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The Canadian Engineer

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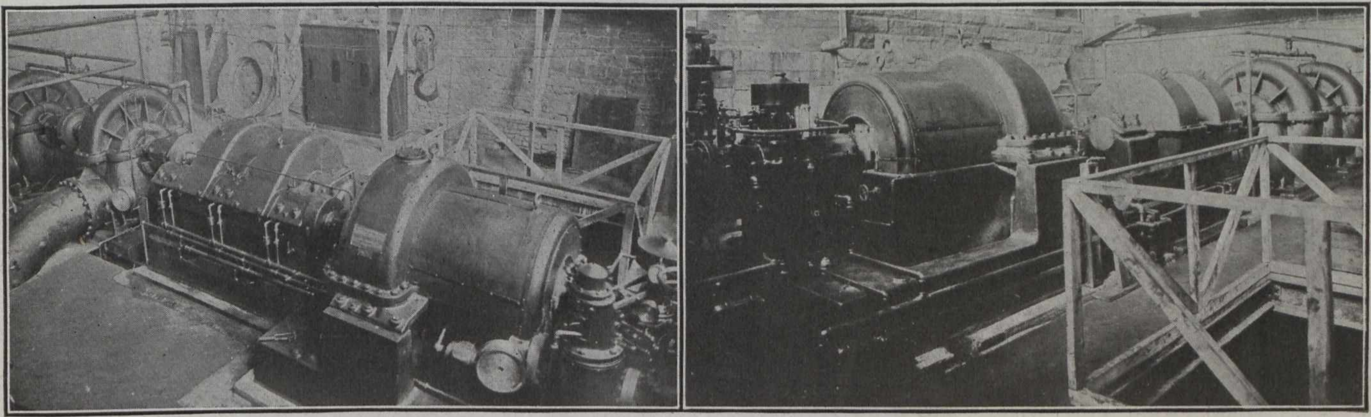
PUMPING STATION EQUIPMENT AT TORONTO

DESCRIPTION OF THE STEAM-TURBINE-DRIVEN CENTRIFUGAL PUMPS AT THE JOHN STREET AND HIGH LEVEL PUMPING STATIONS.

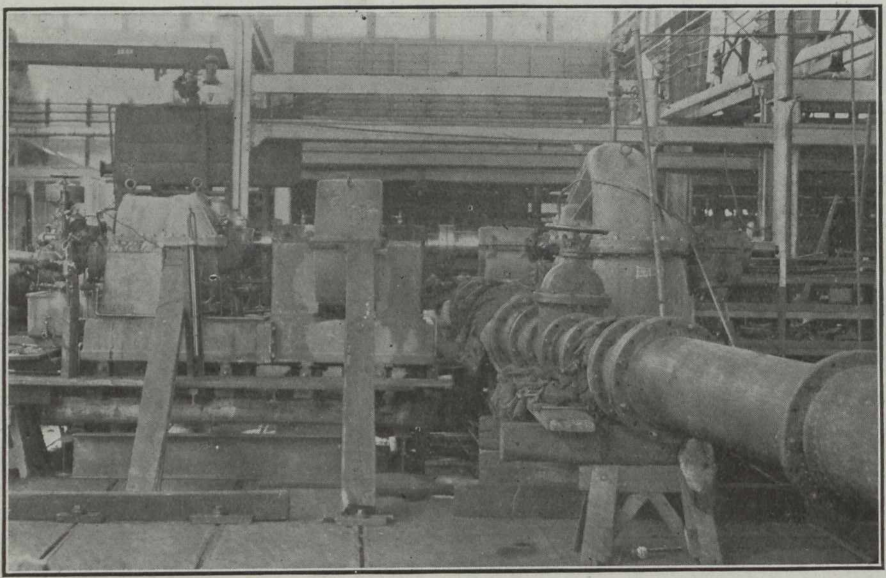
THE two pumping stations of the Toronto waterworks epitomize, it might be said, the whole development of waterworks pumping machinery in America, although at the present time some of the oldest units are being discarded in favor of more modern and economical apparatus. The John Street pumping station, which is the main station, supplies all sections south of College and Gerrard Streets, and delivers water to two large mains, one going to the reservoir in the northern part of the city at a pressure of 20 lbs., and the other to the centrifugal pumps in the high level pumping station, about three miles north. It contains two 10,000,000-gallon horizontal compound Worthington duplex pumps which, though installed about 25 years ago, are still used at certain periods. There are also two 15,000,000-gal. vertical triple-expansion high-duty reciprocating pumping engines, built after Allis-Chalmers designs by the John Inglis Co., of Toronto, installed eight and six years ago respectively, and four 13,500,000-gal. single-stage centrifugal pumps, operating against a head of 110 lbs. and driven at 750 r.p.m. by Canadian-Westinghouse 1,500-h.p. motors. The latter pumps were installed about two years ago and are operated with Niagara power. There are also two 5,000,000-gal. centrifugal pumps directly connected to steam turbines, and two other pumps of the same capacity and make, directly connected to Westinghouse motors, all intended for high-pressure fire service.

