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The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

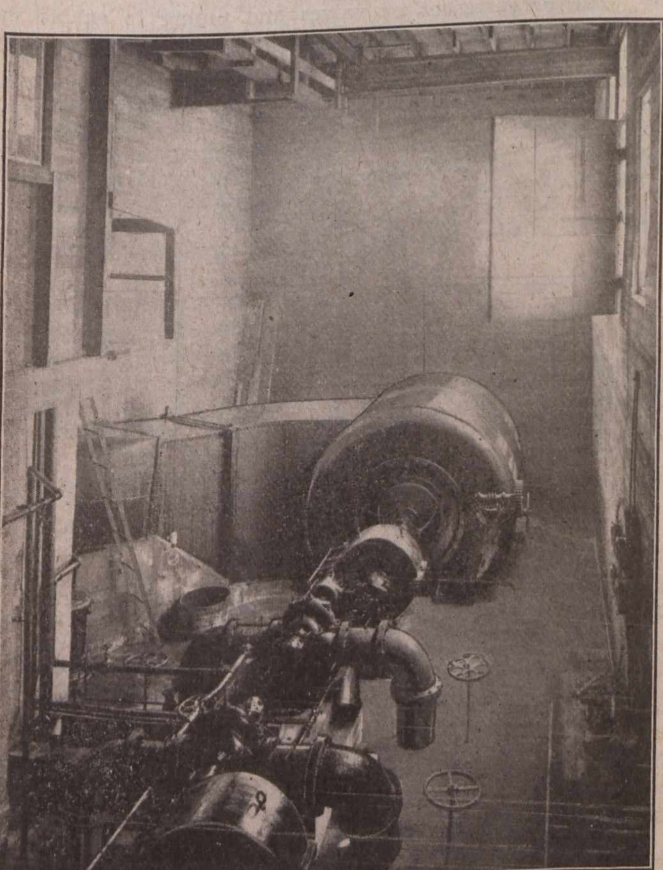
Helical Gears Solve Cornwall's Pumping Problem

High Speed Single-Stage Centrifugal Pumps are Driven by Low Speed Hydraulic Turbines, with Pumping Efficiency of 73% including Gear Loss—Direct Drive Would Have Required Fourteen Stages, Causing Sacrifice of Present Efficiency

By R. N. AUSTIN
General Manager, Turbine Equipment Co., Ltd., Toronto

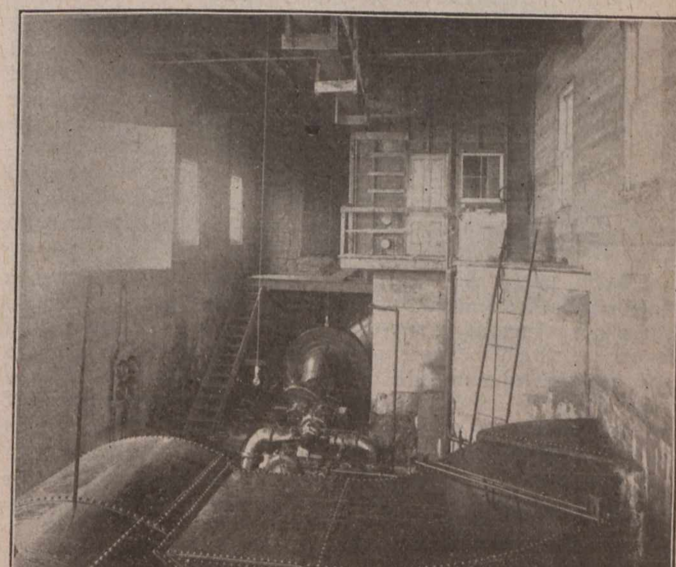
CORNWALL, Ont., has the distinction of being the first municipality on the American continent (and most probably in the world) to install centrifugal pumps driven by horizontal hydraulic turbines through the medium of double helical gears, the low speed turbines driving high speed single-stage pumps.

Reciprocating pumps have generally been used where hydraulic turbine drive was available, as many engineers are not yet conversant with the state of perfection that the high speed double helical gear has attained. In addition to the very much higher cost of reciprocating pumps, at least four times as much floor space and much more massive and expensive foundations are required for reciprocating pumps than for centrifugal pumps. In the opinion of the writer, installations similar to the Cornwall one are bound to supplant reciprocating pumps where hydraulic turbine drive is available (especially as a similar arrangement can be devised for vertical water wheels), just as surely as centrifugal pumps driven by steam turbines through the medium of double helical gears have supplanted triple-expansion high duty steam pumps during the last six years.



Water-Turbine-Driven Pumping Units

In order to keep pace with the rapidly increasing water consumption, the Cornwall town council, toward the latter part of 1916, decided to purchase an additional pumping unit capable of supplying three million gallons in twenty-four hours.



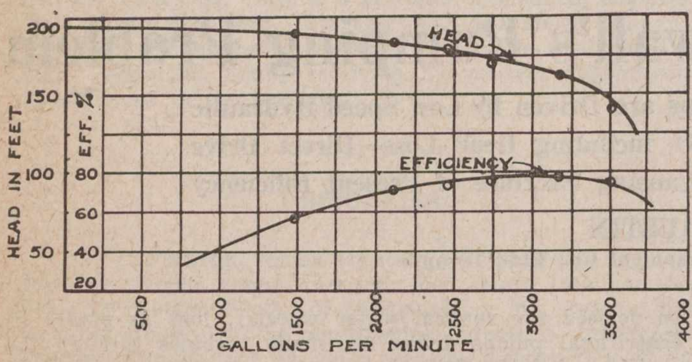
Another View of Cornwall's Pumping Plant

The existing pumping machinery at the waterworks plant at that time consisted of a triplex 12 by 14 in. pump and two duplex pumps, one 8 by 12 ins. and the other 10 by 12 ins. All these units were driven by a horizontal hydraulic turbine of the single enclosed type, with inlet at the side and discharge through an elbow at the end. This water wheel and the triplex pump had been installed seventeen years previously, but the wheel had been rebuilt by the William Kennedy Co., of Owen Sound, Ont., and developed 170 h.p. at 200 r.p.m. under a head of 18 ft.

Spur gearing and friction clutches had been used to drive the pumps referred to above and can still be used in case of emergency. There are also three duplex steam pumps, two of which have 10-in. diameter by 12-in. stroke cylinders and were built by the Worthington Pump Co., the other being 12 by 12 ins., built by the John Inglis Co., Toronto. A wall separates these pumps from the turbines and centrifugal pumps.

As an adequate supply of water was obtainable from the canal, which runs right alongside the pumping station, it was decided to have the new pump also driven by a hydraulic turbine, and in November, 1916, F. W. Stidwill, the town engineer, compiled specifications of the town's requirements and called for tenders.

Six or seven bids were received, and that of the Turbine Equipment Co., Ltd., of Toronto, was accepted for the pumping machinery and the William Kennedy Co. was awarded the contract for the new turbine.



Characteristic Curve Showing Performance of Pump Installed at Cornwall

The successful bidder for the pumps recommended that a new shaft be installed in the existing turbine, to extend at both ends so that it could be used for driving the old reciprocating pumps in cases of emergency, and also for driving (from the other end of the shaft and through the medium of double helical gears) a 10-in. single-stage double-suction De Laval centrifugal pump. It was also proposed that a new turbine be supplied which would drive a duplicate of the centrifugal pump referred to above, likewise through a set of double helical gears.

Each pump was to have a capacity of three and a half million gallons a day against a total head of 180 ft. when operating at a speed of 1,670 r.p.m. When placed in series, which means running both sets of turbines, gears and centrifugal pumps with one pump discharging into the suction of the other, the output was to be four and a half million gallons a day against 308 ft. total head. This latter condition is required in case of fire.

The pump efficiency guaranteed by the successful bidder was 72%, including the loss in the gears, which was guaranteed not to exceed 1½%.

Direct Drive Not Practicable

As stated above, the turbines run at 200 r.p.m. which is far too low a speed for a centrifugal pump, and in order to obtain a head of 180 ft., it would have been necessary to have used fourteen stages, with 36-in. diameter impellers, and the number and size of the impellers would have produced excessive skin friction, resulting in very poor efficiency.

Double helical gears have been extensively used by the De Laval Steam Turbine Co., of Trenton, N.J., who built the pumps and gears, for years as *reduction* gears in their steam-turbine-driven centrifugal pump and electric-generator installations, but it is obvious that they can be used just as successfully as *increasing* gears, although of course there will not be nearly so much call for them in that capacity.

The use of these gears in this manner enabled a standard speed to be chosen for the pumps, namely, about 1,670 r.p.m., and made possible the installation of single-stage pumps with impeller diameters under 16 ins. The builder's shop test showed an efficiency of 73%, including the gear loss, at normal capacity. The accompanying characteristic curve indicates the capacity, head and efficiency over the entire range of output.

Owing to the war greatly interfering with the builder's domestic work, delivery on the machines was very late, and the installation of the first unit was not completed until July, 1918. Since that time they have been in constant operation.

The new turbine is of the horizontal single enclosed type. The wheel is 36 ins. diameter and the steel case is 10 ft. diameter. It is not equipped with a governor as the load is constant. It was designed to develop 200 h.p. at 200 r.p.m. under an 18-ft. head, which is 30 h.p. more than is developed by the rebuilt wheel.

In summer the difference in elevation of the canal which supplies the turbines, and of the St. Lawrence River, into which the draft tubes discharge, is 30 ft. In winter, however, ice dams raise the level of the water in the river, which is sometimes only 10 ft. below the canal.

The steel penstock is 54 ins. diameter where it passes through the canal wall, and from there to the wheel case it is rectangular, 5 ft. by 7 ft.

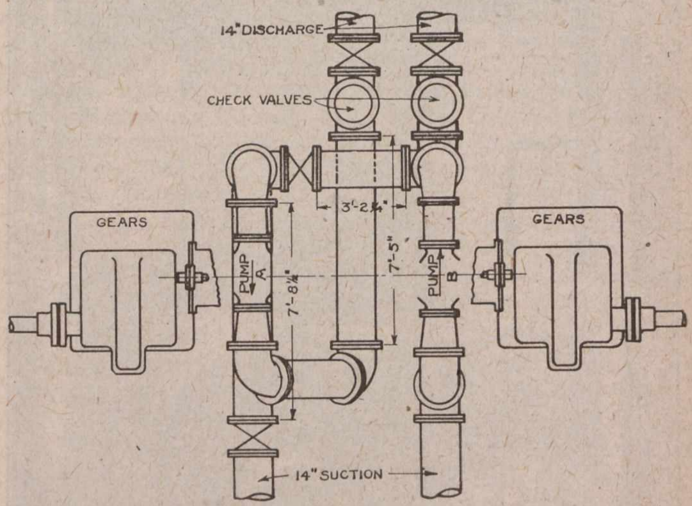
The draft tube is 54 ins. diameter where it connects to the discharge elbow; it then changes to rectangular, 5 ft. by 6 ft. and enlarges to 5 ft. by 7 ft. The total length of the draft tube is 42 ft. and it is all built of reinforced concrete.

Gears are Rigidly Supported

The double helical gears are rigidly supported and enclosed in a cast-iron case. The gears and pinions are made of special heat-treated steel and are lubricated by a spray of oil projected against the line of contact of the gear teeth on the entering side. The pinion bearings are oiled from a gravity system. This oil, after passing through the pinion bearings, flows into the reservoirs of the gear bearings, which are ring-oiled. The overflow from gears and bearings is drained to a reservoir in the bedplate and strained, and then pumped by a rotary pump, driven from the slow speed gear shaft, to a cooling tank located about 18 ft. above the centre line of the bearings. The gear teeth are cut at an angle of 45 degs., which results in low tooth pressures. In this installation they are quite noiseless.

The pumps have 10-in. suction and discharge and are equipped with bronze impellers, wearing rings and shaft sleeves, and have cases split on the horizontal centre line.

The arrangement of valves and piping to enable individual or series operation to be obtained is very simple,



Layout of Piping and Valves at Cornwall

and the change can be made in a couple of minutes. The accompanying drawing shows the arrangement of the piping and valves.

Each pump has 14-in. suction and discharge piping which is reduced right at the pumps to 10 ins. The suction lift during summer is often as high as 20 ft.

Charles Lount is superintendent of water works and had charge of the installation of the hydraulic turbine. The Turbine Equipment Co., Ltd., installed the pumps and gears and also the valves and piping, etc., inside the pumping station, which was enlarged to take the new machinery.

Following are the detailed specifications for the double helical gears which are, of course, the particularly interesting part of the above installation:—

Operating conditions:—The normal rating of the increasing gear will be 160 brake horse-power. The ratio of speed increase is to be 8.35 to 1, the pinion operating at 1,670 r.p.m. and the gear at 200 r.p.m. When operating under the load and speed conditions specified above, the power delivered by the increasing gear shall, after deducting tooth friction, bearing friction, windage and all losses, be not less than 98½% of the power received.

Shape and Pitch Tested

General description:—The De Laval increasing gear . . . . . after cutting is tested for correct angle, correct shape of tooth and correct pitch, and no gear is used that is not correct and that does not have a perfect contact surface for the whole length of every tooth. The teeth are of such shape as to give as closely as possible perfect rolling contact and no scraping or hand work is permitted, since such hand work would produce imperfect contour of teeth. After cutting, the gear teeth are carefully polished by a special process which eliminates the small inequalities left by the cutting tool, without in the least degree altering the profile of the teeth. The direction of rotation is such that pressure on the pinion bearings is in a downward direction. This relieves the bearing caps from all strains and obviates the possibility of damage in case a bearing cap should become loose. The pressure of the pinion tends to lift the gear, the weight of which is slightly greater than the upward pressure, thus reducing the load on the gear bearings. The pinion is sufficiently large to withstand all bending and twisting forces, and of such length that the bearing pressure is low, preventing squeezing out the film of oil or abrasion of the metal.

Gear case and cover:—The bottom half of the gear case is a single casting, which contains both gear and pinion bearings, holding them in rigid alignment and maintaining the correct spacing between the centres of the gear and pinion, and also preventing any movement which would tend to produce unequal pressure, hammering and vibration that would result in rapid wear of the gear and pinion. The bearing seats are carefully scraped to standard size to permit perfect interchangeability of bearings. The bearing caps are separate, and any one can be removed without disturbing any other part. All parts of the increasing gear that may be disassembled for inspection are furnished with taper dowels to insure correct reassembling, and all working parts are made to standard limit gauges and are strictly interchangeable. The cover is so arranged that it can be removed without disturbing the bearing caps or any other part.

Bearings:—Gear and pinion bearings consist of cast-iron shells lined with high-grade babbitt and ground on all contact surfaces to standard dimensions to insure exact alignment and perfect interchangeability. They are split, to allow of removal without disturbing the shafts, and any bearing can be removed without disturbing any part other than the cap. Pinion bearings are arranged for water cooling and all bearings are provided with oil catchers and all shafts with oil slingers to prevent the creeping of oil along the shafts.

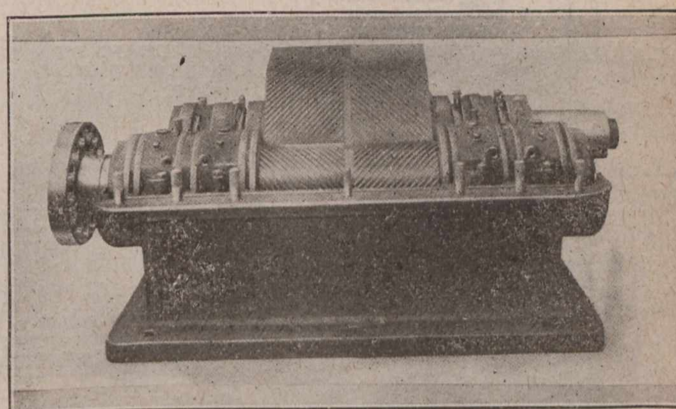
Pinion Cut on Shaft

Gear:—The gear consists of a heavy cast-iron centre, on which are shrunk two seamless rolled steel bands in which the gear teeth are cut. The gear centre is of such shape as to have great strength and be free from distortion by excessive strains or rapid temperature changes. The gear bands are of special steel, heat treated to secure uniform material and proper hardness for the gear teeth. The gear, after complete assembling, is carefully tested for static and running balance. The gear shaft is hammer-forged open-hearth steel, ground on all surfaces to standard dimensions. It is fastened in the gear centre by means of a taper fit and key.

Pinion:—The pinion is cut directly on the pinion shaft, which is a special nickel steel forging, oil tempered, to have a hardness much greater than that of the gear bands in order to provide different quality of metals in contact and to insure long life of the pinion. The pinion is ground on all surfaces and carefully tested for static and running balance.

