the Canadian General Electric Company, Limited, Toronto, describing different types of their RF motors.

Deterioration in the Heating Value of Coal During Storage.—By Horace C. Porter and F. K. Ovitz. Bulletin 136, Bureau of Mines, Department of the Interior, Washington, D.C.

Pleistocene and Recent Deposits in the Vicinity of Ottawa, with a Description of the Soils.—By W. A. Johnston. Memoir 101, No. 84, Geological Series, Department of Mines, Canada.

International Joint Commission.—Supplemental argument in the matter of the measurement and apportionment of the waters of the St. Mary and Milk Rivers and their tributaries in the United States and Canada. Published by the United States Government, Washington.

Poor's Intermediate Manual of Railroads.—Issued by Poor's Manual Co., New York. Price, $7.50. This book gives revised statements of the more important companies, issued for the new fiscal period in accordance with the requirements of the Interstate Commerce Commission. Bond statements, income accounts, and balance sheets have been revised to the latest date. The work contains 1,200 pages of text. It is the only book of the kind issued to date.

OPENING OF TORONTO-HAMILTON HIGHWAY

(Continued from page 454)

under which the work could proceed. As the laying of the concrete in this section was completed October 28th, we feel that fair progress was made, especially since it was necessary to acquire land, move three pole lines, and the radial tracks, in addition to the regular grading and concreting in that period.

"The work has been continued later this fall than we feel is desirable, but the two cities are now joined up and if some extra maintenance work is required we believe that fact will justify its cost.

Maintenance

"Our second year of maintenance closed October 31st, 1917, and the results only serve to emphasize the conclusions that could have been drawn last year. When we are freed from the excessive cost of maintaining the short stretches of macadam at bridge approaches the cost of repairs to the road surface will be almost negligible. On 312,100 square yards of concrete (approximately 30 miles) the commission spent in 1917 on tarring cracks and joints a total for labor and materials of $767.70. When this is contrasted with a cost of $5,932.12 for repairs to 7,900 square yards (approximately three-fourths of a mile) of macadam, the folly of macadam construction on a main highway approaching or connecting the larger centres of population is quite evident.

"The shoulders and slopes of cuts and fills have been seeded. The signs at the worst turns have been electrically lighted. The grass and weeds have been cut, the ditches cleaned out, the shoulders maintained and snow removed, keeping the highway open to traffic throughout the winter. The commission had hoped to begin the construction of pathways and the placing of some stone on the shoulders this season, but the scarcity of labor and the difficulty of securing suitable materials prevented the undertaking of this work.

"Thanks largely to the contributions from our reckless motorists, we are in a position to advise the representatives of the municipalities responsible for maintenance that our income has exceeded our outlay by almost $6,500, and that no accounts will be presented to them for maintenance for the year ending October 31st, 1917.

The Future

"The commission feels that the construction of the roadway is practically completed. It is hoped to begin the replacement of the Mimico, Etobicoke, Port Credit and Bronte bridges just as early in the spring as weather conditions will permit. The erection of a high level bridge at Oakville and the completion of the Hamilton entrance are awaiting the convenience of the municipalities interested.

Traffic

"In 1914 the highest traffic count at any point on the Lake Shore Road was 520, of which 262 were pleasure motor cars, three commercial motor cars, 199 were horse-drawn pleasure vehicles and 56 were horse-drawn commercial vehicles.

"In 1916 a total of 3,254 was recorded, 1,876 being pleasure motors, 142 commercial motors, 271 pleasure horse-drawn and 184 commercial horse-drawn. The corresponding day in 1917 showed a total of 3,840, of which 3,065 were pleasure motors, 107 commercial motors, 148 pleasure horse-drawn and 41 commercial horse-drawn. With this condition before them the commission has endeavored to keep the highway as nearly safe as is possible for this immense amount of traffic. While the total number of summonses issued during the past year exceed 1,900, the number of vehicles operated on the highway exceeds this figure during four hours on many of the busiest days."

Following Mr. Gooderham's paper, Sir William Hearst, who sat at the right of the chairman, and Hon. Finley McDiarmid, who was at his left, were each presented with walking canes. The chairman in turn was presented on behalf of the other members of the commission with a club bag.

Mr. W. D. Flatt, who was the pioneer in the effort to secure some action looking towards the road's construction, was presented by the commission and the councils of the municipalities through which the road passed, with a very beautiful loving cup.