With a view to increasing the capacity and economy of this station, specifications were issued in October, 1912, for machines of three different types: (*a*) A self-contained vertical triple-expansion fly-wheel plunger pumping engine with jacketed steam cylinders; (*b*) a centrifugal pump driven by a triple-expansion condensing engine, running at a speed of not over 350 r.p.m., and (*c*) a centrifugal pump driven by steam turbine, the pump speed not to exceed 750 revolutions; the capacity in each case to be not less than 15,000,000 Imp. gal. of water for 24 hours against a pressure difference of 105 lbs. per sq. in. between the suction and discharge mains. It was provided in the specification that a duty in excess of 100,000,000 ft.-lbs. per thousand lbs. of saturated steam should be guaranteed with a bonus of $1,500 for each million ft.-lbs. in excess of the guarantee, the total bonus not to exceed $10,000, and a penalty of $2,000 for each million ft.-lbs. less than the guarantee; a deficiency of more than 5,000,000 ft.-lbs. below the guaranteed duty to render the pump subject to rejection. It was further provided that the steam pressure should be 150 lbs. gauge at the boiler, and that the steam should not contain more than 1½% of entrained water, also that the steam consumed by the auxiliary pumps, jackets, reheaters, air pumps, air compressors, boiler feed pumps, all of which were to be supplied by the contractor, was to be included in figuring the duty.



Front and Rear Views of the Two 24,000,000-gallon-per-day Units in the John Street Station, Toronto.

The decision as to the type and make of pump was made on the basis of net economy, or lowest cost per gallon of water handled; that is, interest and depreciation charges on the cost of machinery, foundations and buildings and expenses for labor and supplies were taken into consideration as well as steam consumption. The contract was awarded to the Turbine Equipment Co., Ltd., of Toronto, representing the DeLaval Steam Turbine Co., of Trenton, New Jersey, for a 1,400-h.p. steam turbine designed for a speed of 3,600 r.p.m. driving, by means of double helical speed-reducing gears, two 24-in. centrifugal pumps to operate at 600 r.p.m. The turbine is of the impulse pressure-stage type and contains 14 stages. The gear is of the three-pinion bearing type and is connected to the turbine and to the pump shaft by flexible couplings. Both turbine and gear are lubricated by a gravity system, an oil pump attached to the governor shaft forcing the oil through a cooler to an overhead tank from which it runs to the bearings. The larger gear bearings and the pump bearings are ring-oiled.