Oiling system:—The gear and pinion are lubricated by a spray of oil projected against the line of contact of the gear teeth on the entering side, thus insuring ample lubrication. The oiling device is so arranged that it can be examined or cleaned conveniently without lifting the gear case cover or disturbing any other part. The pinion bearings are oiled from a gravity system, with a sight-feed oil glass for each bearing. The oil, after passing through the pinion bearings, flows into the reservoirs of the gear bearings, which are ring oiled, thus replenishing and insuring the proper level of oil in the gear bearing reservoirs. The gear case and cover, as well as all bearing caps, are provided with recessed oil grooves to prevent seepage of oil through the joints. All oil is drained to a common point and returned to the circulating pump. The oil pump is of the positive gear type, driven by means of a worm from the main gear shaft or from the shaft of the driving machine.

Flexible couplings:—The gear and pinion are connected to the driving and driven machines respectively by De Laval flexible couplings. Each coupling consists of two forged steel discs ground and polished on all surfaces, the driving half being fitted with a number of rigid studs which enter



Double Helical Gears at Cornwall, Ont.

holes in the driven half of the coupling, driving the same through the medium of steel lined rubber bushings. This arrangement permits of a certain amount of flexibility and prevents strains on the bearings. The couplings can be quickly disconnected, which permits the removal of one shaft without disturbing the other. Each coupling disc is fastened to the shaft by means of a taper fit and key and locked in place by means of a lock nut.

Bed Plate:—The increasing gear is mounted on a heavy bed plate of the box type, suitably proportioned and arranged for connection to the bed plates of the driving and driven machines.

A discussion has arisen as to whether the new bridge across the Bow River at Banff, Alta., should be steel or concrete. It is stated in a Calgary newspaper that the Department of Public Works has intimated that the cost of a concrete bridge would be $600,000. C. D. Howe & Co., of Port Arthur, state that they prepared an estimate for the Public Works Department showing that the cost of a concrete bridge would be only about $240,000.

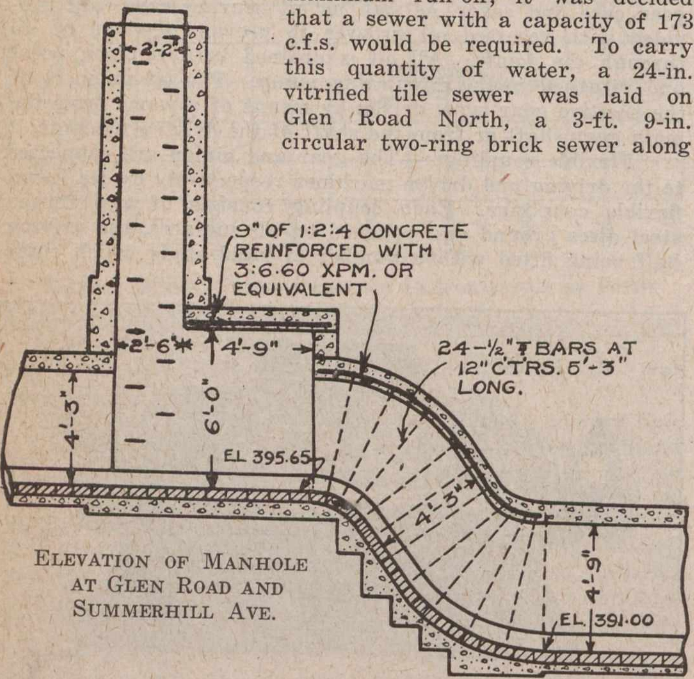
The executive committee of the Water Works Manufacturers' Association have appointed a sub-committee on special publication, and at the annual convention of the association next week at Buffalo, this sub-committee will report in favor of the publication of a book entitled "History and Activities of the American Water Works Association," to be mailed gratuitously to approximately 5,000 water works officials in the United States and Canada, in order to get new members for the association and to let the officials know more about the manufacturers.

MOORE PARK DRAINAGE SYSTEM, TORONTO

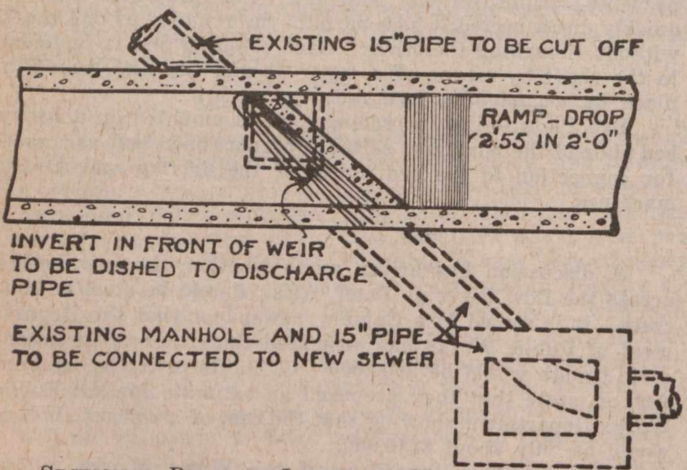
TORONTO'S Moore Park drainage system, the construction of which was commenced in November, 1917, and completed in February, 1919, consists essentially of three parts: The first section, along Summerhill Ave., from Sighthill Ave. to Glen Road; the second, down Glen Road North; and the third, the combined outlet of the other two, down Glen Road to the Rosedale Ravine.

The third section was described in detail in *The Canadian Engineer*, issue of February 27th, 1919, and will be merely summarized briefly in this article.

The district to be drained comprised an area of 233.5 acres. After making the necessary calculations for the maximum run-off, it was decided that a sewer with a capacity of 173 c.f.s. would be required. To carry this quantity of water, a 24-in. vitrified tile sewer was laid on Glen Road North, a 3-ft. 9-in. circular two-ring brick sewer along Summerhill Ave. from Glen Road North to Glen Road South, and a 4-ft. 3-in. circular two-ring brick sewer along the western section of Summerhill Ave. from Glen Road South to Sighthill Ave. From the junction of these two branches a special culvert type concrete sewer was constructed in tunnel down Glen Road South to the Rosedale Ravine. On page 251 of *The Canadian Engineer* for February 27th, 1919, there was published two photographs of the junction chamber at Glen Road South and Summerhill Ave., showing connection at the right for the easterly contract along to and extending up Glen Road North as far as the Canadian Pacific Railway Co.'s right-of-way; and at the left for the westerly contract to Sighthill Ave.



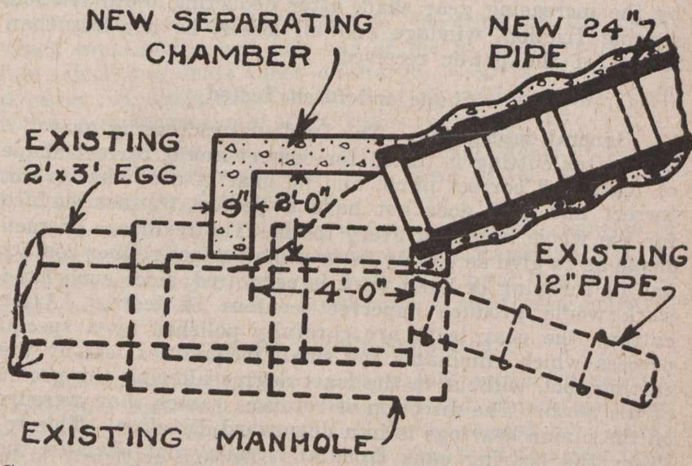
Elevation of Manhole at Glen Road and Summerhill Ave.



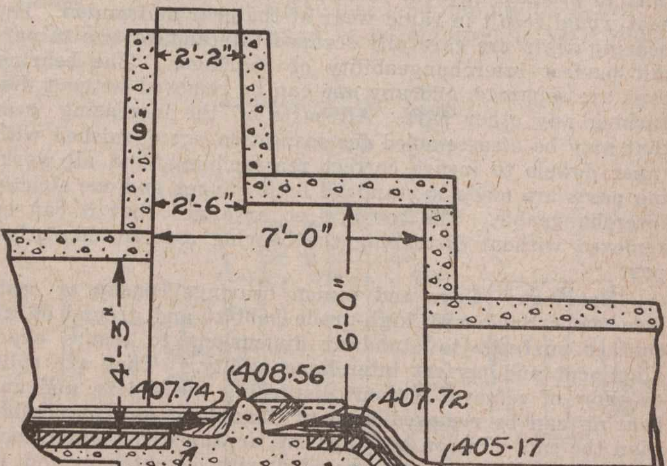
Sectional Plan at Invert of Manhole Chamber, Sighthill and Summerhill Aves.

Two contracts were let for the entire system. The first was for the combined outlet down Glen Road South to the Rosedale Ravine. The special culvert shape was adopted for this section after due consideration of the detailed costs for the equivalent egg and circular sections. In excavating this tunnel section, for about 1,800 lin. ft. north from the Ravine there was found soft, dry, blue clay, and about 10 lin. ft. a day was the average daily progress. Further north, the nature of the ground changed, and it was necessary to construct a 10-ft. ramp. This change in elevation brought the line of the sewer into very hard, sandy clay for a short distance, followed by light, sandy earth for the remainder of the contract, which terminated at the corner of Summerhill Ave.

Concrete was poured through 8-in. diameter borings from the surface of the roadway above, 1-in. screened gravel being used exclusively as the stone aggregate.



Sectional Plan of Separating Manhole at North End of Glen Road



Longitudinal Section of Manhole Chamber at Sighthill and Summerhill Aves.

The second contract, as previously intimated, was divided into two parts, east and west from the intersection of Glen Road South with Summerhill Ave.

For the eastern part or 24-in. vitrified tile sewer, the grade was found to be so flat that it was necessary to change the design for the last 411 ft. to a 3-ft. 9-in. circular sewer. The 24-in. pipe was laid in open cut, but the 3 ft. 9 in. section was built in tunnel.

The excavation for the 24-in. pipe was mostly through a sandy clay loam with a small section of gray shale clay. The depth of the trench was approximately 7 ft. and the length, including short sections of tunnel under sidewalks, etc., was 792 ft. Daily progress averaged 16 to 18 lin. ft. a day. The 24-in. pipe was surrounded by class B concrete (1: 3: 5 mix, city of Toronto specifications) with a minimum thickness of 3 ins.

The 3 ft. 9 in. section was constructed of approved hard red-shale brick, laid in two courses. The brickwork in the invert was laid true by template; the joints and the courses were kept straight between templates for the entire length. The upper part of the ring was laid in centres 3 ft. in length.

In this eastern section there were constructed four new typical manholes, and a fifth manhole was reconstructed. This was the first part of the second contract to be constructed, due to shallow covering and approaching winter.

The western portion was constructed as a 4 ft. 3 in. circular two-ring brick sewer, connecting with the existing brick sewer at the south side of the Canadian Pacific Railway Co.'s right-of-way. This latter sewer, upon completion, had been provided with a wooden bulkhead which was removed for the new connection.

A ramp 2.55 ft. high and a weir, to divert the dry weather flow, were incorporated in manhole No. 4, just east of Sighthill Ave. There are three additional manholes and a ramp raising the elevation of the invert 4.65 ft. above the junction chamber.

For this section of the second contract, tenderers were required to submit prices on a design similar to the special culvert type previously constructed on Glen Road South, and also for a two-ring brick sewer. The successful tenderer submitted the same price for both brick and concrete, and the Works Commissioner of Toronto decided to construct this section also in brick. Of this section, 1,500 lin. ft. were constructed in tunnel, shafts being sunk every 300 ft. and mining being carried on simultaneously in both directions. The average distance mined was 10 ft. in each heading each day.

The material excavated for the first 915 ft. was found to be hard blue clay and soft red sand, as had been indicated by the borings taken by the contractor. The next 588 ft. traversed a stratum of hard blue sandy clay, containing a small amount of water, stones and boulders. For the remainder of the section, a distance of 505 ft., the ground was a soft, yellow sand. This was excavated in open cut, 6 ft. wide by 10 ft. long, alternating with tunnel sections 20 ft. in length, thus obviating the necessity of maintaining hoisting machinery, etc.

Due to the shallow covering and the close proximity of dwellings, very little dynamite was used, and only in small quantities.

At the corner of Glen Road South and Summerhill Ave., a 6-in. water main crossing the top of the sewer was supported by a brick pier laid directly on the crown of the arch of the sewer. This was the only instance during construction where the slightest trouble occurred owing to existing installations.

All of the work was under the general direction of the following Toronto civic officials:—R. C. Harris, works commissioner; George Powell, principal deputy city engineer; W. R. Worthington, engineer of sewers; and W. G. Cameron, engineer of sewer maintenance and construction.

The contractor for the entire construction, including both contracts Nos. 1 and 2, was the A. W. Godson Contracting Co., Ltd., Toronto. *The Canadian Engineer* is indebted to H. F. Barker, the contractor's engineer, for the above information and drawings.

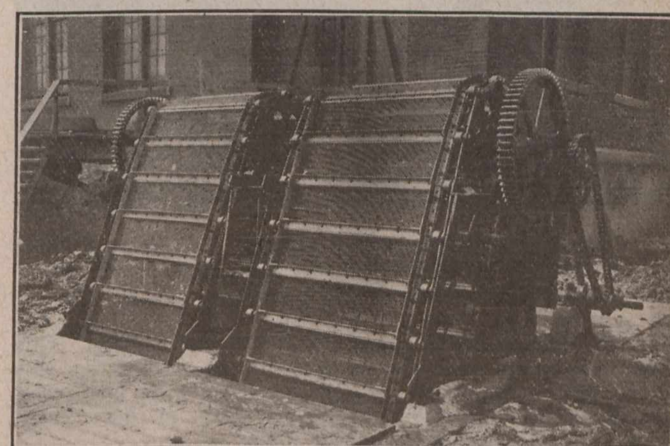
Following is a partial list of Canadian patents recently issued through the agency of Ridout and Maybee, Toronto: Harold W. E. Josling, means for promoting circulation of the fluids in steam generations; Alfred H. Anthony, automatic regulators for boiler feed apparatus; Alfred H. Anthony, float operated water level regulators and the like; Alfred H. Anthony, float operated valves; Aaron N. Warfield, metal car; and Wm. T. Stephens, process of producing iron and steel.

PUMPING PLANT AT SAULT STE. MARIE, ONT.

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

In 1914, the civic authorities of Sault Ste. Marie, Ont., acquired the Tagona waterworks. The pumping station was then in a corner of the Great Lakes Power Co.'s hydro-electric power-house. Under the terms of the purchase agreement, the city was required to erect a new station elsewhere.

In the meantime, investigations were made as to how best to provide a satisfactory supply of water. Alvord & Burdick, of Chicago, reported in favor of a gravity filter near the St. Mary's River. The writer later on made somewhat similar investigations, and advised in favor of obtaining water from the Coldwater Creek by a new route. Owing to the urgency of the demand for a new station, and to the divided local views held by the public with regard to the future source of supply, the Water and Light Commission came to the conclusion that the financial stringency which then prevailed precluded the possibility of carrying out a complete scheme, and, consequently, decided upon an interim undertaking, and that was to erect a new pumping station on Queen St., and to provide in conjunction therewith an electric sub-station, which, as that public utility expands,



Typical View of the C. A. Jennings Band Screen as Used at Sault Ste. Marie, Ont.

may in future require the entire building, and in that event the waterworks plant will again have to be relocated.

The writer was engaged in 1918 to design the whole scheme, but subsequently Major A. G. Tweedie was appointed acting city engineer and resident engineer to the Water and Light Commission, and all outside work was attended to by him.

The new building measures 81½ ft. from front to back and 52 ft. from side to side. The front part of the main floor consists of offices and workshops. The pump-room is 50 ft. long by 31½ ft. wide, 17 ft. high, well lighted and commodious. The floor over the offices is occupied by the electric department.

The water is drawn from the power canal, and in cases of emergency from the ship canal. It gravitates to the pumping station and passes through two Jennings band screens, which move slowly and automatically discharge the screenings into hoppers. A spray of water keeps the screen clean.

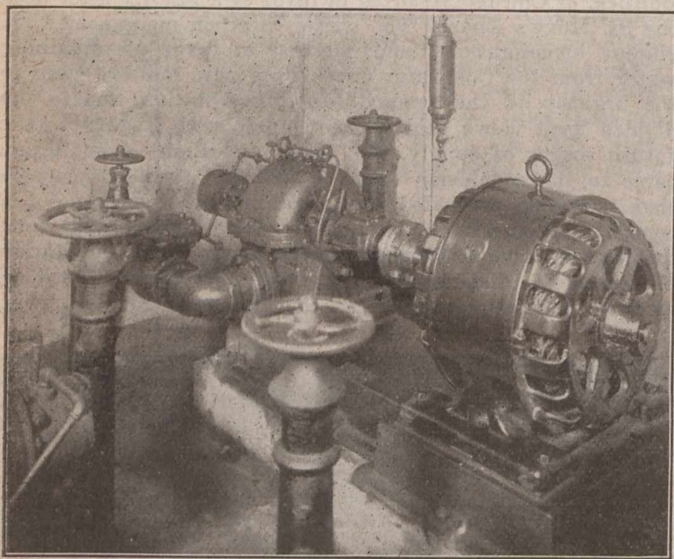
The piping in the pump house is arranged so that any one of the domestic supply pumps can deliver water to any one of the three fire pressure booster pumps. The domestic pressure is 85 lbs. and fire pressure 127 lbs. Two of the domestic pumps were supplied by the Canadian Allis-Chalmers Co. and one by the Bawden Pump Co., Toronto. The fire pumps are very similar in design to the domestic pumps,

(Concluded on page 513)

PUMPING STATION AT AYLMER, ONT.