Following this the premier of the province, Sir William Hearst, Hugh Bertram, member of the commission; E. Duffy, commissioner of highways of New York State, and Mark Irish, M.P.P.. delivered addresses, all of which dealt with some aspect of the road, its design, construction and financing.

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PRINCIPAL CONTENTS OF THIS ISSUE

WARS MUST BE PAID FOR BY SAVINGS

Wars must be paid for by savings. We must save in the consumption in commodities and the consumption of unproductive labor in order that we may divert our manhood to the Army and Navy and to the shops. If by the reduction in consumption of labor and the commodities that it produces and the diversion of this saving to that labor and those commodities demanded by the war, we shall be able to fight almost indefinitely. We can mortgage our future savings for a little while, but a piling up of mortgages is but a short step toward bankruptcy. Every dollar we save is available for subscription to Victory bonds.

The whole of Europe has been engaged ever since the war commenced in the elimination of waste, the simplification of life, and the increase of its industrial capacity. When the war is over the consuming power of the world will be reduced by the loss of prosperity and man power, and we shall enter a period of competition probably without parallel. After the war we must maintain our foreign markets if our working people are to be fully employed. We shall be in no position to compete if we continue to live on the same basis of waste and extravagance on which we have lived hitherto. Simple, temperate living is a moral issue of the first order at any time, and any other basis of conduct during the war becomes a wrong against the interest of the country and the interest of democracy.

EFFECT OF THE WAR ON MUNICIPAL ENGINEERING AND PUBLIC HEALTH

In a notable address delivered at the University of London, in connection with the Chadwick Departments of Municipal Engineering and Hygiene, Mr. H. Percy Boulnois, M.Inst.C.E., paid a well-deserved tribute to the work of the municipal engineer. While he spoke of conditions as they obtain in England, where war and its consequences are in greater evidence than here in Canada, nevertheless his observations are so important that as a matter of record they should be noted.

In the course of his address he stated that so far as his experience and observation went, he did not know of a single case where it could be proved that the war had in any way been detrimental to the health of the public.

He referred to the difficulties under which municipalities have been compelled to work,—the restrictions put upon expenditures, the shortage of labor, the diversion of revenue to war purposes, the depletion of staffs making inspection work difficult, and many other problems imposed by the war, all of which have added to the troubles of the municipal engineer.

To a lesser degree municipal engineers in Canada have been confronted with many of these same difficulties. The public, however, depends upon the municipal engineer to provide well-made roads and streets, to keep these clean and to have them well lighted at night. If pure water is wanted, the municipal engineer must supply it. In fact, there is not much that the average citizen can enjoy in the way of public conveniences that does not depend to some extent, at least, upon the co-operation of the municipal engineer.

Municipal engineers in Canada, who have since August, 1914, been compelled to carry on their work with many handicaps, can be counted upon to meet the challenge with which these new conditions come, in the same spirit that has characterized their fellow engineers across the sea.

RURAL PLANNING AND DEVELOPMENT

While after the war European nations will need restoration and reconstruction, Canada will need conservation and development. That the period of pioneer achievement is not over in this country but has entered upon a new phase, is one of the points emphasized in the valuable report of Mr. Thomas Adams on rural planning and development, just issued by the Commission of Conservation, Ottawa. The question is not whether we will grow but how we will grow. Mr. Adams, who has made a life study of his subject, points out that, broadly speaking, we require to lay emphasis on the following needs as a means of conserving human and natural resources in connection with any policy inaugurated in the future:—

(1) The planning and development of land by methods which will secure health, amenity, convenience and efficiency, and the rejection of those methods that lead to injurious speculation.

(2) The promotion of scientific training, improved educational facilities and means of social intercourse.

(3) The establishment of an efficient government organization and improved facilities for securing co-operation, rural credit, and development of rural industries.

Out of the total area of 2,306,502,153 acres of land in Canada, it is computed that 358,162,190 acres of land are

capable of being used for productive purposes. The population of the Dominion in 1911 was 7,206,643 or 1.9 persons to each square mile of territory. We have 35,582 miles of railway, or about one mile to every 200 persons, providing means of distribution by railway in advance of the needs of commerce. The natural resources may be said to be unlimited in extent, subject to proper conservation and development; and the means of distribution by main railways may be regarded as capable of no limitation in meeting demands for many years to come. But, while there is practically an unlimited quantity of natural resources, and of railways to distribute them, we are limited in the economic use to which we can put them. "Wealth is produced," Mr. Adams reminds us, "not from the existence of natural resources but from the conversion of these resources into some form for human use. Canada is seriously limited in actual resources by the extent to which it lacks sufficient population to apply the human activity necessary to adequately use and distribute its resources. Hence there is nothing so vital in the interests of production in Canada as to conserve and develop human life—not merely to conserve the physical qualities, but also to develop the intellectual qualities." Mr. Adams' volume is well worth a careful perusal by those who have in hand the problems of national development.