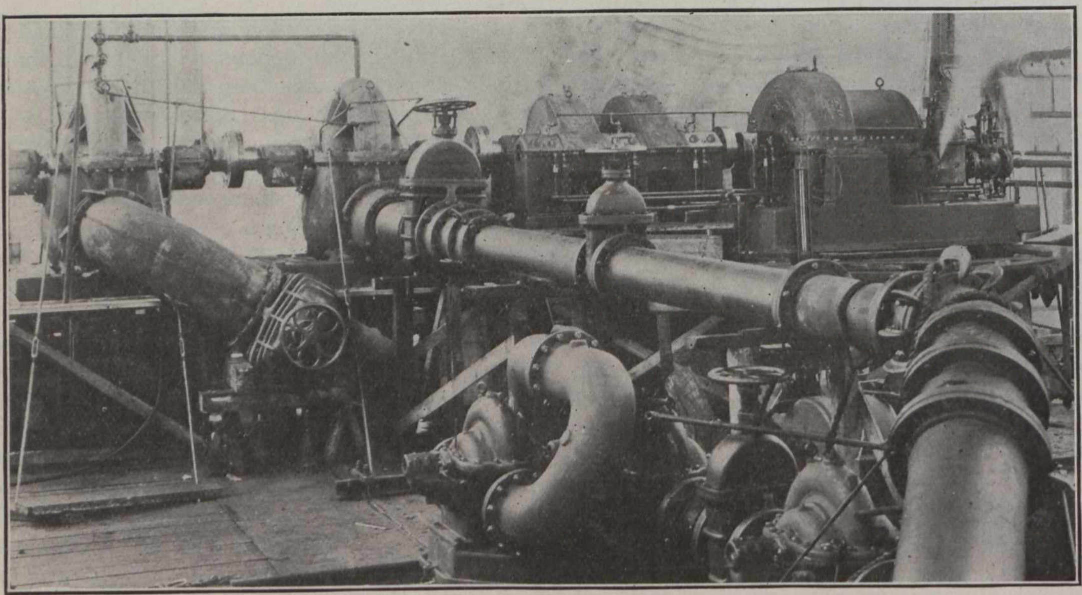
View of the 7,500,000-gallon Unit Now Being Installed at the High Level Pumping Station, Toronto.

The two pumps are of the single-stage double-suction type, and are operated in series; that is, the discharge from the first pump is carried to the suction of the second pump. The pumps are primed by a single steam ejector connected to the top of each pump casing.

The condenser, built by the C. H. Wheeler Mfg. Co., is of the waterworks type, in which the steam is inside the tubes and the water outside, and contains 1,500 sq. ft. made up of one-inch brass tubes each 7 ft. 2 ins. long. All of the water handled by the main pump passes through the condenser. The air pump is of the wet vacuum type, the steam end being of the ordinary slide-valve type, controlled by a throttling governor. The steam for driving the air pump is taken from the main supply pipe between the separator and the steam turbine. As no oil is allowed to reach the inside of the turbine, the condensed steam is passed into the hot-well and delivered to the boilers by a triplex, single-acting boiler feed pump driven by chains from the main pumping unit.

The acceptance test on this pump was run on November 30 and December 1, 1914, under the supervision of Prof. Robert W. Angus, of the University of Toronto, assisted by senior students from that institution. The contractor was represented by Mr. C. R. Waller, chief engineer of the De Laval Steam Turbine Co., and the purchaser by Mr. McRae, chief engineer of the pumping station. Throughout the test, which was of 24 hours duration, suction and discharge pressures, Venturi meter and condensate weight readings were taken every 7½ minutes, while the steam main and nozzle pressures, vacuum, speed, and calorimeter readings were taken every 15 minutes. All gauges were calibrated both before and after the trial and the scales examined and certified by a Government inspector. The barometric pressure during the test was obtained from the records of the Meteorological Office. The principal final results were as follow:

Steam pressure in main—148 lbs. per sq. in.
Steam pressure at turbine nozzles—137.4 lbs. per sq. in.
Absolute condenser pressure—1.06 in. of mercury.
Pressure difference on pump—114.1 lbs. per sq. in.
Moisture in steam—1.05%.
Water delivered, Imp. gals. per 24 hours—18,373,000.
Water horse-power—1,016.4.
Steam per water horse-power per hour—15.18 lbs.
Duty developed per 1,000 lbs. of steam used—130,499,000.
Duty guaranteed—118,500,000.



Shop Test of a 15,000,000-gallon-per-day Pump Installed in the John Street Station, Toronto.

Since placing the first contract, two more units, each capable of delivering 24,000,000 Imp. gal. per day against 260 ft. head have been ordered for the same station, from the Turbine Equipment Co., Ltd., also two De Laval pumps, one of 20,000,000 gallons capacity against 106 ft. head and one 7,500,000 gallons capacity against 266 ft. head, have been ordered for the high level pumping station.

The latter station is situated in the northern part of the city, about three miles in a straight line from the main pumping station, and supplies the district north of

College Street to the Canadian Pacific railroad tracks, and north of Gerrard Street in the eastern part of the city. This pumping station, like the main station, exhibits more or less the history of pumping engines, as it contains a Holly vertical triple-expansion pumping engine, having a capacity of 6,000,000 gallons, and a similar pump built by the John Inglis Co., of Toronto. There are also two Blake-Knowles horizontal cross-compound pumps having a capacity of about 4,000,000 gallons. All of these pumps were installed about eight or ten years ago, and two years ago eight electrically driven centrifugal pumps were installed. An extension is being made to this station for housing the two turbine-driven centrifugal pumps, also two centrifugal pumps directly connected to Bellis-Morcom steam engines.