By H. L. Shepherd
Assistant Engineer, Hydro-Electric Power Commission of Ontario

AYLMER'S water supply is obtained from two sources: First, a spring about two miles to the east, from which there is a gravity line to the reservoir at the main pumping station; and second, springs about one and three-quarters miles to the west, from which the water is pumped by steam to a second reservoir at a milk-condensing plant near the Grand Trunk station. The steam pump at this plant is soon to be replaced by an electric pump. This condensing plant uses a large part of the water from this second source, known as the Caverly system. When necessary, however, to augment the supply at the main reservoir, it can be fed from the condenser plant reservoir by gravity.



4-In., Two-Stage, Motor-Driven Domestic Pump at Aylmer—Delivers 330 Imp. Gals. per Min. Against 90 ft. Head at 1,420 r.p.m.

The reservoir at the pumping station is a concrete structure about 140 ft. by 50 ft., divided into two parts and having a total capacity of about 300,000 Imperial gallons. Close to the pumping station, on a slight elevation, is is steel stand-pipe about 16 ft. diameter and 100 ft. high, having a capacity of about 125,000 Imperial gallons. The population of Aylmer, Ont., is about 2,500.

The original pumping equipment consisted of two steam fire pumps, each having a capacity of about 1,000 gallons per minute. Natural gas was largely used to fire the boilers.

When "Hydro" power became available, it was decided to install a direct-connected electrically-driven centrifugal pump for supplying the domestic requirements, and to replace one of the steam fire pumps with a gasoline-engine-driven fire pump. Later, the remaining steam fire pump will be replaced by an electrically-driven fire pump.

The domestic pump is a 4-in. 2-stage centrifugal pump, having a capacity of 330 Imperial gallons per minute against a head of 90 ft., direct-connected to a 20 h.p. 3 phase, 25 cycle, 550 volt, 1,420 r.p.m., squirrel-cage induction motor, automatically controlled by a self-starter and pressure regulator set to start the pump when the pressure falls to about 35 lbs., and to stop the pump when the pressure increases to 45 lbs.; i.e., when the stand-pipe is full.

The fire pump is an 8-in. 3-stage centrifugal, having a capacity of 850 Imperial gallons per minute against a head of 280 ft. (122 lbs.) direct-connected to a 106 h.p. 4-cylinder, 6 in. by 6 in., 1,500 r.p.m. gasoline engine, complete with electric starter, charging generator and storage battery.

A steel gasoline-storage tank of 450 gallons capacity is buried 3 ft. below ground outside the station. A one-half gallon long distance measuring pump is located inside the station. This pump delivers the gasoline to an 8-gallon galvanized-iron feed tank fastened to the outside wall of the station. Gasoline is delivered to the engine from this tank by gravity through a ⅜-in. copper tube. A float in this tank operates a "tell-tale" in the station to show the quantity of gasoline in this tank. All pipes of the gasoline system drain to the underground storage tank. The exhaust is carried to an underground concrete exhaust chamber from which a vent pipe is carried above the roof.

It is estimated (from the electric energy consumed since November 1st, 1918, when the domestic pump was put into service, and from the number of hours this pump will probably operate per day during the summer months, when several manufacturing concerns greatly increase their consumption) that the average cost of pumping will be 3.8 cents per 1,000 Imperial gallons. This figure includes:—

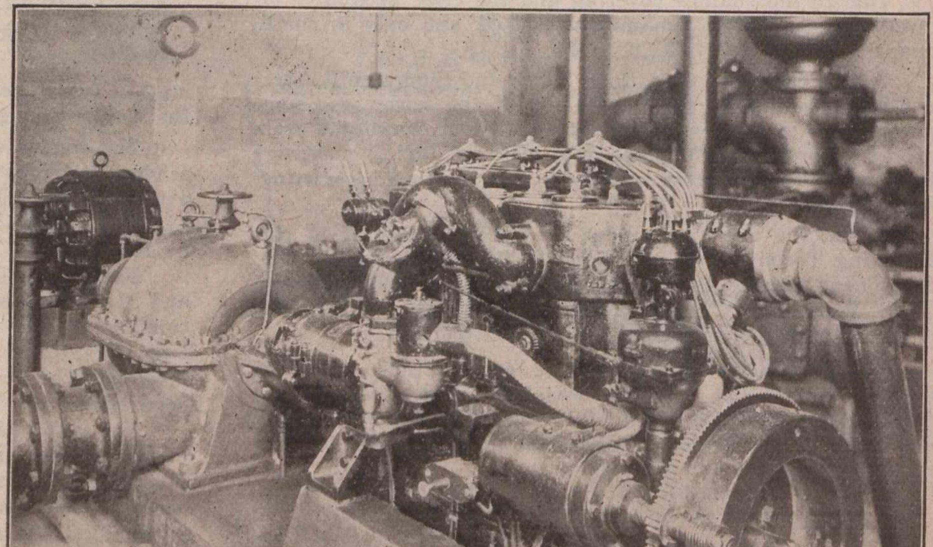
1.—Interest at 6% and depreciation at 7½% on the cost of the domestic unit, piping, valves, installation charges and engineering, which totalled about $2,100.

2.—Cost of class "D" power to the water department.

3.—Allowance for station labor apportioned to daily inspection of the pump, and making repairs when necessary.

4.—Maintenance, covering replacement of worn parts, packing, oil, etc.

A conservative estimate of the previous average cost of pumping by steam (based on a capital investment for a steam pump and boiler of sufficient capacity to handle only the domestic requirements and allowing for interest, depreciation, etc., as above) was 6.3 cents per 1,000 gallons. The saving using "Hydro" power would therefore be about 2.5 cents per 1,000 gallons, or a total annual saving of about $940, based on a yearly consumption of 39 million gallons.



8-In., Three-Stage, Gasoline-Engine-Driven Pump at Aylmer—Delivers 850 Imp. Gals. per Min., 280 ft. Head, 1,500 r.p.m.—106 h.p. Engine

The saving using "Hydro" power, will pay for the cost of the domestic unit in less than three years.

The fire pump installed cost about $5,950. Except in the case of fire it will only be turned over two or three times a week to keep it "tuned up." An estimate of the running time per month, under these conditions is one hour. The gasoline consumption of this engine when delivering its rated output of 106 h.p. is 12 to 15 gallons per hour.

The standby charges, exclusive of running expense during fires, will therefore be about $75 per year for gasoline and oil. The annual fixed charges at 13½% on the investment of $5,950 will be $803. The fuel costs of a steam standby maintaining 40 lbs. steam pressure may, for a municipality of this size, amount to $800 to $1,000 per year, exclusive of firemen's wages.

The accompanying illustrations show the domestic unit with self-starter and pressure regulator, and also the fire unit.

The installation was laid out and purchased by the Hydro-Electric Power Commission of Ontario, in accordance with instructions received from the municipality. J. L. Millard, local superintendent of the Water and Light Commission, superintended the installation and is operating the equipment.

PUMPING PLANT AT SAULT STE. MARIE, ONT.

(Continued from page 511)

and were also supplied by the above-mentioned firms. Each pump is designed to deliver at the rate of 3,500,000 gallons a day.

The water is measured by means of a Venturi meter, supplied by the Allen General Supplies, Toronto, and this meter also controls a Wallace & Tiernan chlorinator.

The motors supplied in connection with the Canadian Allis-Chalmers pumps were built by the Canadian General Electric Co., while the Canadian Westinghouse Co. supplied the motors for the Bawden pumps.

The building is constructed of Natco hollow tile, and the walls are plastered inside and out. The facade is faced with red Milton brick. The basement contains all pipes and valves, heating equipment, etc. It also contains one Chicago bilge pump, supplied by the Equipment Specialties Co., Toronto. In the pump room is installed a Herbert Morris Crane and Hoist Co.'s two-ton overhead travelling crane, and same firm supplied a half-ton jib extension spur gear chain block for the electric department.

The contractors for the building were Fitzpatrick & Gibson, of Sault Ste. Marie. The total expenditure has been about $110,000. The plant will likely be in steady operation within a few days.

The annual meeting of the Canadian Gas Association will be held August 21st and 22nd at the Clifton Hotel, Niagara Falls, Ont. C. C. Folger, general manager of the Light & Power Department, Kingston, Ont., is president of the association, and the secretary-treasurer is George W. Allen, advertising manager and superintendent of employment of the Consumers Gas Co., Toronto. Mr. Allen was recently appointed editor of the "Intercolonial Gas Journal of Canada," which is the official organ of the Canadian Gas Association.

The annual convention of the Canadian National Clay Products Association was held May 26th to 28th at Montreal. The officers elected for the ensuing year are as follows:—Past president, Thomas Kennedy, Swansea; president, Wm. Burgess, Todmorden; 1st vice-president, Ryland H. New, Hamilton; 2nd vice-president, Millard F. Gibson, Toronto; 3rd vice-president, T. H. Graham, Inglewood; secretary-treasurer, Gordon C. Keith, Toronto; councillors, Andrew Dods, Mimico; John S. McCannell, Milton; H. H. Hallatt, Tilbury; W. H. Freeborn, Brantford; N. T. Gagnon, Montreal; Chas. B. Millar, Toronto; F. B. McFarran, Toronto; and Chas. B. Lewis, Toronto.

NEW WATERWORKS SYSTEMS FOR AMHERSTBURG AND OJIBWAY, ONT.

By Charles W. Tarr
Vice-President, Morris Knowles, Ltd., Consulting Engineers, Windsor, Ont.

AMHERSTBURG, Ont., was the original terminus of the Michigan Central Railway and gave promise of becoming an important town, but when the railway was relocated, the town lost much of its importance and the population has remained practically stationary, as is shown by the following statistics:—

Year.	Population.	Source of Information.
1881	2,672	Canadian census
1891	2,279	" "
1901	2,222	" "
1911	2,556	Assessment rolls
1915	2,356	" "
1917	2,900	Mayor's estimate

Fortunately, however, the population growth did not need to enter largely into the design of the water purification plant recently completed for Amherstburg, but prudence demanded that provision be made in the works to be built for a population of at least 5,000, with allowance for the addition of units when the population increases.

The old water works system of Amherstburg consisted of a cost-iron intake pipe delivering to a well outside of a pumping station at the foot of Rankin Street. Within the pumping station there were two 12 by 18 by 12 by 12 compound direct-acting duplex pumps operating against 40 lbs. water pressure. One of these, manufactured by the Kerr Engine Co., of Walkerville, Ont., was 29 years old, and the other, by the Canadian Fairbanks-Morse Co., was 8 years old. The steam was furnished by two fire-tube boilers.

The water was pumped to a small stand pipe close to the station, which was shut off at times of fire and the pressure in the town's distribution raised from 90 to 100 lbs. The distribution system consisted of cast and wrought-iron mains, stated to be about 4½ miles in total length and varying in size from 4 to 10 ins. There were about 50 fire hydrants upon these lines and approximately 600 connections. The capacity of the standpipe was 68,000 gallons.

The report of the Commission of Conservation of Canada stated that the water consumption was about 500,000 Imperial gallons per day, and this was confirmed by other statistics, and by the statement of the mayor.

For a population of 2,900, this gave an excessive use and was due possibly to the fact that the town was supplied with water under flat rates, and there was a large amount of small piping, outdoor closets and outside hydrants. No doubt, there was also a considerable slippage in the pumps, which are of an obselete type.

For a system such as this, it was not wise to anticipate any considerable decrease in the use of water for some time, and even though meters were installed and methods of curtailing the waste were adopted, it would not be possible to reduce materially the size of the plant required to supply the water because of the fire protection consideration, although an economy could be secured in the operation which would be proportional to the reduction in use of water. A town of about 4,000 population requires between four and five fire streams of 210 Imperial gallons each per minute according to the requirements of the Canadian Underwriters, and this was confirmed by our own practice and by the recommendations of the National Board of Fire Underwriters of the United States.

Quantity of Water Required

By proper restrictive and controlling measures such as meters and inspection and a proper rate schedule for the water used, it will undoubtedly be possible to reduce the amount of water per capita from the high figure now existing. On the other hand, the purified water may be of considerable value in certain manufacturing processes. It was not considered that even after all waste has been eliminated that the per capita consumption could be reduced much below 83 Imperial gallons. Summarizing these figures, we had the following:—

Present use, 500,000 Imp. gals. a day.

Future estimated use for a population of 5,000 with meters and all restrictive measures, 83 gallons per capita, or 420,000 Imp. gals. a day.

Future use restricted, with conditions somewhat improved over the present, 670,000 Imp. gals. a day.

Fire capacity, 1,200,000 Imp. gals. a day.

The fire use in this case was the determining factor, but the domestic average use also influenced the size of the unit. The fluctuation in a domestic supply of this nature will be from about a minimum of 60% of the average to a maximum of 150% or even 175% of the average, or from a rate of 360,000 gallons in the middle of the night to 1,000,000 gallons at the peak on the Monday morning, due to washing, or on some hot day in the summer, due to lawn sprinkling, or some cold spell in the winter, due to allowing the water to run to waste to prevent freezing.

The fire use at the rate of 1,200,000 Imperial gallons a day would not last longer than from 12 to 14 hours, as a conflagration continued longer than that would wipe out the town, and might be taken care of either by sufficient storage connected to the distribution system, in which case the filters and pumping capacity would be dependent upon the maximum daily use, or by increased capacity of the filter and pumps. In this location, storage at sufficient elevation to give the desired fire pressure was very costly and, therefore, dependence had to be made on the capacity of the pumps and filters. With these considerations in mind, the following capacities for the various units were recommended:—

Low lift pumps, three at 500 Imp. gals. per min. High lift pumps for filtered water, three at 500 Imp. gals. per min. Filters, three at 500,000 gallons a day normal capacity, with space reserved for one additional unit.

Quality of the Water

The quality of the Detroit River was carefully investigated by the International Joint Commission's sanitary experts and the result published in a report dated January 16th, 1914, which had this to say about the lower Detroit River:—

"From Fighting Island to the mouth of the river, the water is grossly polluted and totally unfit as a source of water supply. It is our opinion that such raw water would impose an unreasonable responsibility on any known method of purification even with the most careful supervision. Unfortunately Wyandotte, Trenton and Amherstburg are taking their water supplies from this part of the river.

"The B coli contents per 100 cc. has increased from below 5 in Lake St. Clair to an average of 315 at the head of Fighting Island. Fighting Island divides the river into two channels. There is a great difference in the degree of pollution in these two channels. In the channel between the United States shore and Fighting Island, the pollution is enormous. The channel east of Fighting Island shows gross pollution but very much less than the United States channel. The extensive pollution of the lower Detroit River is shown by the averages, to reach the considerable figure of 11,592 B. coli per 100 cc."

Sample 261 above the Livingstone channel and sample 117 just opposite the lower end of it, show that the purest water is close to the channel and that the pollution increases greatly towards the Canadian shore.

It was evidently very desirable, in order to reduce the load upon the filtration plant, to secure the best water possible, and for this purpose we examined these reports closely, and also the investigations of the Detroit Public Works Department under the direction of Mr. Hubbel, and from a consideration of them, together with the configuration of the channel, the data on which was very kindly furnished by the United States government official in charge of the Livingston Channel improvements, it was concluded that the best location for an intake was about 1,500 ft. from the Canadian shore at the Lime Kiln Crossing, and that water from this source could be adequately purified by filtration. This meant a line across the channel, which was undesirable, and further study indicated that it could be avoided, and the supply was taken from the Canadian channel.

The New Water Supply

After passing through a revolving screen, the water is picked up by the low-lift centrifugal pumps, driven by electric motors, which have a combined capacity of 500 gallons against a 40-ft. lift. These pumps, one of which will be in service and the other held as reserve, will deliver the water to the mixing chamber, where it is treated with a chemical coagulent. After passing through a series of baffles, in order to give a sufficient velocity and time to secure thorough mixing of the chemical with the raw water, the water is delivered to the coagulating basin in such a manner as to ensure a uniform flow across it.

In the coagulating basin, which is in duplicate, and has a total capacity of six hours, based upon one million gallons daily use, the suspended matter and the larger part of the bacteria of the water are removed. The remaining pollution and sufficient coagulant to form the necessary mats required for proper filtration, are carried over to the filters, and there the water passes down through a bed of sand 30 ins. in thickness, supported upon a graded gravel layer about 12 ins. thick, and is collected in an underdrainage system which delivers it to the effluent pipe from the filters.