OBITUARIES

Flight Commander GEORGE MCLENNAN has been officially reported killed. Commander McLennan was a B.A.Sc. of 1912.

REUBEN G. LUNT, a pioneer shipbuilder, ship-owner and electrical engineer, and a former resident of Toronto, passed away on Monday at his late residence in Los Angeles, Cal., at the age of 97 years. Mr. Lunt had the contract for the first electric lights ever used in the city of Toronto, and in the early eighties he exhibited equipment of the first electric railway system ever operated in this part of the country at the Toronto Exhibition.

Flight-Lieut. PAUL H. RANEY, R.F.C., son of W. E. Raney, of Toronto, previously reported missing, was killed when his airplane went out of control in a battle with German airmen at Roulers, on August 21st. Lieut. Raney was a graduate of the School of Practical Science, University of Toronto, class of 1914. After graduation he was inspector for the G.T.P. and later was employed with munitions, enlisting with the Royal Flying Corps in February, 1917. He reached England in June, and had only been at the front a month. He was 24 years of age and a student member of the Canadian Society of Civil Engineers.

PERSONALS

Lieut.-Col. LINDSAY MALCOLM, professor at Queen's University, Kingston, has been appointed successor to Lieut.-Col. Irving, recently killed.

GEORGE H. CLARKSON, B.A.Sc., of Toronto, after having served in England in several capacities under the Imperial Munitions Board, has been appointed assistant superintendent of the Frodingham Iron and Steel Company, Lancashire, England.

Capt. ARTHUR J. LATORNELL, B.A.Sc., 1903, Associate Member Canadian Society of Civil Engineers, has been wounded in action. Capt. Latornell, who is an honor graduate in Civil Engineering, University of Toronto, qualified in March, 1916, at Kingston, for a commission in the artillery, and went overseas early this year. Prior to enlistment he was city engineer of Edmonton, Alta.

J. FRATER TAYLOR, president of the Algoma Steel Corporation, Sault Ste. Marie, Ont., has announced his impending retirement at the end of the present year. Mr. Taylor will still retain his association with the Soo industries in an advisory capacity as chairman of the Lake Superior Corporation. It is understood that W. C. FRANZ will succeed Mr. Taylor as president of the Algoma Steel Corporation.

Sergt. CHESTER A. HUGHES, son of Mr. Chester M. Hughes, Mimico, Ont., was wounded in the shoulder on October 26th and is now in a hospital at Norfolk, Eng. Sergt. Hughes was serving with the artillery, having gone overseas in September, 1915. He is 22 years old, and prior to enlisting was in his third year at the School of Practical Science, and is a student member of the Canadian Society of Civil Engineers.

WALTER C. TEAGLE, the man who at the age of thirty-nine has been called to an office which ranks among the first five executive positions in American commerce, is not widely known, even in Canadian business circles. As president of the Imperial Oil Co., he always shunned publicity, and even when recently appointed president of the Standard Oil Co., of New Jersey, he was reluctant to allow his photograph to be given to the press. In the oil trade, his is a well-known family. His maternal grandfather, Morris B. Clark, was the first partner of John D. Rockefeller. Mr. Teagle's father was a member of the oil firm of Scofield, Shurmer & Teagle. When he graduated in chemistry from Cornell University, Mr. Teagle wanted to accept a position as instructor at the college, but Teagle, Sr., put him to work firing an oil still at nineteen cents an hour. He obtained first-hand practical knowledge of every phase of oil refining, and with his knowledge of chemistry, he soon became vice-president of the firm with which his father's company was merged. He attracted the attention of Standard Oil executives and was sent abroad to study the oil industry of England, France, Germany and Rumania. On his return to the United States he was made head of the export department. His subsequent rise to the head of the Imperial Oil Co. and to the vice-presidency of the Standard Oil Co., of New Jersey, took but very few years. He organized the International Petroleum Co. in order to get for Canada a supply of crude oil from Peru. He built a fleet of tank steamers and bought and merged a number of Peruvian oil companies. In three years he increased the annual capacity of the Imperial Oil Company's refineries from 2,000,000 to 6,500,000 barrels, and another large refinery is nearly completed at Dartmouth, N.S.