The De Laval turbine-driven centrifugal pumps installed or under contract for the City of Toronto aggregate 90,500,000 gallons per day capacity, and 4,390 water horse-power.

PUMP OPERATION.

For a direct-acting pump in fair condition, operated at a piston speed of 100 ft. per min., "Coal Age" calculates the steam required to operate it by assuming an average steam consumption per indicated horse-power-hour of, say, 150 lb. dry saturated steam, which is a so-called "water-rate" of $150 \div 60 = 2.5$ lb. i.h.p.-min.; and multiplying this water rate by the indicated horse-power of the pump, as shown by the following:

Find the steam required to pump 9,000 gal. of water per hour, from a shaft 450 ft. deep, using a simple direct, double-acting pump running at a speed of 100 ft. per min. and discharging through a 3-in. column pipe.

The effective head, in this case, is

$$h_1 = 450 + \left(\frac{9,000}{60}\right)^2 \frac{450}{800 \times 3^5} = \text{say } 502 \text{ ft.}$$

The indicated horse-power of this pump will then be

$$H = 0.00034 \times 150 \times 502 = 25.6 \text{ h.p.}$$

The weight of steam required to operate this pump, under the assumed conditions, will be

Steam consumption,

$$2.5 \times 25.6 = 64 \text{ lb. per min.}$$

MEASUREMENT OF STREAM FLOW.

In determining, by the weir method, the flow of a stream, or the amount of water available for power purposes, the following handy table, for a weir one foot in length, will be found of interest:—

Depth in In. on Crest	Quantity in Cu. Ft. per Sec. for Bach Ft. in Length	In Miners In.	Depth in In. on Crest	Quantity in Cu Ft. per Sec for Each Ft. in Length	In Miners In.
1	0.08	3.2	7	1.50	60
1½	0.15	6	7½	1.66	66
2	0.23	9	8	1.81	72
2½	0.30	12	8½	2.00	80
3	0.40	16	9	2.18	87
3½	0.50	20	9½	2.35	94
4	0.65	26	10	2.55	102
4½	0.77	31	10½	2.75	110
5	0.90	36	11	2.93	117
5½	1.04	42	11½	3.15	126
6	1.18	47	12	3.35	134
6½	1.34	54			

This table was calculated for depths of water from one to twelve inches by one-half inch increments and for a weir width of one foot.

ELECTRICITY IN GRAIN ELEVATORS AT PORT ARTHUR AND FORT WILLIAM.*

By H. E. Stafford.

ELECTRIC power first came into the limelight in the grain elevator industry in Fort William, in 1902. It was first introduced by the Canadian Pacific Railway, which built a power house operated by steam, for the purpose of electrifying its numerous elevators. This company was the only one using electric power until the advent of the Kaministiquia Power Co., in 1905, which established a power house at the foot of Kakabeka Falls, 18 miles from Fort William, in June, 1905, and the first two units of 7,000 h.p. capacity were put into operation in December, 1906. A third unit of 7,000 h.p. was added in October, 1911, while a fourth unit of 13,000 h.p. was added in August, 1914, making a total of 27,000 h.p.

At this point the power is generated at 4,000 volts, and stepped up to 25 kv. It is transmitted at this voltage to sub-stations at Port Arthur and Fort William, where it is stepped down to 2,200 volts. The loss in transmission is approximately 3,000 volts. The sub-station at Fort William has, at present, three banks of three transformers with a capacity of 5,500 kv.a. for each bank. The station at Port Arthur has six transformers of 750 kv.a. each. The connections from power house to station are star-star, star-delta, with grounded neutral. Port Arthur has in addition, a hydro-electric plant at Current River with a total capacity of 2,500 kv.a., at 2,200 volts, which is used at the heaviest load period to keep down the peak.