This effluent pipe is supplied with a Simplex controller to regulate the rate of filtration, and discharges to the filtered water reservoir underneath and forming the foundation of the filters. The accumulated sediment on top of the sand layer of the filter is flushed off periodically by water delivered through the underdrainage system under high pressure, and carried to the river through a suitable drain. To provide sufficient wash water, a concrete tank having a capacity of about 35,000 gallons was built in the upper portion of the filter house. The filtered water is stored underneath the filters in a basin having a capacity of 100,000 gallons, or five hours' storage at average rate of filtration. This will provide for an equalization of the varying rates of consumption without changing the rate of filtration.

The filtered water is delivered to the town by three motor-driven centrifugal pumps, taking their suction from the filtered water reservoir.

All of the pumps are housed in a fireproof building located on the channel bank. The filter equipment was supplied by the Norwood Engineering Co. of Canada, Ltd..

Ojibway Water Plant Design

The intake is planned to be located on the east bank of the Detroit River, about 2.3 miles above the head of Fighting Island. It is to consist of a submerged timber crib located in a depression in the river bottom approximately 250 ft. beyond the harbor line, with a submerged pipe line connecting the crib with the low-lift pumping station on the shore. The top of the crib will be not less than 28 ft. below minimum low water, and the pipe line to the shore will be laid in a dredged trench and backfilled.

The crib will be a frame structure, with a central compartment containing the inlet pipe castings and two ballast pockets loaded with rip-rap as anchorage. Rip-rap will also be placed around the crib to a depth of 4 ft. as protection from scour. Guide poles, used for construction purposes, will be cut off at the top of such rip-rap on completion of the work.

The intake line is to consist of a 24-in. cast-iron main, with bell and spigot and flexible joints, laid in a dredged trench and backfilled to the original surface of the ground, or covered with rip-rap where exposed near the crib.

The rapid sand filter plant, consisting of six half-million gallon units, two coagulating basins, mixing chamber, filtered water basin, wash-water tank and superstructure, is planned for the east bank of the Detroit River, near the northern boundary of Ojibway.

Both the Amherstburg and Ojibway improvements were designed by the firm of Morris Knowles, Ltd., of Windsor, Ont. The Ojibway contracts have not yet been arranged.

WINTER ROADS*

By A. Lalonde
Assistant Engineer, Outremont, P.Q.

Snow removal is becoming more important every year. The public is looking for and demanding good roads, not only for summer, but also for winter. Fine roads, built of permanent materials, are found in the vicinity of towns and at different points in the rural districts, and the cry is becoming more and more persistent for their maintenance in good order during the winter.

The problem of snow removal is acquiring greater importance every year, not only from the fact that difficulties must be surmounted to solve it in an efficient and economic manner, but also on account of the considerable expense which it entails. It appears to me that these obstacles are sufficient to mobilize all those whom the problem interests in any way, in order to reach the most practical solution.

Rolling Not Always Satisfactory

In our cities the problem has been given particular attention by the authorities. Excellent methods to deal with it have been devised. The study and introduction of those new methods have been forced upon the engineers of municipalities by the enormous growth of automobile traffic within a few years, even during the winter months. It must not be forgotten that snow removal is governed by fundamental principles.

Different parts of the province, different sections of roads, call for different treatment. The methods to be employed on main roads are not the same as used for a city street or a rural road. These different methods are explained by the different kinds and the volume of traffic to be accommodated.

In the maintenance of winter roads, we have to take into account two kinds of traffic: (1)—Sleigh traffic; (2)—mixed traffic, chiefly automobiles.

As regards sleigh traffic we need not linger at any length; there is no snow to be removed except where it accumulates in large drifts. The system of spreading the snow on the streets or on the roads, to be rolled and hardened with a snow roller, does not always give satisfaction as regards the second class of traffic. It is plain that this method of caring for the roads should only be used at the beginning of the season to prepare the foundations at the time of the early frost, and later to prevent the formation of ruts.

Where the traffic is confined exclusively to sleighs, I do not know of any machine more useful than the snow roller. The rolling process produces a surface hard enough to support loads of considerable weight. The snow which gathers on the side thus disappears and the road is kept free from snow, which decreases the cost of maintenance. We can thus have fairly good roads over six or seven feet of snow; everything depends upon the ability of the man in charge of the roller, and the help given him by a few men to level the surface where there is need to do so.

Motor Traffic Complicates Problem

It is in the case of automobile traffic that difficulties are added and the problem becomes very difficult and costly to solve. First of all there must not be more than six inches of snow covering the roadbed. The organization system to deal with the snow must not be restricted. A foreman, for instance, should be free to employ all the men he requires in urgent cases; the number of hours of labor should not be limited. The different gangs should begin their work as soon as the snow begins to fall and keep up with the storm, if possible, in order to prevent too large an accumulation of snow. Otherwise, if the storm is given headway, if too much snow is permitted to accumulate, the cost of removal will be greater, the snow having become more compact. Automobile traffic will be interrupted for some time, and it would be impossible to use motor trucks with a snow plough, which would not be able to work when the surface of the road is covered with six or seven inches of fresh snow.

When a storm breaks during the night, the gang should be put at work early in order that traffic may not be obstructed in the morning. The space of road cleared should be wide enough to permit two vehicles to pass. The road should be carefully watched before and after the frosts set in. A little neglect during these periods, which are ordinarily short, can undo a month's good work.

Snow Fences are Effective

Snow fences should be used wherever they are found necessary. They are very effective when they are properly placed. Their cost is relatively low, and they can be used for a number of years if care is exercised in moving them and they are properly piled after the winter to prevent as much as possible the deterioration of the wood.

I shall now touch briefly upon snow removal at Outremont. That city has a superficial area of 975 acres. It is divided into thirteen sections, with a man in charge of each section. These section men, with the help they require, look after the sidewalks, the crossings and catch-basins. Twenty-eight snow ploughs are used. We also use four scarifiers, two single and two double, fitted up with steel teeth, which make small ridges on the slippery surface of the sidewalks. The plough may also occasionally be used as a scarifier by the addition of a small steel bar with teeth. The catch-basins are thawed by means of a steam boiler. Twenty-eight miles of sidewalk (5 ft. wide on an average) were cleared, maintained and sprinkled with sand last winter at a cost of $373.15 per mile; 24 miles of drains were opened at a cost of $130.51 per mile. These figures include (pro rata) the cost of keeping the catch-basins open.

Special gangs were employed for the clearing and maintenance of the streets; 16 miles of streets were cleared and opened to automobile traffic throughout the winter at a cost of $165.81 per mile. The snow is not carted from these streets. Throughout the winter 2.3 miles of street with double tramway tracks were cleared and kept open for automobile traffic at a cost of $1,535.20 per mile. This amount, so much higher than for the streets mentioned before, is explained by the fact that traffic is considerably heavier on account of their greater width (45 to 58 ft.) and also because the snow is completely removed and carted to vacant lots or to the city snow dump.

Equipment Used in Outremont

For the removal of snow, vehicles with a capacity of eight cubic yards are employed. Half the cost is paid by the tramway company. We are assisted on these streets by the tramway company, whose snow ploughs and levelers accomplish good work. The city's equipment to clear its streets is as follows:—

Six steel snow ploughs, 20th century type.

One road plough mounted on runners. (This is very useful and can also be used in summer).

One double, wooden plough drawn by six or eight horses. This plough is 24 ft. wide, with wings on either side to level the sides of the road. It is used particularly after a snow fall to widen the road, and also during the month of March to level the surface.

Two snow ploughs 8 ft. long (two sections of 4 ft.), 6 ft. in diameter, and drawn by two horses. These are used at the beginning of the winter and after storms, when the surplus snow has been removed.

One 5-ton motor truck, with plough of the "good roads" type fitted in front. This truck is very useful, but only where the bottom of the road has been hardened.

One rotary snow plough of the "Stadig" type, invented by W. L. Stadig and manufactured by the Canadian Fairbanks-Morse Co. It resembles very much the ploughs used by railway companies. It is a steel structure, measuring 20 ft. in length and weighing about three tons.

This rotary plough can hurl the snow a distance of 40 ft., and a peculiar fact notable in this operation is that the

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*Paper read May 22nd, 1919, at the Canadian Good Roads Congress, Quebec.

snow is powdered so fine and scattered so evenly that it seems to have disappeared.

Drifts of 5 or 6 ft. may be cleared wth this machine. It is equipped with an apparatus to load the snow into vehicles at the side of the road. A vehicle with a capacity of 8 cu. yds. can be loaded in three minutes. We made a comparison last winter of the weight of snow loaded with this machine and the weight of snow loaded by shovelling, and found that the former was about double the latter. The machine is ordinarily drawn by four horses.

At the beginning of the winter, 2,400 ft. of snow fences of the Montreal Tramways Co. type, were made at a cost of 34c. per lineal foot, and distributed throughout the city.

The quantity of snow which fell last winter in Montreal, according to the reports of the McGill University meteorological bureau, was as follows: November, 3.25 ins.; December, 18.4 ins.; January, 16.8 ins.; February, 18.6 ins.; March, 23.2 ins.; April, 4.4 ins.

ROAD BUILDING IN QUEBEC*

Will Not End Until at Least 40,000 Miles Have Been Improved—What French and English Genius Have Jointly Accomplished in Highway Work

By Sir Lomer Gouin

Premier of the Province of Quebec

To be fair, we have to praise the people of the Province of Quebec for the very keen understanding they have of the good roads policy. A good roads policy is not a mere matter of course, nor is it, by any means, quite clear to everybody. In fact, when we first put the proposition before the public, we certainly met with an enthusiastic answer in general, but very often we came across stubborn opposition and had to face difficulties of all kinds.

However, we went to work and devised a comprehensive policy which provided both for local needs and the general requirements of the traffic. The farmer needed a road to bring the milk to the butter or cheese factory, to haul all the farm products to the station; he needed an improved road to connect his farm with his village; the commercial traveler, the doctor, the priest needed the road. To all we said: "Go on and build your roads, we shall supply money, the engineers and the machinery, whenever necessary."

And we find that things came out pretty well, if we remember that 140 complete macadam outfits are possessed by our different municipalities; that our Department of Roads has 57 outfits, besides several other pieces of machinery which are at the disposal of the municipalities under easy conditions; that, in 1907 a trunk road was an unknown thing, while now we have over 300 miles of trunk roads connecting the main points of the province; that several other trunk roads to be built by the municipalities are under way, including the Montreal-Sherbrooke, Montreal-Levis, Sherbrooke-Beauceville, Sherbrooke-Beauce Junction and Levis-Fraserville roads, and that since 1912 we have spent towards the improvement of our roads about $20,000,000.

Twenty-two Resident Engineers

I don't want you to take this as conceit. I don't look at the things we have done only for the purpose of bragging; far from indulging in self-contemplation, I look into the things of the past for the purpose of comparing the work done with the work remaining to be done. I never can forget that, if we have over 2,500 miles of improved roads, our total mileage is 40,000, and that consequently we have in store an immense quantity of work and pains; 40,000 miles is a very long stretch of road. There is a saying which, I think, is Irish: "A long lane has no turn." I am afraid that such a stretch as 40,000 miles is long enough to be without any turn, and that none of us will ever see the end of it.

However, we look forward with confidence to the final performance of the task, knowing that a very large proportion of the mileage will remain earth roads and will require, for a long time to come, nothing but intelligence and close care. In this connection, I may say that we have provided in the best way possible for the improvement and maintenance of all kinds of roads with the least cost possible. We have divided the province into 22 sections, under the direction of an engineer. Each engineer has in hand the road proposition in his division and has to handle it along the lines of economy and efficiency.

Best Engineers Avoid Construction

It has been said that the best engineer is he who finds some means of avoiding construction. We expect our engineers to avoid construction; that is, to do away with expenditure, or to curtail expenditure, whenever possible without hampering the normal development of road improvement. We want the roads to be up to the needs in every part of the province,—nothing more, nothing less. We want the expenditure to cope with every requirement,—nothing less, nothing more. This is an important point; I mean the care we have taken, and are taking, to balance the expenditures with our resources.

We make it a point to do all that we can, but nothing that we cannot. Unlimited expenditure does not agree with us. We have an everlasting consideration for the modest little million which is so productive of good if spent honestly and properly. As a matter of fact, every question we have to deal with is a question of money. Even sentiment sometimes is governed by money. The trouble would be if money were governed by sentiment. At any rate, I am sure you are awake to the fact that the very important questions that will be the matters of your discussion are intimately connected with money, inasmuch as they involve expenditure, and also intimately connected with sentiment, inasmuch as the carrying out of road work is bound to have an influence upon the welfare of the whole community.

Road-Building History

The history of road-building offers a few facts which, in my mind, are related in a similar way to certain facts of our political and social life. Is it not striking to note that Trésaguet, the French engineer, set forth in 1775 certain principles of road-building which are still of daily application; and that, 25 years later, Telford and Macadam, both English engineers, introduced a method almost identical? Is it not remarkable to note that the stone-crusher was invented by Blake, an Englishman, in 1858, and the steam roller by Lemoine, a Frenchman, in 1859?

I am sure that this alternate action of French and English genius towards a common object appeals to you as an example of what these two nations have achieved, and can achieve, for the betterment of the conditions of life. United, they have, and they will, in the world, and particularly in our country, journey towards the great and noble ideals that have always been the stake of civilized nations.

I am confident that our aims will be attained if we join our efforts as regards road improvement. We have already taken up our part of the big work, and it affords me satisfaction to see the distinguished delegates of the sister provinces to-day with us, ready to take up the same work and to carry it out in a way that will benefit each of the provinces, and, consequently, the whole of our beautiful Canada.

All Elements Now Co-operating

I think I am not mistaken in pointing out that this convention opens under very favorable auspices, since the various racial, political and social elements of the country are co-operating in carrying out one of the most important works the Confederation has ever undertaken. Gentlemen, you have had, and you shall have, our support, financially and morally. We expect you, in your turn, to give the best of your ability and of your knowledge to the solution of the great problems in which we are all interested.

*Address delivered May 20th, 1919, at the Canadian Good Roads Congress, Quebec.

PUBLICATIONS RECEIVED

HELPFUL HINTS ON PAVING CONSTRUCTION.—Twelve-page booklet, 6 by 9 ins., distributed gratuitously by the Canada Cement Co., Ltd., Montreal. Illustrated by five photographs and four diagrams. Discusses drainage, grading and concreting.

BUILDING CONSTRUCTION DRAWING—By Richard B. Eaton, lecturer on building construction, Poole School of Art and Technology. Published by Spon and Chamberlain, 120 Liberty Street, New York City. Parts 1, 2 and 3, size 7¼ by 10¾ inches, cloth cover. 77 illustrations with specifications. Price, vol. 1, 1/6 net; vol. 2, 1/6 net; vol. 3, 3/6 net.

IRON AND STEEL—By Hugh P. Tiemann. Published by the McGraw-Hill Book Company, Inc., New York City. Second edition, revised, enlarged, entirely reset and illustrated. 4 by 6¾ inches, flexible cover. Price $4 net. In this 2nd edition, the author has elaborated on the more important subjects connected with the industry, such as heat treatment, testing and metallography, in all of its branches. With the addition of tables, graphs, etc., this volume now becomes a valuable text book and dictionary combined.

MICA MINER'S AND PROSPECTOR'S GUIDE—By A. A. C. Dickson, consulting mining engineer. Size 5 by 7½ inches, 50 pages, illustrated, published by E. and F. N. Spon, Ltd., 57 Haymarket, London, S. W. 1., price, 4/6 net. Contains descriptions of different mica mines with notes on timbering, drilling, pumping, hoisting, haulage, ventilation and lighting. Gives general and practical hints on mica deposits, classes of mica and prospecting; also criticisms of other writers and their mistakes. The author concludes the pamphlet with good advice for the miners and managers, followed by a glossary of mining terms.

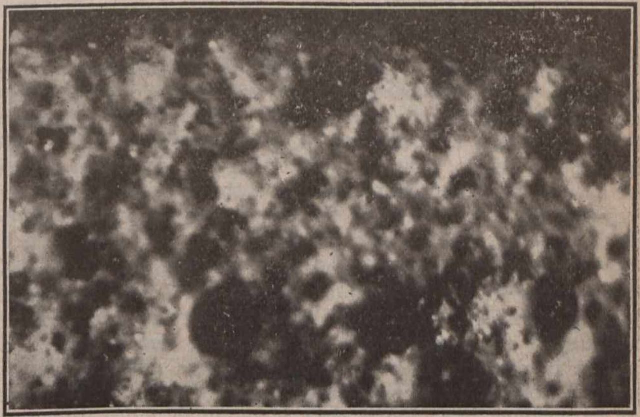
HANDBOOK OF MATHEMATICS FOR ENGINEERS—Third edition enlarged, 1919; published by John Wiley & Sons, Inc., New York; compiled by L. A. Waterbury, C.E., professor of civil and architectural engineering, University of Arizona; vest pocket size, morocco, tables and double index, price $1.50 net. Two new sections have been added. The first section, on heat engineering, together with tables relating thereto, has been prepared by G. A. Goodenough, professor of thermodynamics of the University of Illinois, and deals with fundamental and essential equations applicable to the problems relating to gases, steam, compressible fluids, orifices, boilers, steam and combustion engines, air compression and refrigeration. The second chapter, on electrical enginering formulæ was prepared by H. H. Highbie, professor of electrical engineering, University of Michigan, embodying formulæ required in the study of magnetic fields, condensers and electrostatics, alternating and direct current circuits and machines, with useful tables relating thereto. The addition of the new sections increases the present value as a reference book.