Barrett Specification Roofs

Made in Canada

Canadian Pacific Railway Hotel, Calgary, Alberta.
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How the 20-Year Guaranty Operates—

THE following illustrates the working of our new plan to guarantee Barrett Specification Roofs for twenty years:

When the question of roofing is reached in the specifications covering the building the following, or its equivalent, should be inserted in the building plans:

> "This roof shall be laid according to The Barrett Specification dated May 1, 1916, and the roofing contractor shall upon completion of the job deliver to us the Barrett 20-Year Guaranty Bond, in accordance with Note 1 of such Specification."

Competitive bids may then be asked for from a number of roofing contractors.

The concern to which the job is finally awarded promptly notifies us regarding the work, asks for our Inspection Service, and the 20-Year Bond.

Our inspectors supervise the job, see that the Specification is strictly followed both as to methods and materials, and on its completion certify that the roof is O.K. in every respect.

On this certification the guaranty company issues a 20-Year Surety Bond which *exempts the owner from any maintenance or repair expense to the roof until 1937.*

The Guaranty Bond costs the owner and the roofing contractor nothing.

The service is free in the interest of good workmanship and the good repute of our materials.

How to Get the 20-Year Guaranty Bond

This new Guaranty Bond is issued on all Barrett Specification Roofs of fifty squares or more in all towns of 25,000 population and over, *and in smaller centers where our Inspection service is available.*

Our only requirements are that the roofing contractors shall be approved by us and that The Barrett Specification dated May 1, 1916, shall be strictly followed.

If you are interested we should be very glad to send you further details or copy of The Barrett 20-Year Specification, with diagrams, ready for insertion in your building plans.

The Barrett Company LIMITED

MONTREAL ST. JOHN, N.B. TORONTO HALIFAX, N.S. WINNIPEG SYDNEY, N.S. VANCOUVER

Coast to Coast

Toronto, Ont.—The Toronto-Hamilton highway was officially opened on Saturday, November 24th, by Premier Hearst.

Orillia, Ont.—Orillia's new electric power plant at Swift Rapids, on the Severn River, was formally opened on November 22nd.

Chin, Alta.—The Irrigation Department, Canadian Pacific Railway, Calgary, have nearly finished survey for canal to irrigate 7,000 acres of land.

Edmonton, Alta.—Operations have begun on the new track across 106th Avenue from 97th to 101st Streets. The material for the purpose has been taken up from the unused spur on the Highlands line, and will be laid in place at once. The construction is expected to take about a week, and the new routing of the low level cars will then be put in force. Only a single service track will be laid.

Montreal, Que.—The American International Shipbuilding Corporation has placed an additional large contract for fabricating structural steel, to be used in building cargo boats for the government, with the Dominion Bridge Company. The two orders thus placed amount to 40,000 tons of steel plates and shapes. The fabrication of this steel will take up the entire capacity of the Toronto and Montreal plants for ten months.

Hamilton, Ont.—The Industrial Department has announced that the Robert H. Hassler, Ltd., manufacturers of the famous Hassler shock absorbers for Ford cars, has decided to locate their Canadian factory in London. The American factory which is located in Indianapolis, Ind., is securing a considerable number of orders from Canada—the F. G. Morris, Ltd., of this city, who are the Canadian distributors of the Hassler shock absorbers, having twenty-eight cars on order with the Indianapolis factory at the present time. Mr. J. C. Piper will be the managing director of the new company

Sault Ste. Marie, Ont.—The connecting link between the upper St. Mary's River and the new three-million-dollar power canal at the St. Mary's River has now been broken, the water which will flow for the development of a greatly increased supply of power for this city has been let into the new canal, and it is expected that the first unit in the new power house will be generating power by the middle of January. Thereafter units will be placed in commission until the whole 34 units will have been set in operation. This process will take about five months longer to complete, but the whole work of erecting the machinery and setting the new power plant in full operation will be completed by June next.

Vancouver, B.C.—Taking advantage of favorable tides and the fact that all the necessary gear and plant was on the spot, the city waterworks crew has just about completed the hauling into place of the last of the old 12-inch cast-iron submerged mains in the First Narrows, which were temporarily disconnected to allow of dredging operations for widening the channel of the narrows on the north shore. One of these two 12-inch mains was hauled into place and connected up a couple of weeks ago, and on the recommendation of City Engineer Fellowes, the waterworks committee made an additional appropriation to have the remaining main placed in commission. With the gear, donkey engine and plant necessary all on the spot, this second main will be placed in commission at about one-third of what it cost to get the first of the two old mains connected up.