Western Terminal Elevator.—This elevator is a recent type, and is the second in Fort William to purchase a power at 22 kv. The station was completed in August, 1914. The old plant which was built a few years ago is of concrete, with steel and tile cupola, while the tanks are tile. The new house, built in 1914, is of reinforced concrete throughout. The building is built on a foundation of piles driven sixty feet below cut-off. The piles are driven in blue clay, and are capable of standing a stress of between 16 and 20 tons per pile. The grain capacity of the elevator is 2,000,000 bushels. The power contracted for is 700 h.p. The plant is equipped with 56 motors of a total capacity of 1,140½ h.p. The motors are used for various purposes, some of which are given below.

There are two car-haul motors (one for each track) of 40 h.p. capacity each, capable of hauling 25 cars each. There are six receiving pits and three receiving legs with 22-inch buckets. Each leg is operated by a 75-h.p. motor. The distributing belt conveyers are operated by a 20-h.p. motor each, and the shipping belt conveyers are operated by a 15-h.p. motor each. The loading legs require from 60-h.p. to 75-h.p. motors each.

There are also seven cleaners and three cleaning legs. The cleaner legs take from 15 h.p. to 25 h.p. each, while the cleaners are operated by a 10-h.p. motor each. This plant is equipped with four flax machines, of 10-h.p. capacity each, and two special flax machines of 7½ h.p. each.

Two fans for collecting dust are operated by a 10-h.p. and 15-h.p. motor respectively, and the building is piped with compressed air supplied by a 4½ by 6-in. compressor for cleaning motors.

*From a paper to be presented at the 32nd Annual Convention of the American Institute of Electrical Engineers, Deer Park, Md., June 29, 1915.

The station equipment consists of three 250-kv.a. single-phase transformers. The connections are star-delta. The power factor is kept at 90 per cent. by two 125-kv.a. condensers. In addition there is a 30-kw. single-phase transformer for lighting purposes. The load factor is about 25 per cent.

Fort William Elevator Co.—This plant was built in 1913 and is of reinforced concrete with brick panelling. The plant, which has a grain capacity of 1,500,000 bushels, is operated by both steam and electric power. The boiler capacity (four boilers) is 500 h.p. The engine capacity is 800 h.p. These operate at a steam pressure of 120 lb.

The electric plant consists of a 300-h.p. marine engine direct connected to a 225-kw., 600-volt, 60-cycle, three-phase alternator supplying current to three 100-h.p. motors operating three shipping legs, four 15-h.p. motors operating four shipping conveyer belts, and one 20-h.p. motor operating a reversible conveyer belt.

The plant uses 2,000 tons of coal per annum at a cost of $4 per ton. Below is given the cost of operating the plant for one year.

Coal	$ 8,000.00
Oil	250.00
Waste	32.00
Packing	200.00
Wages	4,000.00
Total per annum	$12,482.00

This makes an average of $34.194 per day. Average load for 365 days = 300 h.p. Average cost per h.p. per annum = $41.606. As this plant also supplies steam for the drier, the actual cost is somewhat below this amount, the actual cost not being known.

The storage capacity of the plant is 48 tanks, each containing 27,000 bushels, and 35 intermediate tanks, each containing 7,000 bushels. There are six receiving pits capable of handling 12 cars or 13,200 bushels per hour. Also nine wheat cleaners and two flax cleaners of 1,000 bushels capacity per hour.

The shipping capacity is about 45,000 bushels per hour, and each conveyer belt of 15 h.p. capacity handles 20,000 bushels per hour. Two extra features of this plant are a separator, for separating various grains, and a drying plant. The capacity of the drier is 1,000 bushels per hour.

Consolidated Elevator.—The total grain capacity of this plant is 1,750,000 bushels. Power is delivered at 2,200 volts on a contract basis of 700 h.p. The average load is 600 h.p. The total number of motors is 37, ranging from 2 h.p. to 75 h.p., delivering 1,007 h.p.

The transformer station consists of 2,200 to 600-volt transformers, a synchronous condenser, necessary switch gear, and motors. All other characteristics correspond to the plants previously described.

Canadian Pacific Railway Co.—As before stated, the C.P.R. was the pioneer in the use of electric power for elevator purposes. This plant, which is the only one operated by this company in this city, has a total grain capacity of 8,000,000 bushels, and is the second largest plant in the world. The shipping capacity is 80,000 bushels per hour.