INTRODUCTORY MATHEMATICAL ANALYSIS—By W. P. Webber, assistant professor of mathematics, University of Pittsburgh, and L. C. Plant, professor of mathematics, Michigan Agricultural College. First edition, size 5 by 8 inches, 300 pages. Published by John Wiley & Sons, Inc., New York City. Price, $2 net. Compiled as a text book to assist students commencing mathematics in the various university courses. It commences with a rapid, concise review of algebra and geometry. Chapters 4, 6 and 12 give valuable lessons on graphic representation of statistical data and equations. Chapter 8 gives in detail, with numerous illustrations, the trigonometric functions. The formulæ are derived and explained with clearness by the help of the figured illustrations and examples which make the study of trigonometry much easier for the average student. The chapter on conic sections has also been carefully written. Chapter 16 on series and chapter 17 on integration are rather advanced for the introductory mathematical course and might have been omitted, although they are certainly introductory to their particular branch of mathematics, and are written with the same clearness as the preceeding chapters. This book may readily be used to advantage by students taking this course of mathematics and by graduates as a reference book.

Letter to the Editor

PROPERTIES OF MORTARS AND CONCRETES

Sir,—I have read with considerable interest H. M. Thompson's article, "Physical Properties of Mortars and Concretes," in your issue of May 1st, and desire to express my appreciation of the valuable information it contains. However, I deem it advisable to call attention to two errors appearing in the table at the bottom of page 418. This table was not taken, as indicated, from an article by the writer, but instead from a "Letter to the Editor," written by Mr. Thompson and printed in *The Canadian Engineer*, September 12th, 1918, as a discussion of the writer's paper, "Proportioning the Materials of Mortars and Concretes by Surface Areas of Aggregates" (see *The Canadian Engineer*, July 4th and 11th, 1918).



PHOTOMICROGRAPH (×75) SHOWING THE VOIDS IN A NORMAL CONSISTENCY PAT OF NEAT CEMENT

The second error appears in the column headed, "Ratio of Cement to Aggregates by Weight." The tests were made on mortars, and these ratios should read: 1:2.22, 1:2.55, 1:1.69, etc. While the "surface area" method of proportioning bears no direct relation to the more commonly used "arbitrary volume" method, yet it seemed advisable to include this column of ratios in my original article in order to call special attention to the radically unscientific nature of the latter method. Incidentally, this column shows the fundamental principle underlying the common practice of using coarse sands in concrete.

It would have been well had Mr. Thompson pointed out in connection with his discussion of maximum density (p. 418) the fact that, even in our best laboratory practice, it is impossible to produce a cement matrix surrounding the sand and stone aggregate which does not contain a comparatively large percentage of voids. The accompanying photomicrograph (× 75) shows the voids in a normal consistency pat of neat cement.

LLEWELLYN N. EDWARDS,
Supervising Engineer of Bridges,
City of Toronto.

Toronto, Ont., May 29th, 1919.

[NOTE.—In publishing Mr. Thompson's article in the May 1st issue, we inserted a line, "From article by Capt. L. N. Edwards," in the heading to the table referred to in the first paragraph of the above letter from Capt. Edwards. This table gave the results of tests made by Capt. Edwards, but was compiled by Mr. Thompson. We meant to credit the test results to Capt. Edwards, but not the arrangement of the table, which was Mr. Thompson's. This was perhaps more an ambiguity than an error. In any event the "error" cannot be attributed to Mr. Thompson.—EDITOR.]

TESTING STATIONS FOR DETERMINING CRITICAL FACTORS FOR WATER PURIFICATION PLANT DESIGN*

By W. T. M'Clenahan and R. S. Rankin,
Assistant Engineers, Pearse & Greeley, Hydraulic and Sanitary Engineers, Chicago

The size of the testing station which it is advisable to build depends on the nature of the tests and the funds available. In general, a testing station is a miniature replica of a complete purification plant. Sometimes, however, the tests are run on parts of a completed plant prior to enlargement, or a portion of one of the component parts of a plant is built in advance for test purposes. This method deserves attention and is to be tried out on a sewage treatment plant at Decatur, Ill. It is planned to build two small sprinkling filter units and to use them as a testing station. These units will establish rates of application and any other factors necessary to be determined before the time when full sized units for all the city's sewage can be built. When this is done, these two sprinkling filter units will become a part of the completed plant.

Full-Sized Units Used

When basic engineering principles are already well established and it is necessary to determine only the rates and areas required to make these principles applicable to local conditions, this method of testing would seem to offer great possibilities, first, because full sized units can be used for the tests, and second, because the testing station can very often be built out of funds already appropriated for partial or complete treatment.

When a small testing station is to be built, the purpose of the tests should be kept clearly in mind, and the limitations of a small station should be considered. A test run to investigate color removal, for instance, needs only proof that it is possible to remove color. It is not necessary to produce absolutely sterile water in the testing station itself for experience has shown that it is much more difficult to get sterile water from a small test filter than from the larger units used in regular filtration work. As long as the test demonstrates that the color can be removed and shows how it is to be done, the plant has accomplished its mission.

A testing station should be compact, convenient, and easy of access to all parts. As far as practicable the course of the water through the plant should be progressive. Each step in the treatment process should be in logical sequence in order that the work of the operator may be simplified and that it may be easier to watch and understand. This is particularly important when the operator is a non-technical man. An operating platform is convenient and desirable.

The designer should keep in mind that a plant of this kind is often subjected to quite radical changes. The baffling and piping arrangements are most often affected and the chemical used for treating purposes may have to be changed also. In this case, a change in the method of applying or in its point of application may be required.

Temporary Materials Sometimes Suitable

Because of the temporary character of a testing station, the first cost is relatively very important, while durability of material and cost of operation are not so important. Wooden construction therefore is quite suitable, sheet iron is useful and black iron pipe is often satisfactory. The salvage value after the plant is dismantled may, however, call for better material than would otherwise be used. Obviously, the material and construction should be substantial and good enough to give satisfactory service and to last throughout the period of test.

Recently the firm of Pearse & Greeley have designed and built two small testing stations to study unusual problems in water purification. One of these was installed at Whiting, Ind., the other is at Midland, Mich. They are both good examples and show the value of such tests when little literature or experience is available.

Whiting, a city of 8,200 people, is located along the south shore of Lake Michigan in the heart of a great industrial district. Surrounding it are the cities of Indiana Harbor, East Chicago and Hammond. At present all the sewage from this great manufacturing region finds it way into Lake Michigan, but the Calumet Sag Canal promises some relief in the near future. Some of the industries produce large quantities of troublesome wastes, notably several chemical works, a glucose factory, and the great steel mills. The most troublesome waste, however, is that from the Standard Oil Refinery, located in Whiting, which imparts a very objectionable taste and odor to the city water. The amount of oil actually existing in the water is exceedingly small and is very difficult to detect by any chemical means. Nevertheless the effect is quite apparent to the consumer.

Oil Refinery Causes Trouble

Most of the oil is said to come from the agitators where the motor spirits are clarified. Soda and sulphuric acid are added in this refining process and the resulting sulphates are washed out into the lake and form what is called "soap" or "white water." This white water carries off small quantities of oil in mechanical suspension, some in the form of an emulsion and some in colloidal solution. Portions of the oil are volatile.

The city water supply is drawn through a 66-in. brick tunnel extending out into the lake about 24,000 ft. At times the white water described above discolors the lake as far as the intake and the water is rarely without some odor or taste.

The problem for design was this: Given a city water supply contaminated by a variety of unusual wastes with oil waste predominating, to design a filter plant effective in removing odors and tastes as well as the bacterial content. The purpose of the testing station was to study this problem along the following lines:—

(1) The effect of aeration on the odor and taste.

(2) Kind and amount of chemical to be used and its effect on the odor and taste.

(3) Period of sedimentation and the time of contact giving best results.

(4) Any peculiarities that might develop in the treatment of water contaminated by oil.

Details of Experimental Station

The following is summary of details of this station:—

Aeration:—Size of collecting platform, 14 ft. x 13ft. Nozzle used, No. 9 Spraco, made by Spray Engineering Co. of Boston, Mass. Pressure at base of nozzle, 8 lb. Water rate, 8½ gal. per minute.

Chemical Treatment:—Chemical used, alum. Admitted, between aerator and coagulation basin. Strength of stock solution, 10 per cent. Strength of solution fed, 1¼ per cent.

Method of Feeding:—Through a small hole drilled in side of ⅜ in. brass tube stuck through rubber cork in bottom of wooden bucket Head on orifice maintained by means of fountain similar to the inverted water bottle often found in offices.

Amount of Chemical Fed into Water:—Ranged from 6 grains to 1 grain per gal. of water treated.

Coagulation Basins:—Number used, 2. Size of each basin, 5 ft. 6 in. x 8 ft. x 2 ft. 9 in. deep inside measurements. Depth of water, 31 in. Capacity each basin, 825 gal. Capacity in hours, 1 h. 40 min. each when tanks were run in series (3 hr. 20 min. total) or 3 hr. 20 min. each when run in parallel. Number of baffles in each tank, 1 lengthwise at first with 2 passageways; later changed to have 3 baffles with 4 passageways. Velocity of flow:—

When run in parallel:—

With single baffle, 0.76 ft. per min.
With triple bafflle, 1.72 ft. per min.

When run in series:—

With single baffle, 0.152 ft. per min.
With triple baffle, 0.344 ft. per min.

*Excerpts from paper presented before the Illinois Section of the American Waterworks Association.

Filter:—Number of filters, 1. Area, 4 sq. ft. Filtering rate, 8 gal. per min. Underdrain system used, Harrisburg type with pipe grid. Depth of gravel, 8 in. Depth of sand, 30 in. Wash, hand controlled from barrel storage. Rate of wash, 15 gal. per sq. ft. per min. Method of supplying wash water, hand pump lifting water from filtered water barrel to wash water barrels. Method of rate control, float valve and orifice.

Test at Whiting Station

The results of aeration showed that the improvement in the water was not at all uniform. Its efficacy seemed dependent upon the direction and velocity of the wind which, when it blew across the plant of the Standard Oil Co., not only caused the air to become heavily laden with oily odors but also drove before it a great deal of sand and cinders which had become coated with oil. Under such conditions the spray actually washed oil out of the atmosphere instead of giving up that which it already contained. Nevertheless the aeration seemed helpful at all times for the water required a smaller amount of chemical to accomplish the final removal in the coagulation basins and filters, due perhaps to a breaking down of the emulsion.

Alum was the only chemical tried and it proved successful. As the oil which remained in the water after aeration was probably removed by absorption, that is, by sticking to the flocculent precipitate of alum, any other coagulant of the same general character would doubtless have done as well. It was not thought worth while to go further into the matter. A fair average of the amount of alum required was about 0.7 grain per gallon of water treated.

In regard to sedimentation and the period of contact, it seemed that the oil required some time to attach itself to the coagulant and when the floc was kept in suspension for a while longer than the common practice, a smaller amount of alum could do the same work.

Among the peculiarities which developed during the test, the most important was the necessity for frequent washing to maintain the normal rate of filtration. The filter acted as though it were air bound. This was probably due to the oily floc forming a water tight film over the surface of the sand, for it was discovered that by lightly raking the surface of the sand the filtering rate was restored and the loss of head returned to nearly normal. Later it was found that the same result was obtained by "shaking" the filter, i. e., by simply opening and closing the wash water valve without actually washing the filter. In this way the period of service between washings was increased from 6 to 16 hours, with a consequent reduction in the amount of wash water used.

Difficulty was also experienced in making satisfactory analyses of the samples. Since no other method was available for detecting oil in such minute quantities, appeal had to be made to the senses of taste and smell. Obviously, these senses are somewhat unreliable. However, the tests were made independently by three different persons so that the results were well checked. It was found that it was impossible to judge odors in Whiting because of the atmospheric conditions so the samples were brought to Chicago for judging. Conclusions from the tests were that the taste and odor could be thoroughly removed when the modifications of filter practice noted above were put into effect.

Midland Testing Station

Midland is a town of about 10,000 inhabitants, and is approximately 25 miles from Saginaw. It is located near the centre of a brine well district and is the home of the Dow Chemical Co., a company which utilizes this brine and other chemicals in solution to manufacture a large number of chemical products.

Two rivers, the Chippewa and the Tittabawassee, unite in Midland. The Chippewa is less turbid and colored than the Tittabawassee, but has a drainage area more thickly settled and, consequently, much more polluted. Both waters are fairly hard.

At the present, Midland obtains its supply from the Chippewa River principally because of its clearness. On account of the rapid growth of the chemical company during war time and the consequent increase in population, the town has awakened to the necessity of improving its water supply.

The problem of Midland is in part as follows:—

1 Determination of the more suitable supply, the Chippewa or the Tittabawassee River.

2 Determination of the best method of reducing the color of the Tittabawassee River, if that supply is selected.

3 Determination of the best method for reducing the alkalinity of either source.

The testing station as constructed consists essentially of two coagulating basins, a filter, and a filtered water storage tank. Supplementary to these are an inlet orifice box, a divided orifice (one portion of a flow) passing through a lime saturation and joining the other portions, a mixing trough, wash water barrels and a filter rate controller of the adjustable float type.

The supply is obtained from the river through a small electric driven centrifugal pump, and delivered to the inlet orifice box.

The following summary of the different devices furnishes an outline of the essential features in the resign and operation:—

Chemical Treatment

Lime—Admitted as lime water. Quantity used, approximately 8 grains per gallon. Method of feeding, by diverting a portion of flow (about one-tenth) through a lime saturator, uniting with the remaining portion as lime water.

Alum—Point of application, between two coagulating basins. Method of feeding—a 20 litre bottle with site outlet controlled by adjustable screw cock. A glass tube through a cork in the top which terminated in an upturned gooseneck near the bottom supplied the air and regulated the head on the outlet. This bottle was capable of very fine adjustment.

Lime Saturator—Size, 16 in. in diameter at the top, 4 in. in diameter at the bottom, depth 30 in. Flow period, 30 minutes to 1 hour. Method of admitting lime, as a 10 per cent. milk of lime mixed in barrel above.

Mixing Troughs—Number of passages, 5. Each 3 in. wide, 3 in. water depth and 6 ft. long. Period of mixing, approximately 3 minutes. Each passage was baffled with 1 in. cleats spaced 3 in. centres, and had a slope of 1 in. from end to end.

Coagulating Basins—Number used, 2. Size and capacity, the same as those used at Whiting. Period of flow used in tests, 8 hr. and 6 hr.

Filter—Number of filters, 1.

A small laboratory was fitted up in conjunction with the station. Alkalinity tests on the raw water, lime water, coagulated water and filtered water were run at frequent intervals. Anything wrong or unusual in the operation was apparent to the operator at once. The solutions were made up so that no computations were necessary in order to interpret the results.

The testing station itself was housed in an old pump house, heated and lighted. This was a distinct advantage. The tests were run 24 hours of the day and thus approached actual working conditions.

A number of draughtsmen and designers of the city of Toronto have formed an organization, the main objects of which are to promote the economical and intellectual welfare of the members, to encourage intercourse between all draughtsmen, to facilitate the acquirement and interchange of professional knowledge among the members, to bring about a better understanding between employers and employees, and to procure the means of securing employment and supplying help. The association is to be Dominion wide, and is to include all draughtsmen in all the branches of the engineering profession, viz: Civil, mechanical, electrical, mining and architectural. A few meetings have been held which were attended by a large number of draughtsmen, representing all the branches of the profession and nearly every corporation in the city of Toronto.

THE ORGANIZATION OF A STANDARD MUNICIPAL TESTING LABORATORY*

By J. O. Preston
Assistant Engineer, Rochester Bureau of Municipal Research, Inc.

(Continued from the May 22nd issue)

On the staff of the laboratory, in addition to the director, should be specialists in the various branches of science used in the testing of materials. For example, a chemist is needed to attend to the testing and aiding in the proper usage of bituminous materials, to analyze gas, water, coal, sewage, gasoline, rubber, explosives, etc. A civil engineer is required to test paving, building and other construction materials. An electrical engineer is needed to test and experiment with the street lighting system, etc. A mechanical engineer will be needed to take care of tests on such things as structural materials and machinery, when the volume of such work increases enough to unbalance the regular duties of the civil and electrical engineers. Later, when the laboratory expands to include the bureaus of health and public safety, a specialist in sanitary chemistry will be needed to test foods of a special nature or over which there is a controversy and to assist the police bureau to solve poison cases and other such problems. The textile expert should determine the paper and binding best for use in school books, etc.