Taber, Alta.—The Canadian Pacific Railway is stated to have run lines for a big irrigation ditch in which to carry water from the Belly River, west of Cardston, to the St. Mary's River. This is in preparation for the supplying of water to the Taber project, work on which it is understood will be commenced next spring. The plan is to take the water from the Belly River, which rises in the vicinity of Waterton Lakes Park, and carry it east through a ditch through Leavitt and empty it into the St. Mary's River above the present intake of the A.R. & I. main ditch. This project is made necessary owing to the present waters of the St. Mary's River being practically all used up by the ever-increasing irrigation area on the A.R. & I. ditch.

Vancouver, B.C.—A health clinic building to cost approximately $30,000 will be erected by the Vancouver Rotary Club on the old hospital grounds facing Pender Street, with the object of making a more determined fight against the white plague in Vancouver. The Rotary Club plans to start a campaign to raise funds for the erection of this building, which is to be presented to the city free of all cost, on the condition that the city grant the use of the old hospital site on which to erect the building. The Rotary Club already has a large share of the necessary sum pledged for the erection of the building. Not only does the club plan to erect and equip the building and present it to the city's health department free of all encumbrances, but the club will maintain the clinic in operation for one year, on condition that the city then take over the clinic and maintain it.

Vancouver, B.C.—Arrival at a practical agreement on a number of questions in regard to waterworks cost and maintenance was the result of a recent visit of members of the civic water committee to the municipality of North Vancouver district, when representatives of the municipal council were met. An inspection was made of the Capilano pipeline, the intake and system, the chief question at issue being the maintenance of the pipeline road up the Capilano. The city built this road when first constructing the waterworks and later turned the road over to the municipality on the condition that the latter undertook the upkeep This the municipality has not done to the entire satisfaction of the city, and there is also the question of municipality's share of some cribbing work which was necessary to prevent the pipeline and road being undermined in certain places. As a result of Friday's conference the municipality agreed to repair the road, while the question of the division of the cost of the cribbing and other work will be referred to both councils to the incoming councils for next year to deal with. This agreement is to be submitted to both the city and municipal councils for ratification at their next meetings.

Ottawa, Ont.—The postal census of the manufacturers of Canada, taken in 1916, for the calendar year 1915, just issued, shows a general expansion in the manufacturing business of the Dominion. The number of establishments in operation was 21,306, representing an invested capital of $1,994,103,272, employing 52,683 persons on salaries and 462,200 persons on wages, and producing goods to the value of $1,407,137,140 from raw materials valued at $802,135,862. During the decade 1905-15 the number of establishments increased by approximately 34 per cent.; capital, 135 per cent.; employees on salaries, 44 per cent.; employees on wages, 29 per cent.; salaries, 96 per cent.; wages, 70 per cent.; and the value of products, 95 per cent. The value of the products of factories in 1915 was $1,407,137,140, as compared with $718,352,803 in 1905, an increase of $688,537, while wages paid totalled $229,456,210, an increase of $95,080,285. There were in Canada during the year covered by the statistics 65 establishments employing over 500 hands; 25 employing over 1,000; 9 employing over 2,000; 5 employing over 3,000: and 3 employing 4,000. Of these three establishments two employed over 5,000 hands. During the five-year period 1910-1915 the capitalization of Canadian industrial enterprises increased by $746,520,663, or about 60 per cent.

Welland, Ont.—The four plants of the Canada Foundries and Forgings Company are working almost to capacity, both on war orders and on ordinary business. The company recently obtained an order for 500,000 shells from the United States. The first delivery was to be made on December 15th; delivery was given a month ahead of time and as a result the company obtained another order for 500,000 shells. The Brockville plant has enough business to keep it going until May 1st, 1918, and the two Welland plants have orders which will keep those factories busy until January 1st, 1918. While it is turning out war orders, domestic and export trade have not been neglected. In an interview with *The Canadian Engineer* recently, Mr. B. J. McCormick, general sales manager, said: "We are not neglecting our peace trade. We keep a certain percentage of our equipment available for regular customers. We make a large range of forgings including axe, hatchet and hammer heads, wrenches, crank shafts, connecting rods, and so on. We are doing a good business in our regular lines as well as in the munition business. We are also fostering our export trade, now shipping our products, among other countries, to Great Britain, New Zealand and Australia. Our chief difficulty at present is cargo space. While our plant is working at almost capacity we are still able to accept more business." The company is turning out a large quantity of ship forgings for Canadian yards.