The company discontinued the use of its own power plant and purchased power from the Kaministiquia Power Co. in 1907. Power is purchased at 2,200 volts and stepped to 600 volts at its own transformer station. The transformer capacity is three single-phase, 588-kv.a., or a total of 1,764 kv.a. The power factor is maintained at 90 per cent. by a 750-kv.a. condenser. The total motor capacity is 2,100 h.p., while the average load is 1,400 h.p.

Canadian Northern Railway Elevator.—This plant is a double one; that is, there are two work houses with the storage tanks between. It has a storage capacity of 9,500,000 bushels and is the largest plant in the world. This plant was first started in 1900, and has been added to at various times, the last addition being made in 1913. Up to that time it was a steam plant throughout, but when the annex was built in 1913, a 200-kv.a. three-phase generator was installed to supply power for it alone.

The total engine capacity of the plant is 2,000 h.p. supplied by a 1,250-h.p. and a 750-h.p. unit. The coal consumption of this plant is 7,000 tons per annum, 950 tons of which are used in the driers. The average horsepower (steam) is about 1,700. The cost of producing power is 0.9 cent per kw.-hr. figured on a basis of 3½ lb. of coal per h.p.-hour. Statistics of this plant also show that the cost for one year was $22.56 per h.p. for steam power, which is an exceedingly low rate.

The average amount of grain handled in one year is 40,000,000 bushels.

In January, 1914, the elevator was remodelled, necessitating the installation of additional power. As the company was considering using electric power throughout in the near future, it was deemed advisable to erect a sub-station to accommodate the extra power needed, which could be enlarged as more power was required.

The transformer station is a separate building of brick and tile construction, and was built in 1913. The equipment was put in operation in April, 1914. Power is purchased from the City of Port Arthur at 22 kv. and stepped to 600 volts by three 150-kv.a. transformers connected to a six-panel board.

The total capacity of the switchgear is about 2,000 h.p. while the capacity of the transformers is only 450 kv.a. These, of course, can be added to at any time. The transformers are delta-delta connected. The station is protected by three electrolytic lightning arresters. The total motor capacity at present is 765 h.p., while the average load is 385 h.p.

Grand Trunk Pacific Elevator.—This elevator has a grain capacity of 5,750,000 bushels. The motor capacity is 1,800 h.p. It was the first in this district to purchase power at 22 kv., having contracted for it in 1909. The sub-station is large and roomy with a maximum of safety. The building is three stories high. The top-floor contains the choke coils, lightning arresters and high-tension switchgear. The arresters are the electrolytic type. The second floor contains the light and power transformers. There are three single-phase, 22-kv. to 600-volt transformers with a total capacity of 2,025 kv.a., and three lightning transformers of 60 kv.a. each. The ground floor is taken up with the condenser and switchboard. The condenser is self-starting and has a capacity of 750 kv.a. It draws about 800 amperes at starting, and takes about 1½ minutes to get it on the line. The switchgear and busses are mounted directly on the board. An extra feature of this station is a fire pump of 500 gallons per min. capacity, driven by a 50-h.p. motor.

The Horn Elevator.—This plant, better known as "King's Elevator," was built in 1883 and is the oldest elevator in this part of the country. This elevator, which is an exclusive cleaning and drying plant, is called a "hospital." The grain capacity is 800,000 bushels.

The plant is operated by steam, the boiler capacity being 1,200 h.p., while the engine capacity is 600 h.p. The excess boiler capacity is used in the drying process. The plant is equipped with seven driers with a total capacity of 20,000 bushels per day, with grain at 8 per cent. excess moisture.

Ogilvie Milling Co.—This company owns and operates an elevator in connection with its flour mill. The grain capacity of the elevator is 1,250,000 bushels, while the capacity of the mill is 3,000 bbl. per day.

The rated capacity of motors is 2,000 h.p. and the power is purchased on a 1,300-h.p. demand basis. Power is delivered to the plant at 2,200 volts and stepped to 600 volts. The milling machinery is connected to a lineshaft driven by an 800-h.p. motor, while the mill cleaning equipment is lineshaft connected to a 250-h.p. motor.

Summary.—The power applied to grain elevators, steam and electric, may be summarized as follows:—

Electric power (max. demand)—Total h.p., 14,412½; average h.p., 8,680.

Electric power (flat rate)—Total h.p., 495; average h.p., 475.

Steam power—Total h.p., 4,710; average h.p., 3,105.