One of these specialists should be designated as the principal assistant to the director and instructed to assume charge of affairs during the latter's absence. It is not necessary that this man be the one receiving the highest salary or having been employed longest; ability should be the determining factor.

Sample Collection Corps

Another addition to personnel that as yet has not been considered by laboratories in general, is a corps of inspectors for collecting samples. The laboratory should not wait for samples to be sent in for tests but should arrange for their systematic collection. This calls for the development of an organization to collect them. Usually it has been the custom for field inspectors assigned to the particular job to collect the samples from it and, by various means, to send them to the laboratory. This not only leaves the collection of samples to chance, but just as experience has proved the inadvisability of leaving to the field inspectors the determination of quality of materials, so it is true that field inspectors seldom are qualified to select samples for varying grades of materials. The only safe and sure procedure is to have trained laboratory men go into the field and collect all samples. This is in direct opposition to the now obsolete theory governing the policy of many laboratories, that the tester should know as little as possible of the source and identity of the samples.

The inspection (or sample collection) corps should be headed by a chief inspector who should see that the work of each of the laboratory specialists receives the relative attention due it. Besides collecting samples it should be the duty of the collection organization to keep laboratory records of contracts advertised by the city, bids and materials received, contracts awarded, work about to be begun, construction in progress (by the use of a graphic progress chart, etc.), and jobs completed. As will be shown later, this would be an invaluable aid in planning the laboratory work.

The collection organization is of great value in other respects. By its use laboratory control of materials is more complete, and field inspectors can be instructed in the proper use of materials. Certain of the inspectors should be stationed at asphalt plants when in operation, also at the plants of local manufacturers of brick, tile, etc., thereby ensuring better plant control and also aiding the laboratory in checking or rather inspecting the output of such plants. Moreover, complaints arising from the field or from property owners as to the character of materials and workmanship, can readily be investigated by the laboratory inspectors, independently of the regular field inspectors.

Incentive for field inspectors and, at the same time which is very important, a nucleus for a future laboratory staff, will result if the laboratory inspection (or sample collection) corps is selected by merit, whenever possible, from the best qualified men in the construction (or field inspection) corps. Such men, if they have the necessary professional qualifications, become fitted for the laboratory inspection corps because of their experience and training by the present laboratory inspectors in the use of materials. Also they frequently merit further promotion to regular staff positions in the laboratory. Laboratory inspectors who do not have the essential professional qualifications, can be transferred when conditions warrant it to some other branch of the technical service, such as the engineering department, or the department of public works, etc.

Suggested Civil Service Requirements

Because of the usual increase of work for the collection corps during the summer construction season, it is good policy to employ a few students from advanced technical schools during their summer vacation, to aid in the gathering and routine testing of samples.

A stenographic clerk is needed in the laboratory in order that clerical work may not consume time properly applied to scientific work; for the experts should not stop their important duties to typewrite records, reports, letters, etc.

Civil service is necessary to ensure a stable organization for the laboratory. Clearly defined requirements for staff positions should be set up, and provision made for advancement both in salary and position as a reward for meritorious service. This is the only way in which capable and energetic men can be attracted, on the one hand, and in which political interference can be prevented, on the other. Tentative requirements for a few of the various positions in the laboratory staff are suggested as follows:—

The laboratory director should be at least thirty years of age; he should be a chemist or civil engineer, having graduated with a degree from a college of recognized standing; and should have at least five years' experience in testing and using the majority of the materials cared for by the laboratory. He should have the demonstrated ability to plan and to direct the work of men.

The chemist should hold a degree from a college of recognized standing, and he should have at least two years' experience in the standard methods of testing and using such materials as bituminous paving materials, water for municipal consumption, gas, coal, sewage, rubber, explosives, gasoline, etc.

The qualifications for the other men should be developed along these lines. The specifications and requirements set up for positions in the Central Testing Laboratory of New York City, offer a good basis for further development, but they are not thought to be complete in many respects.

The number and type of specialists mentioned are not necessarily all of those needed; those mentioned are the ones generally required for engineering work but do not include the men needed to attend to textiles, etc., as will be required as the laboratory expands to more fully cover its proper fields.

Development of Laboratory

The size and number of rooms required for laboratory purposes is a matter which must be determined differently for each case. In some cases the laboratory may be started in three or four rooms in the basement of some public building; but in any event it should be kept in mind that by the time it has developed to fully care for its proper fields, the laboratory will require not only several rooms but several floors of a building.

A basis for determining the number of rooms and their arrangement is given by the following items: The entrance into the laboratory should be through or by way of the office. This will prevent visitors from walking promiscuously through the laboratory and interrupting work. Sometimes the objection has been raised that by having the entrance room the office, it is impossible to keep the room clean, because of the frequency with which bulky and dirty samples are brought into the laboratory; for this reason it is best to have a side door or hall-way entrance opening into an alley-way, so that samples may be taken in by it, and thus not dirty the office. However, the objection is minor and should not prevent the office from being the entrance room.

The office should contain desk room for each man; a large table to be used for computing data; a folding drawing table; plenty of space for record files; cabinets for delicate apparatus and book cases.

Room for Bituminous Materials

A special room is needed to contain apparatus and chemicals for testing bituminous materials, etc. Such a room should be amply provided with gas hoods and ventilating fans. It is also very good practice to have a gas-tight enclosed shelf in the centre of the chemical testing room in which should be kept all bunsen burners and other apparatus which may ignite inflammable gases. This shelf should be enclosed with glass windows which can be opened to allow the entrance and removal of materials as needed; it should have several connections for water and gas and should be covered with a water and fire-proof material (such as galvanized tin); and should be ventilated at the top by means of electric fans opening to the free atmosphere. The centrifugal machines used for washing bituminous mixtures should be located at some distance from this enclosed shelf in order to prevent carbon-disulphide vapors from reaching the bunsen burners.

Another room should be allotted for use in testing sand, cement and concrete. It should contain storage racks and ovens for briquettes, cubes, etc. Another room may be needed for electric testing and will require electrical meters, switch boards, transformers, lamp racks and motor connections.

The brick testing rattler machine, the Deval stone machine and the coal testing apparatus are best located in the cellar, as should be all other large and heavy crushing and grinding machines also.

A stock room is essential to contain a good supply of chemicals and other needed materials required over a given period.

Unless the laboratory is very large, it is not thought economical to equip a room as a machine or carpenter shop, because ordinarily the tools needed for minor repairs to apparatus can be obtained from the municipal shops.

Reference Library Most Important

Most of the testing procedures have been standardized enough to warrant the manufacture of standard apparatus and testing equipment to replace the "make-shift" equipment, which was formerly customarily prepared in laboratories. Standard apparatus saves time and enables the tester to obtain more accurate results; and by its use the "personal factor" is largely eliminated and data and results obtained are more easily duplicated. Considerable apparatus is necessary to perform standard tests by standard methods and in order that its purchase may be economically made, it is suggested that it be purchased in instalments of comparatively small lots. Once the laboratory becomes properly equipped, it should be kept so by a system, whereby a definite quantity of apparatus is obtained each year.

Apparatus that has become obsolete due to improvements in methods of testing, etc., should not crowd and overburden the laboratory, under the excuse that it may "come in handy." Apparatus out of repair should be put into workable condition at the earliest possible moment, in order that tests may not be delayed. Improper care of equipment will result in rapid deterioration; delicate apparatus should be kept in specially designed cases. Some of the spare time of the laboratory men should be utilized to inspect the apparatus periodically.

A library should be considered properly as part of the equipment of a testing laboratory. The most important working tool to any professional man is a complete reference library. It is important that a scientific man develop methods and understand principles and laws, but the details and data attached to them should not clog his brain; thereby hindering clear thinking. He should be familiar with the details, however, and should know where to find them, and have books containing them readily accessible.

The library should be kept up-to-date with the latest editions of technical books of a wide range of subjects. It should be the object to collect books containing specific data. Books of a general nature need not be had in the laboratory, but it is advisable to have a list of such books that may be found in the local libraries.

Technical magazines are an important item in the library. The laboratory director should make it his duty to obtain and study all information published in the leading technical journals, and the men should be required to devote a specific amount of their time in following their fields as covered by certain of the magazines. The magazines should be referenced and bound for the future use of the laboratory specialists.

Essentials of Operation

One important factor that can aid or greatly hinder the success of the laboratory is the degree of co-operation given by the city officials, field engineers and city purchasing agents whose duties are related to the work of the laboratory. These men should adhere to the strict policy of obtaining the laboratory's approval and endorsement before accepting materials and before permitting their use. Contractors should be forced to promptly notify the laboratory of the arrival of materials, and then to respect its findings.

An example of how this co-operation should be cared for on the part of the specifications, so that the related persons may have a definite basis for co-operation, is indicated by an extract from the "general provisions" for the division of the specifications dealing with "materials" for use in "local improvements" (that the writer recently assisted in preparing for the city of Rochester, N.Y.) as follows:—

"All materials shall be subject to the approval of the Engineering Testing Laboratory. Before any construction work, which includes the use of any materials covered by these specifications, is begun, the contractor shall obtain the official written permission of the Engineering Testing Laboratory, endorsed by the engineer, authorizing the use of such materials. Failure to obtain such written permission shall be considered proof of the inferior quality of the materials in question.

"Furthermore, if tests made after such materials have been used in the work shall prove conclusively that they are of inferior quality, then the engineer may order all work which includes such materials to be torn out and replaced with approved materials at the contractor's expense; or, if the engineer shall deem it for the best interests of the city, he may direct that deductions be made from moneys due or to be due the contractor, in sufficient amount fully to compensate for the inferior quality of such materials."

Cannot Always Submit Samples

The specifications in several places, call for the contractor to submit samples of the materials in question with his bid. Now it is seldom that a contractor can do this for all, or even most of his materials, simply because he does not know whom or where he will get all of his materials from if he is awarded the contract. Therefore a clause is provided in the "Instructions to Bidders" which reads:—

"Attention is especially called to the general provisions of division 'B' of the specifications relating to materials. Samples of all materials to be furnished in the work shall be submitted with the bids in accordance with the specifications, or the contractor shall obtain written instruction (in duplicate) from the testing laboratory before making his bid, as to when and where such samples shall be submitted, and shall include a copy of such instructions in with his bid."

The regularity and promptness of testing is another factor affecting the success of laboratory operation. System is required to insure the daily performance of duties, to make sufficient plans to properly balance duties and to give to any one item the attention which its relative importance warrants. It is necessary, in order to plan the work in advance, that charts and information of the nature suggested when the laboratory's corps of inspectors was discussed, be utilized. The laboratory should make daily itemized work schedules by the use of the work plans; by insisting that contractors give ample notice before beginning various phases of work; from report cards sent in by the field inspectors; or by written reports of the field engineers and city purchasing agents; and by other means of co-operation. These schedules should be rigidly adhered to, and only deviated from by force of dire emergency.

Without a work schedule, or with one that is but partially enforced, the writer has observed that samples frequently were not collected in time or that test results were obtained too late for use, or were so late as to materially delay and interfere with the work schedule of the contractors. Furthermore, but a limited amount of work could be handled and even that amount was hastily and incompletely performed. What happened was simply that the multiplication of duties was allowed to become a complication.

The work schedule should be checked by records of work done from day to day, thereby giving data on which to base plans and from which to prepare a yearly budget and other tabulated information essential to the development of the laboratory.

Records of all tests made by the laboratory during the past five years should be referenced on file. Law suits which have developed from disputes by contractors have been settled by such reliable facts.

Interruptions by visitors should not be tolerated; only essential interviews with the laboratory employees should be permitted, and those by appointment only, the time then being set so as not to interfere with the work schedule. All requests should be made in writing or by telephone, for otherwise the constant interruptions to tests in progress would make it a physical impossibility to care for the work or to obtain reliable results.

It may appear unessential to remark that although personal liberty within reason is always permissible, that it should be curtailed when it causes the neglect of regular duties. The writer has observed in some laboratories that the men constantly use their working time for personal affairs; they do their shaving, develop personal photographs, construct petty articles for private presents, and waste time on many other unofficial matters. The nature of the laboratory work breeds such habits in certain types of men. Of course, this is an affair dependent upon the laboratory director.

Another caution is that tests in progress should not be set aside in order that promiscuous ideas that have occurred during their progress be followed out. A record of such ideas should be made, however, and they should be followed up at such times as the director may determine; preferably during the winter season.

Utilization of Results

The data obtained from tests may be utilized in many ways. Attention has been called to the inadequacy of the practice of testing materials with the idea only that they must pass the minimum requirements of the specifications. For some types of public works and materials, with our present limited knowledge, this is all that can be expected. However, whenever it is practical, the policy of the laboratory should be to give preference on the basis of relative quality; and in many cases weighted payments should be made, based on average or relative quality. In any case it should base such weighted payments on the relation of the furnished materials to the quality of the original sample and percentage deductions should be made for payments on certain classes of materials (according to definite specifications) when tests show them to fall below a specified average (not minimum) quality. When the laboratory expands to supervise large numbers of purchases, such a policy will result in material savings to the city and also greatly increase the average value of the goods purchased.

Another very important use to which test data should be put is to arrange it in tabular form showing how materials and the structures in which they were used compared as to quality and according to the contractor furnishing or doing the work. This practice is an easy proof to the "practical" contractor who for example, uses too much water in his concrete, that he must improve or fall below the standards of competitors and thereby lose prestige. This use of the data results in marked improvements in both the quality of materials and in construction practice and repays the effort and expense of it. Moreover, such a table furnishes the city's board of contract and supply (or similar body) with the data which it needs to weed out the unscrupulous contractors.

Conclusions

Among the main conclusions developed by this paper the three following are most important:—

1—A standard testing laboratory is an economical investment for any municipality.

2—Seldom are its advantages more than partially utilized.

3—Its field of service is of almost unlimited expansion.

Furthermore, human performance always lags behind human knowledge and it is the duty of the municipal laboratory to urge local practice to approach closely scientific knowledge. Real efficiency or economy cannot be obtained through mushroom growth but developments must come through a gradual and earnest effort fully to cover its useful field. Occasional testing is not sufficient to insure proper value or usage of materials. Investigations must be based on knowledge gained through experience, scientific observation of conditions, accurate analysis and practical interpretation of results obtained.

The field of usefulness is subject to further enlargement by the ready adoption of improved methods and through scientific experiment and research. Specifications for materials must be constantly improved; obsolete parts must be weeded out and others made to conform to advanced methods. Not only should the laboratory follow the recommendations of the national technical societies but it should of itself contribute toward the advancement of that service. To be ever unsatisfied with conditions and to make every effort to improve them is the only policy by which progress will be made.

A rather unusual feature in roof truss construction was adopted for the metal machine shops at the national aeroplane factory near Manchester, Eng. Considerable difficulty having been experienced in obtaining the required steel with sufficient dispatch, a reinforced concrete roof truss was adopted. It is said that these trusses are carrying all of the shafting and have been tested with a live load of 7½ tons, without showing deflection.

Curing concrete pavements by ponding, that is, keeping them flooded with water retained by earth dams built across and along the pavement, originated in California. Now there comes from California the ponding method of settling fills. An earth dike about 12 inches high is thrown up along the extreme outer edge of the fill section. Cross dikes, also 12 inches high, are then thrown up, forming rectangular areas approximately 24 feet wide by 6 to 10 feet long. The width is constant but length will generally vary with the gradient, although it may be kept constant by varying the height of the cross dikes. Holes are made in each dike section with a post hole auger, the depth of the holes varying with the depth of the fill. The section is then filled with water until within 2 inches of the top of the dikes. It is conducted to practically every stratum of the fill section, resulting in uniform settlement. Sections are refilled with water two or three times or until the maximum settlement has resulted. On heavy adobe or clay fills, care must be taken not to introduce an excess of water, especially if the season is late, as the fill may not dry out sufficiently during the remainder of the season to permit rolling and completion of the subgrade.

GOOD ROADS AND AGRICULTURE*

By Hon. Geo. S. Henry
Minister of Agriculture, Province of Ontario

It is a well-known fact that the commercial life of a nation is dependent upon its means of transportation. A healthy nation, enjoying growth and prosperity, must have its various arteries of trade free and unobstructed, permitting the producer and consumer the privilege of an easy access to each other at the lowest possible cost. If this is true, and the very life blood of a nation requires to flow from the centres to its most extreme boundaries, returning again to the centres, it must be recognized that the citizen who occupies a farm producing the sinews of life, even though that the farm may be in some remote place, to function properly must be provided with an outlet.

The roads of the country provide the vital link between farm and market, and are more closely related to agriculture than to any other of our national industries. The country has arrived at a point in its development when much depends upon the work of the farmer. The war has left us with annual interest charges of approximately $125,000,000. To meet these charges, together with the sinking fund, our national resources must be developed, while strictest economy must be practised.

Must Increase Productive Power

It is evident that the railway machinery created to take care of the production of the country is sufficient to deal with at least twice, if not three times, the existing output, and it is obvious that the burden of interest upon the immense amount of capital supplied will be a heavy one until the productive power of the country is greatly increased. I am convinced that every possible effort will be made by all concerned—the Canadian government, the provincial governments, the municipalities, the great railway companies, bankers, traders and others to increase rapidly the agricultural output of the country upon which the welfare of the Canadian people, both individually and collectively—absolutely depends, and that the effect of their concerted effort will be so great that the country will carry with safety a burden of interest which might otherwise overtax its strength. It is, however, of the greatest possible importance that the work of directly increasing the productive power of the country by placing a larger proportion of the population upon the land should be carried out with the least possible delay.

In other words, in the years which are coming upon us, the farmer and the farm must occupy an even more important place in the economy of the nation than ever before, for while our forests, our mines, our fisheries, and our manufactures, are all important, agriculture has and will play in the future by far the largest part in the wealth production of this Canada of ours.

Speaking more particularly of agriculture in the Province of Ontario, and what is said of that province is true proportionately even to a greater extent of the other provinces of this Dominion, the strictly rural population of the settled portions of the province stood in 1911 at 1,024,000 as against 1,271,000 in the urban municipalities, so that the farmers constitute by far the most numerous single element in the community. In the aggregate they have the largest capital investment in the province. The last census shows the following comparison:—

Capital investment in agriculture (Ontario only) $1,283,000,000; capital investment in manufactures and industries (Dominion of Canada) $1,247,500,000; so that agriculture in Ontario exceeds the investment in manufactures and industries in the Dominion by $35,500,000.

These figures have changed materially since the war period, and while our manufacturing plants have greatly increased in value, the value of the agricultural products of the province have grown from $175,000,000 in 1911, to $536,500,000 in 1918, and it has been demonstrated that the application to all the farms of the province, of the methods employed on the best 10% of them, would double the value of its agricultural production. How great would be the prosperity of Ontario if her agricultural production rose to $900,000,000. In no other department of the life of the community is any such increase of wealth even remotely possible within a reasonable period.

Proper Equipment Includes Roads

General conditions are necessary to such a result, and they range from willingness on the part of the farmer to adopt the methods actually in use by some of their number, to the provision by the people of the equipment which is necessary. Good roads are part of the equipment supplied to the individual farmer by the community. The man whose farm is separated from its market by several miles of difficult roadway, wastes part of his time, his energy and his capital on unnecessary effort in transportation. He is driven into the less productive kinds of farming, and he loses part of the proper returns, even from his unproductive type of farming. Good roads will not of themselves increase production and enhance values, but they give the farmer a chance to do these things, and they are an indispensable preliminary to the process of getting more from the land.

The suggestion that the social development of the rural section is necessary for the purpose of rendering the farm a more pleasant place to live, and thus checking a further movement from farm to city, is important and necessary, and good roads will undoubtedly play a big part in eliminating the isolation of the farm. It is logical that good roads will aid the further establishment of the rural mail, and as distance to-day is measured by time rather than by miles, good roads, with the family automobile and market truck, will prove wonderful savers of time. This is important when help is at a premium.

The cost of marketing farm produce plays an important part in agricultural profits. While there are no figures available which can be considered authentic, a careful survey has placed the cost of hauling produce over average country roads at 25c. per ton mile. At this rate, 20 miles to market, or a cost of $5 for this distance, would often take the profit from an otherwise profitable crop. In England the haul cost per ton is placed at 8c. It is a fair conclusion that hauling cost can be reduced at least 50%, and this saving is profit to the agriculturist.

Educational advantages of the farmer are closely indentified with the road question. Community interests are broadened; people are less sectional; ideas circulate more rapidly, neighborhoods are widened; the city and the country are bound closely together and it is easy to discover that their interests are one and the same. A cash value cannot be placed upon the advantages accruing to the rural section from improved roads. But with a nation's prosperity and future depending largely upon the farm, and the farm depending in turn upon the highway, road improvement does not remain a local question but resolves itself into one affecting the very life of the nation itself.

Farmers Started the Roads

In the past, the farmer has played an important part in building the roads. Much criticism is offered the statute labor system. I am not contending that this system has been perfect, but it has usually played an important part in the road-building program of this country, and this condemned system, operated by the honest labor of the farmer, is responsible more than anything else for the splendid network of roads radiating throughout this Dominion and now awaiting to be properly surfaced in order that they may be made the modern convenience and may play the important part for which they are intended.

Our roads to-day are largely a monument to the faithful labor of the agriculturist. This has been recognized by governments, and the distribution of cost has been considered an unfair one. The farmer is not the sole user of the road. It is as important that the urbanite reach the country as it is to have the farmer reach the city. The

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*Address delivered May 21st, 1919, at the Canadian Good Roads Congress, Quebec.

government of Ontario, as well as the governments of other provinces, have arranged a system of assessment and expenditure whereby all may bear a fair proportion of the cost.

Provincial government assistance to roads is a contribution to the agriculturist. The cities' responsibility is shown in that suburban areas have been established, and in such areas the cities of Ontario have to contribute 30% of the cost of certain main designated roads. The importance of agriculture is recognized. The necessity of an equitable assessment of cost is established, and with the early improvement of all our roads, a solid and contented constituency will be established within our Dominion, and we will rapidly reach that position among the nations of the world which has been purchased for us by Canada's brave sons on the fields of France and Flanders.

CHAMPLAIN THE FIRST ROAD BUILDER*

By H. E. Lavigueur
Mayor, City of Quebec

QUEBEC claims the honor of having been the birthplace of the pioneer Canadian roads department. Its founder was no less a personage than Champlain himself, who traced the primitive pathway around "L'Habitation de Quebec," and the next in date was probably the one leading from the river shore to the higher level, where the old Chateau St. Louis was built.

This is now the moment to welcome the advent of the automobile, which has entirely changed the face of things. As one of the most prominent American authorities on road-making used to say: "There are three factors in transportation: Canals, railways and roads."

Canals and railways cannot reach everybody and everywhere, and with the tremendous increase of trade of our age, they are now found to be unable to cope with the requirements of business.

The automobile, with its lightning speed, invaded our roadways, and, finding them too primitive, clamored for speedy improvement according to the most modern ideas.

During the last 15 or 20 years the powerful influence of motorists has wrought miracles in the improvement of our ways of transportation, and it is gratifying to find that this sixth congress of your association, judging from its rich program, marks a wonderful progress in the most important factor of our national development.

We are indebted to the present provincial administration for the bold and enterprising policy which has endowed our province with a new department in this special branch of public works.

A whole modern organization has sprung up in a short time, and has developed all over the province a system which has given most promising results. These results are publicly admitted and recognized, as was again the case recently before parliament, when the House of Commons discussed the federal law for highway construction. The government then declared that if such an organization as that of the province of Quebec could be obtained, we would have every reason to be satisfied.

We are indebted to the Hon. Sir Lomer Gouin and to the Hon. Mr. Tessier for the compliments thus bestowed upon our province for their wise policy in connection with good roads, which are highly appreciated by the people of our province.

Public opinion is now better informed and enlightened as to the value of country roads, and the whole of our province will soon be enriched by a national system of modern highways.

May this congress mark an eventful day in the patriotic task of securing a friendly "entente cordiale" between us all, and may it strengthen the bonds of Canadian national unity!

*Address of welcome to the Canadian Good Roads Congress, Quebec.

FIRE-RESISTIVE CONSTRUCTION CHEAPER IN FIRST COST*

By Henry K. Holsman
Architect, Chicago

SIX years prior to the erection of the building described in this article, the writer had a similar building under construction. The earlier building was the same length, three stories and low basement instead of four stories in height, finished on two sides instead of three sides, and built in the ordinary manner with brick exterior walls, wood joists, wood studs, etc. The units in the old building were practically the same as those of the new and were designed for the same purpose, namely, apartments.

The new building is fire-resistive, throughout, except that the roof is a frame construction built over fire-resistive slab, forming the ceiling of the top story. The new building is composed of better material throughout, and yet its cost per cubic foot was nearly 4 cents less than the cost of the old building.

This was done in spite of the fact that the market price of steel was at its highest point, namely, $72 a ton at the mill. Reinforced concrete frame construction was used, the exterior wall being curtain walls of hollow building tile, faced on the outside with shale brick. Stairs were built of iron with concrete treads and wood rails.

The floor construction in the newer fire-resistive building is of the concrete beam type, with removable steel dome.

Only Floors More Expensive

Another interesting feature is that the building contains 43 concrete mantles made of a Portland cement, sand and color mixture, of a composition to give a Caen stone appearance. The mantles were made in one piece and by having 43 of them made on one order, in one factory, it was possible to get them installed at a price of $17.50 each. They are better than wood mantles and are, of course, much more economical, both as to first cost and upkeep.

The lobby of the building has a concrete mantle of more elaborate design.

The remarkable difference in the cost of the two buildings could easily be accounted for, and this difference would have been much greater had the two buildings been built at the same time. In the fire-resistive building there was no wood trim whatever used around any of the windows, and the wood finish and trim throughout the building was reduced to a minimum. Where heavy brick walls were required between the units in the building of ordinary construction, 3-inch tile was used in the fire-resistive building. Of course, the floor construction in the fire-resistive building was much more expensive than the floor construction in the ordinary building, but almost every other feature of the building was much less expensive in the fire-resistive building.

My experience in changing plans from ordinary construction to fire-resistive construction, after taking bids on the ordinary construction, leads me to say that if the designer will give due consideration to the points of difference between the two types of construction he will find that, as the markets now are for buildings of this type, fire-resistive construction will cost no more than ordinary construction. I think the reason this is not more generally understood is because when the architect usually designs a fire-resistive building he uses all of the features of the ordinary construction and adds to them the fire-resistive construction. This is not necessary, and, in fact, not desirable.

*Excerpts from a letter written to "Concrete," March, 1919.

Anglins, Ltd., and Norcross Bros. Co., both of Montreal, have merged as the Anglin-Norcross Co., Ltd. J. P. Anglin will be president of the new concern.

According to an announcement by chief engineer Burton Hill of the New Brunswick Highway Department, it will not be long before there will be gangs at work on road construction and improvement in every county in New Brunswick.

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NEW WATER POWER LEGISLATION

DURING the past month new legislation has been introduced in the House of Commons and in the Nova Scotia and New Brunswick legislatures that indicates a very lively appreciation on the part of governments, both Dominion and provincial, of the fundamental importance of water power.

The two bills, "An Act Respecting Water and Water Courses," and "An Act Respecting the Development of Electrical Energy from Water Power and Other Sources," that have been passed by the Nova Scotia legislature, introduce a hydro-electric policy for that province that is very similar to that which has been in force for some years in the province of Ontario. Of course, the opportunities in the Maritime Provinces for the development, transmission and sale of power by government commissions, are not comparable with the opportunities in Ontario, nevertheless the legislation is undoubtedly of great importance.

The bill introduced by the Premier of New Brunswick was tabled owing to "press of other important matters and the necessity for early prorogation," but it is understood that it will be brought to a vote at the next session of that legislature.

In both Nova Scotia and New Brunswick there are provincial water-power commissions that are busily engaged in making an exhaustive investigation of their water-power resources, and in effecting an appropriate scheme of administration. This work has been carried on in co-operation with the Dominion Water Power Branch and has been extended recently to include Prince Edward Island, so this activity now embraces all the provinces east of Quebec, which is soon likely to be flanked on both borders by government commissions with absolute control over water powers and their use. Whether that province is likely to follow this legislative tendency is a matter of considerable conjecture, as it is being very ably served at present by a number of competitive private concerns that are very energetic and progressive in the efficient development of all the water powers in that province in connection with which a market can be found for the electrical energy produced.

The Dominion legislation applies only to the provinces of Manitoba, Saskatchewan and Alberta, the Northwest Territories and the Yukon. It provides for a more definite and complete basis of administration than is now permissible under the Water Power Section of the Dominion Lands Act. Through it, authority for granting expropriation rights to power companies has been clarified.

This new Dominion Power Bill also provides for the appointment of a "Director of Water Power," and our readers will note with pleasure that this position has been safeguarded for engineers, as the bill specifically states that the post must be held by a "duly qualified" officer. By a recent order-in-council, J. B. Challies, superintendent of the Dominion Water Power Branch, was appointed as the first Director of Water Power for Canada. As is well known, Mr. Challies is a technically trained and experienced engineer, who is well qualified to carry out the duties specified in the bill. In fact, these duties will be substantially the same as those which he has performed for some years past as superintendent of the Dominion Water Power Branch, excepting that the scope of his authority has been somewhat broadened and more clearly defined.

AMERICAN WATER WORKS CONVENTION

MANY Canadians will undoubtedly attend the thirty-ninth convention of the American Water Works Association, which will be held next week at Buffalo, N.Y. From present indications the convention will be one of the best the association has ever held, and many matters will be discussed of the greatest possible interest to all municipal engineers and waterworks officials. We understand that all such officials, whether they are members of the association or not, will be cordially welcomed at the meetings. Among the many very interesting subjects to be discussed will be the damage to fire hydrants by motor vehicles and remedies therefore; flanges for light cast-iron pipe; the trend of prices; portable filtration and purification plants; and the effect upon waterworks of the war period and public control.

Buffalo is at its best at this season of the year, and most Canadians can get there either entirely or partly by means of a boat trip, which will be very enjoyable if the present weather conditions continue. Entirely aside from the pleasure of the trip itself and from the educative value of the papers and discussion, the meetings are conducive to the get-together spirit of good fellowship, mutual help and co-operation without which no profession, business or calling can reach its greatest success.

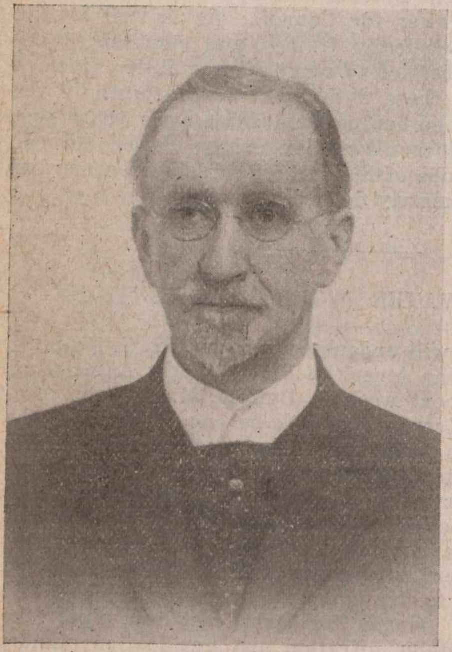
Incidentally we hope that it will be possible for arrangements to be made to bring the fortieth annual convention of the association to Canada. The last convention in Canada was in 1907 at Toronto. By next summer it will have been thirteen years since the association has met in Canada, and as this country has roughly one-thirteenth of the membership it ought at least to have one out of every thirteen conventions. The total membership is approximately thirteen hundred, and the Canadian membership probably now totals upwards of one hundred.

QUEBEC ROAD CONGRESS PAPERS

IN next week's issue of *The Canadian Engineer* will appear several more of the technical papers that were read two weeks ago at the road congress in Quebec, including those by Messrs. Fraser, Fenn and Sandles, and possibly also a translation of Mr. Paradis' paper, which was read in French.

PERSONALS

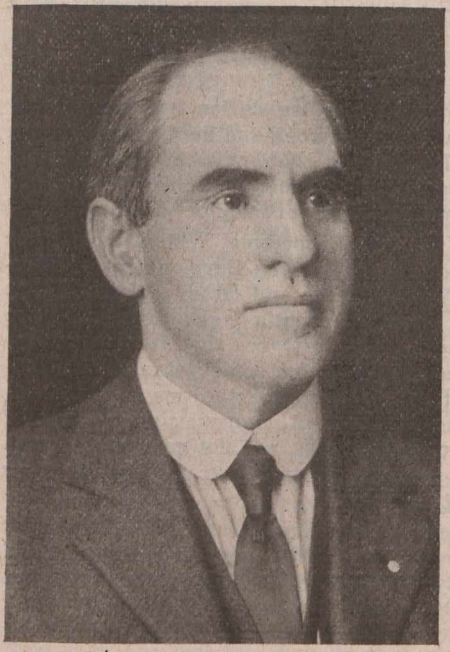
ROBERT OWEN WYNNE-ROBERTS, Toronto, has been appointed consulting engineer to J. A. Ellis, the director of the Bureau of Municipal Affairs of the Province of Ontario, for the purpose of reporting on the domestic water supply, fire fighting facilities and sanitation of the towns and cities of the province, for the guidance of the department in directing the expenditure of the housing funds. Mr. Wynne-Roberts was born October 12th, 1864, at Liverpool, Eng., and began his engineering career when 18 years of age as assistant town engineer of Llandudno, Wales. He held that position for seven years, and then became water and gas engineer of the Borough of Carnarvon. Five years later he was selected from 120 candidates as borough engineer of Oswestry. He subsequently inspected over 60 sewage disposal plants and reported thereon, and also published a small book on the subject, and later constructed one of the pioneer bacteriological sewage disposal works in England. In 1898 he was appointed city engineer of Capetown, South Africa, and during the following eight years carried out improvements totalling over $7,000,000, besides controlling an annual expenditure of about $1,000,000. During the general financial depression after the Boer war, Mr. Wynne-Roberts resigned and returned to London, where for four years he practiced as a consulting engineer and was employed by various municipalities in connection with sewerage, sewage disposal and water works. He was twice appointed by the British government as sole arbitrator to settle disputes between several metropolitan municipalities involving street railway expenditures of over $5,000,000, and was appointed an arbitrator of the London Court of Arbitration. During this period he was also associated with a large contracting firm in the preparation of tenders for the construction of a reservoir in Manchester costing over $1,750,000. In 1911 Mr. Wynne-Roberts came to Canada and was retained as consulting engineer by the city of Regina, Sask., and by the government of the Province of Saskatchewan to report on the development of power from the lignite coal fields. He was subsequently appointed consulting engineer for the city of Regina in connection with the enlargement of the water works system and the natural gas supply. In 1915 he moved to Toronto and opened an office as consulting engineer, subsequently becoming associated with Frank Barber, engineer for York Township, Ont., and has assisted Mr. Barber in the design and construction of an extensive scheme of water works distribution for that township. He has also been retained by Sault Ste. Marie and other Ontario municipalities in connection with water works reports and construction. Mr. Wynne-Roberts is a member of the Institution of Civil Engineers of Great Britain, Engineering Institute of Canada, American Society of Civil Engineers, Institution of Municipal and County Engineers of Great Britain, Institution of British Water Engineers, American Water Works Association, and a fellow and examiner of the Royal Sanitary Institute of Great Britain.