Combined steam and electric—Total h.p., 1,165 (800 steam, 365 electric); average h.p., 300.

The total capacity of all terminal elevators is 42,090,000 bushels. The total capacity of prime movers is 19,982½ h.p. and the average power is 12,360 h.p. During the season of 1914, the total grain shipments from these terminals was 126,398,622 bushels.

There are two types of plants, public and private. A public plant is one in which the grain is handled on a percentage basis for any grower or grain company, while the private plant buys the grain outright and disposes of it to suit its needs.

The cost of handling grain is rather hard to figure. A plant may not handle the same amount of grain two years in succession. It may also be stated, that while the characteristics of these elevators as to major details are identical, the conditions under which they operate are at a variance. One plant handles 20,000,000 bushels of grain on 1,500 tons of coal at $4 per ton. Including the operating costs, the cost per bushel over a number of years was shown to be 0.057 cent per bushel. Another plant handled for one year, 30,000,000 bushels of grain on 675 kw. at a maximum demand charge of $10,492.44. This brought the cost per bushel down to 0.035 cent per bushel.

Another plant handled 500,000 bushels on 100 h.p. flat rate at $25 per h.p. or 0.05 cent per bushel. This plant handled 40,000,000 bushels on 7,000 tons of coal, which, with the operating expenses, brought the price to 0.042 cent per bushel.

This information, while authentic for the period mentioned, can hardly be called an average.

RECORD SPEED IN FILLING OVER-SEAS ORDER.

The equipment for the Over-Seas Construction Corps in Europe, commanded by Major C. W. P. Ramsey, includes an order from M. Beatty and Sons, Welland, for five carloads of material-handling machinery, made up of hoisting engines, derrick irons, turntables, centrifugal pumps and clamshell buckets. This order, from the War Purchasing Commission, was received by the company on May 29th, and goods went forward knocked down and packed for ocean shipment on Tuesday, June 1st.

DEVICES FOR MEASUREMENT OF SEWAGE FLOW.

When designing new parts of sewerage systems, such as treatment works, relief or intercepting sewers, it is important to be able to compute, within a few degrees of approximation, the flow of sewage in the existing mains. Sewer gauging has other uses as well, and has come to be, in fact, a very necessary part of system maintenance work. There are various methods and devices in use, some of them simple and inexpensive and others rather complicated. Some of the measures adopted in several cities in United States were described in the Journal of the Boston Society of Civil Engineers, a few months ago. A description of the recording gauge which the State Board of Health of Massachusetts has been using is described by Mr. Ed. Wright, Jr., as follows:

The gauge is used mainly for measuring sewage at disposal works where the sewage passes over a weir, although it has been used somewhat in the measurement of stream flow and in the measurement of the flow of trades wastes where it is possible to install weirs. It consists of a copper float to which a rod and pencil are attached (Fig. 1) and a cylindrical drum, which is caused to revolve by an ordinary clock mechanism. The float rod engages

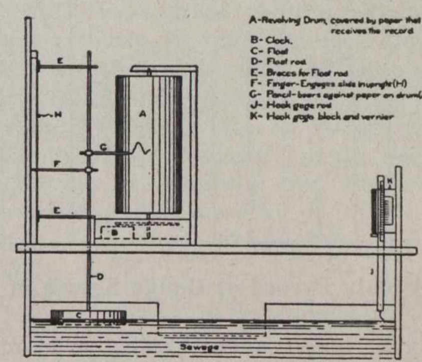


Fig. 1.—Automatic Gauge Used by Massachusetts State Board of Health for Recording Heads on Weirs in Measuring Sewage Flow.

in two brackets which are provided with roller bearings. The paper upon which the diagram is indicated is wrapped around the drum and held in place by pins at the top and bottom and by rubber bands, and the elevation of the starting point in relation to the crest of the weir is obtained by means of a hook gauge. The actual head on the weir is indicated.

The moving parts are constructed of brass, and while corrosion starts in very rapidly, the gauge is so constructed that little or no difficulty ensues from this cause in its operation. The clock is so constructed as to run seven or eight days, and except when weather conditions interfere, the gauge will run without attention for this length of time.

Owing to the great amount of moisture which at times rises from the sewage in the tanks where the gauge has been used, it has been found that it was impossible to produce a pen-and-ink diagram, and, in fact, the moisture rising at certain sewage disposal works has been so great that the paper would be torn by the pencil, and to overcome this the best quality of paper has been used.