T. LINSEY CROSSLEY, who has been associated for a number of years with Dr. J. T. Donald, of Montreal, and who established the Toronto laboratory of J. T. Donald & Co., consulting chemists and chemical engineers, has taken over the Toronto office and laboratory of that firm.

BRIG.-GEN. CHAS. H. MITCHELL, who recently accepted the position of Dean of the Faculty of Applied Science, University of Toronto, sailed from England on Tuesday on the "Melita." Upon his arrival in Montreal, Gen. Mitchell will be accorded a reception and dinner by members of the Montreal branch of the Engineering Institute of Canada. Arrangements are being made for a similar reception at Toronto by the members of the Engineers' Club. Gen. Mitchell is one of the most noted Canadian engineers in the army, having won great distinction in France as commanding officer of the Intelligence Corps of the Second British Army, and later in a similar capacity with the British expeditionary force in Italy. He has received numerous decorations from the English, French, Belgium and Italian governments.

LLEWELLYN N. EDWARDS has resigned as supervising engineer of the Department of Railways, Bridges and Docks of the city of Toronto, to accept an appointment as bridge engineer in the Bureau of Public Roads, United States Department of Agriculture. Mr. Edwards left Toronto this week to report at Washington, D.C. He was born near Portland, Me., and in 1898 graduated from the University of Maine with the degree of B.C.E. In 1901 obtained his C.E. degree. For seven years after graduation, Mr. Edwards had valuable experience as draftsman, checker, designer, etc., with various bridge and structural companies, including the Cambria Steel Co., Riter-Conley Mfg. Co., Pennsylvania Steel Co., Purdy & Henderson, and the Boston Bridge Works. In 1905 he became designer and estimator in the office of the bridge engineer of the Boston and Maine Railroad, and the following year accepted a similar position with the Chicago and Northwestern Railway. In November, 1907, he went to Montreal as structural engineer of the Grand Trunk Railway. The first year he was at Montreal, Mr. Edwards worked on designs and estimates for all classes of railway bridges. He was then placed in charge of the design and construction of the Coteau bridge over the St. Lawrence River at Valleyfield, P.Q. This work involved the removal of the existing metal bridge and the erection of two swing spans and seventeen fixed truss spans. This bridge is 3,165 ft. long and cost approximately $510,000. After the completion of this work, Mr. Edwards was engaged in special investigations and valuations of bridges and other structures. From September, 1912, to February, 1913, he was engaged in exploration and estimation of cost of structures on a proposed railway line, and in February, 1913, he joined the staff of the city of Toronto. During the past six years he has supervised the construction of the Crawford Street, St. Clair Ave., Mount Pleasant, Olympic-Island, Strachan Ave. and other Toronto bridges, and various smaller structures, and has also had charge of the maintenance of all existing bridges. Besides this work he has devoted a great deal of



time to experiments in the proportioning of materials for concrete, and in tests of cement and various aggregates. He devised the so-called "Heath-Edwards method" of proportioning materials by the area of the aggregates, and on this and other subjects he has written numerous valuable articles which have appeared during the past few years in *The Canadian Engineer*. When the United States entered the war, he resigned his position in Toronto to accept a captaincy in the engineer corps of the American army, but while instructing a squad in trench tactics at one of the Southern camps, he suffered an accident to a foot, which incapacitated him from further duty. After being honorably discharged from service, he returned to his former position with the city of Toronto. He is a member of the American Society of Civil Engineers, American Railway Engineering Association and American Society for Testing Materials, and has taken a prominent part in the work of those society committees which have dealt with masonry, cement, steel, and concrete aggregates.

GUNITE SHOWS ECONOMY IN CONSTRUCTION

By R. Ewart Cleaton
Montreal, P.Q.

WITH the cost of materials showing very little sign of decreasing and the cost of labor decidedly the reverse, engineers, architects and contractors are casting about for means of obtaining cheaper construction. The product of the cement-gun, now familiarly known as "gunite," is receiving a great deal of attention in this respect, due to the satisfactory results that have been obtained from it during the last few years.

Although the aggregates of "gunite" and hand-applied cement mortar are the same, viz., sand and cement, the characteristics of the finished product differ widely and are greatly in favor of the former, the two chief reasons being that "gunite" is hydrated at the nozzle and therefore only as the material is being shot into place, thus obtaining the benefit of the whole of the initial set; and secondly, the material being applied by air pressure ranging from 35 to 50 lbs. per sq. in., it is very much denser and enters into every pore of the surface to which it is applied, and a far better bond is obtained.

Exhaustive tests have absolutely proven that "gunite" of a thickness of 1 in. is not only fire-proof but waterproof, neither of which, of course, can be claimed for the same thickness, or even double the thickness, of hand-applied mortar. Tests made at Washington, D.C., by the Bureau of Standards and at Lehigh University by Prof. Frank P. McKibben, have established the fact that the relative strengths of "gunite" and hand-applied mortars or concretes are as follows:—

	"Gunite," Average of Samples	Hand-placed 1:2 Mortar
Compressive strength, lbs. sq. in.	4,145	2,184
Modulus of elasticity, lbs. sq. in.	4,278,000	1,538,000
Tensile strength, lbs. sq. in.	690	142

Besides its intrinsic merits, "gunite" possesses the additional one of very materially reducing the costs for labor on the work on which it is used. For example, on wall work, practically no form-work is required, thus making it possible to dispense with carpenters and eliminate the heavy cost of lumber for forms. An example of this class of work is the large machine shop recently built by the Traylor Engineering & Manufacturing Co., at Allentown, Pa. Over a framework of steel, "gunite" was shot onto 2 in. mesh No. 16 gauge expanded metal. The panels were designed of uniform size, and the only forms required were three removable ones which were used alternately and moved ahead of each other as the work proceeded. The thickness of the walls is 2 ins., and the total cost, exclusive of air but including the expanded metal, was 17¾c. per sq. ft.

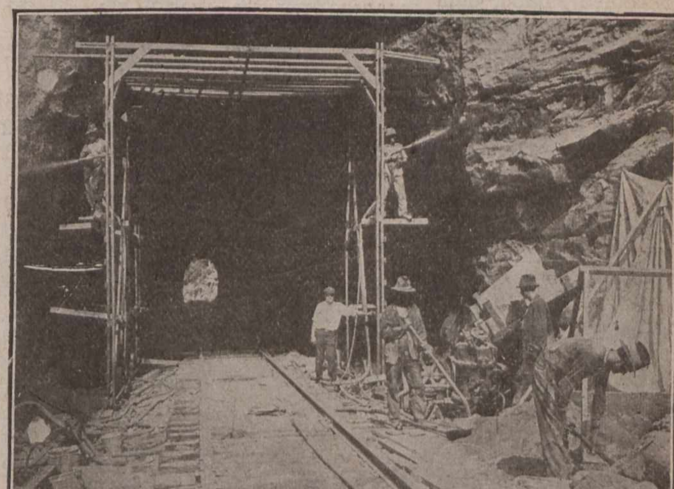
This is practically the most expensive type of construction on which "gunite" can be used. A much cheaper form has been adopted by the Hydro-Electric Power Commission of Ontario in connection with the various construction camp buildings on the Chippawa-Queenston hydro-electric development. In this case the majority of the buildings are of wood. Tar-paper and poultry wire, 2 in. mesh, No. 15 gauge, were attached, and over this a 1-in. coating of "gunite" was applied. The most recent building erected on this job has merely a wooden framework to which the tar-paper and reinforcement are nailed and the "gunite" shot over them. All of these buildings have proven themselves weatherproof, the last mentioned one being used as a cement store, and are fire-proof from the outside.

Other uses to which the cement-gun is being put are innumerable, but a few of them are as follows:—

Firefroofing of steelwork.—"Gunite" was specified for this purpose on the new Parliament Buildings at Ottawa, and the Union Station at Toronto. Also at the new paper mill now being built for the Kipawa Co., Ltd., at Temiskaming, P.Q.

Coke-oven repairs.—The cement-gun was used by the Wilputte Coke Oven Corporation at the Hamilton plant of the Steel Co. of Canada, Ltd., for filling in the preheating cracks, and is used by them on all their jobs.

Stucco work.—"Gunite" is specified on several hundred houses being built by the Halifax Relief Commission, the upper part of these houses being covered with "gunite."



Lining Railroad Tunnel With Gunite

Shipbuilding and lining.—A number of barges have been built for use on the New York State Barge Canal and others for the Standard Oil Company, the principle adopted being to use precast ribs and "gunite" sides, decks and bulkheads.

Lining steel smoke-stacks and acid tanks.—Remarkable results have been obtained on work of this nature, the "gunite" successfully resisting gases of combustion, and dilute sulphuric as well as strong nitric acid.

Repairs to masonry and coating of dams.—A typical example of the former is the coating of the piers of the Grand Trunk Railway bridge at Weston, Ont.

Mine work.—Fire-proofing of timbers and building of stopes has been carried out in the mines of the Acadia and Dominion coal companies in Nova Scotia.

The cement-gun is not a restricted article and is sold outright by the Cement-Gun Co., Inc., and is not rented. The ease and cheapness with which it can be operated is rapidly causing it to be looked upon as a standard part of their equipment by the more up-to-date contractors, whilst the superior qualities of "gunite" are appealing more and more every day to engineers and architects, as it becomes more widely known.

The annual convention of the Canadian Electrical Association will be held June 27th and 28th at the Thousand Island House, Alexandria Bay.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

ADDITIONAL TENDERS PENDING

Not Including Those Reported in This Issue

Further information may be had from the issues of *The Canadian Engineer*, to which reference is made.

PLACE OF WORK	TENDERS CLOSE	ISSUE OF	PAGE
Bare Point, Ont., breakwater	June 25.	May 29.	50
Brantford, Ont., pavements	June 7.	May 29.	506
Bury, Que., bridge	June 14.	May 29.	506
Connaught Station, Ont., wharf	June 11.	May 29.	43
Dundas, Ont., sewage works	June 23.	May 29.	43
Guelph, Ont., pavements	June 14.	May 22.	43
Metcalfe, Ont., drains	June 9.	May 22.	48
Nicomen Island, dam	June 18.	May 29.	44
Port Arthur, Ont., repairs to breakwater	June 10.	May 22.	52
Saskatoon, Sask., physics building	June 7.	May 29.	48
Souris, P.E.I., breakwater	June 12.	May 22.	52
Spry Bay, N.S., wharf	June 11.	May 29.	50
St. Ignace de Loyola, Que., wharf	June 11.	May 29.	50
Toronto, Ont., school	June 17.	May 29.	50
Toronto, Ont., sidewalks	June 13.	May 29.	44
Toronto, Ont., water mains	June 14.	May 29.	44

BRIDGES, ROADS AND STREETS

Alliston, Ont.—Tenders will shortly be called for resurfacing streets at a cost of about $9,000. J. E. Addis, clerk.

Banff, Alta.—Engineers are working on plans for a combination steel and concrete bridge to be erected across the Bow River at Banff. Hon. F. B. Carvell, Minister of Public Works, Ottawa.

Beinfait, Sask.—Tenders addressed to the Council of the Rural Municipality will be received at the office of the undersigned until 6 p.m., June 13th, for all or parts of the undermentioned works situated exclusively in rural municipality No. 4 and consisting of approximately 20,000 cubic yards of grading, 14 miles of turn-piking, 18 miles of regrading and hauling and placing of about 400 lin. feet of vitrified clay pipe. Detail plans and specifications can be seen at the office of the undersigned or at the office of the Parsons Engineering Co., 1704 Scarth St., Regina. A. J. Milligan, secretary-treasurer. Parsons Engineering Co., engineers, Beinfait, Sask.

Bishop's Mills, Ont.—A petition is being signed by the ratepayers of the Township of Oxford asking the members of the County Councils to designate and build a county road from Prescott through Domville to Bishop's Mills.

Caledonia, Ont.—McConnell and Kracplain have the contract for construction of 13 miles of road. Contract price, $96,800.

Chatham, Ont.—Contracts for bridges over Doyle and Deary drains have been awarded to G. J. Gilhula, Merlin, Ont.

Exeter, Ont.—Town Council contemplates construction of pavements costing about $25,000. Clerk, J. Senio.

Ford City, Ont.—Tenders will be received by the undersigned up to 4 p.m., June 10th, for the construction of concrete sidewalks, 4 ft. wide, on Cadillac St., Albert Rd. and Drouillard Rd. Plans and specifications may be seen on application to Owen McKay, C.E., Walkerville. J. F. Foster, clerk, Ford City.

Fredericton, N.B.—Tenders will be received by the undersigned until 5 p.m., June 11th, for reconstruction of concrete arch culvert and embankments. Hon. P. J. Venoit, Department of Public Works, Fredericton.

Fredericton, N.B.—Tenders will be received by the undersigned until 5 p.m., June 11th, for reconstruction of bridge. Hon. P. J. Venoit, Department of Public Works, Fredericton.

Galt, Ont.—Tenders will be received by the undersigned until noon, June 18th, for construction of pavements. W. H. Fairchild, city engineer. Official advertisement elsewhere in this issue.

Hamilton, Ont.—According to an announcement made by Engineer Jeffreys, of the Hydro Commission, work will be commenced almost immediately on laying of steel for electric railway, from Toronto to the Niagara River.

Ingersoll, Ont.—Tenders will be received by the Town Clerk up to noon, June 9th, for construction of approximately 9,000 square yards of reinforced concrete pavement, with curbing, storm sewers, etc., for the Town of Ingersoll. Plans, specifications and forms of tender may be seen at the offices of either W. R. Smith, town clerk, Ingersoll, Ontario, or F. W. Farncombe, C.E., London, Ontario.

Kingston, Ont.—Arrangements have been completed for the construction of a provincial highway crossing the counties of Frontenac, Leeds, Lanark and Carleton.

L'Orignal, Ont.—Town Council has made preparations for construction of roads. Estimated cost, $16,000.

Lotbiniere, Que.—Tenders will be received by the undersigned until June 11th, for construction of steel bridges. J. Bedard, city secretary-treasurer.

Mitchell, Ont.—The Ellice Township Council has awarded the contract for construction of new bridge on the 6th Con., to A. Hill and Co., of Mitchell, Ont. Contract includes 170 yards concrete abutments, 57 ft. 6 ins. centres steel bridge and concrete floor. Contract price, $3,466.

Moncton, N.B.—Tenders, addressed to the undersigned, will be received up till noon, June 9th, for the construction of concrete sidewalks, according to plans and specifications on file at the city engineer's office. J. Edington, city engineer.

Mont Laurier, Que.—The approximate cost of construction of the Montreal-Mont Laurier Rd. is $600,000. This works out at $4,000 per mile.

Montreal, Que.—It has been decided to proceed with the work of paving Commissioners St.

Montreal, Que.—The City Council will shortly proceed with construction of the asphalt pavements on St. Dominique St., from Prince Arthur to Sherbrooke, and on William St., from McCord to Canning Streets.

New Liskeard, Ont.—The united Boards of Trade of Haileybury, Cobalt and New Liskeard, and the Temiskaming Motor League are considering the question of improvements to roads. The government will be asked to contribute half of the cost of reconstructing the highway.

New Westminster, B.C.—Grading work on the right of way of the C.N. Ry. line through the city will begin shortly. R. Yates is in charge of the work and estimates that it will take about four months to complete the grading, after which track laying will commence.