The gauge is very sensitive and, in fact, the effect of matters rising with gas in the sewage in the measuring tanks under the float has frequently been indicated. The greatest cause for inaccuracy is due to the floating matters in the sewage, which displace the float and tend to clog the weir.

The diagram (Fig. 2) was obtained from a measuring tank to which sewage was conveyed in a system which admitted large quantities of ground water and probably some surface water, and the high heads indicated on the weir on the 22nd are accounted for by a heavy precipitation which occurred at a time when a large portion of the winter's snow was melting.

Another apparatus, described by F. A. Marston and in use at Marlboro, Mass., involves the use of a trapezoidal or Cippoletti weir, placed in a channel leading to the sedimentation tanks. The sewage enters the screen chamber through a long cast-iron pipe siphon, passes through a coarse bar screen, and along a channel 7 ft. wide, to the trapezoidal weir, as shown in Fig. 3. The crest of this weir is 2 ft. long and the sides have a batter of 1 in 4. The crest of the weir is set 18 ins. above the floor of the channel. The weir itself is made up of 6-in. by 3½-in. by ½-in. steel angles bolted together and set in concrete. The inner edge or crest is planed to a true, sharp edge. The depth of flow over the weir is measured

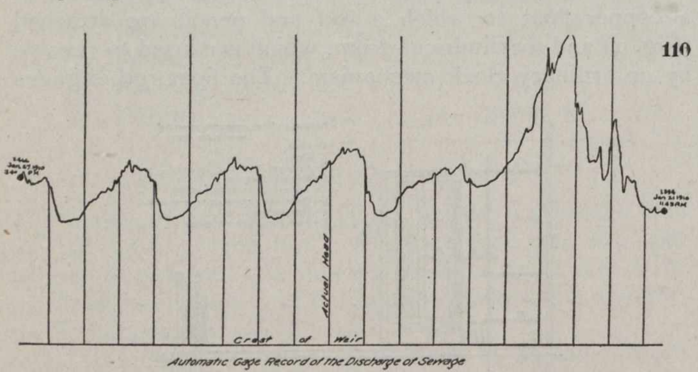


Fig. 2.—Weekly Record of Gauge Shown in Fig. 1.

either directly by hook gauge or rule, or by means of a recording gauge of the Bristol type.

The original plan provided a cast-iron pipe well, with connection to the channel a few feet above the weir, in which the diaphragm was suspended. The recording gauge was fastened to the wall of the screen house. After operating the plant for several months it was found that considerable sludge and scum collected in the diaphragm well and proved to be objectionable, although it may not have had any serious effect on the diaphragm or on the operation of the recording gauge. Because of this collection of scum the diaphragm was removed from the well and was suspended in the channel itself, which arrangement has proved more satisfactory.

The average depth of flow is obtained from the circular chart by the use of a circular planimeter, and the quantity discharged by the trapezoidal weir is computed from the following formula:

$$Q = 3.366\tfrac{2}{3}\, L\, h^{3/2}.$$

Q = quantity in cu. ft. per second.
L = length of crest of weir = 2 ft.
h = head on crest in feet.

There was considered, in the design of the plant, the possibility of using a Venturi meter or some other form of measuring apparatus which would obviate the necessity of constructing an open channel with its attendant difficulties due to the deposition of solid matter, but it was felt that the city would not be justified in going to additional expense for this purpose.

The trapezoidal form of weir was chosen because of the great variation in flow to be measured. During dry weather single daily flows have been recorded as low as 150,000 gallons per twenty-four hours, and during the spring flow has reached as high as 2,300,000 gals. per twenty-four hours for a single day.

In studying the operation of the plant, it was found desirable to know the number of doses discharged by the automatic siphon from the dosing tank each day, and to obtain this information another gauge was installed in the dosing tank. The charts from it show the rise and fall of the sewage level in the dosing tank, and are used not only as a check on the quantity of sewage, but especially to determine the quantity applied to the various filter beds.

From the beginning of the operation of the recording gauge in the screen chamber, the attendant has kept daily readings of the depth of flow over the weir, measured directly at a point a short distance above the weir. The attendant was instructed to take these measurements at approximately 4 o'clock each afternoon, and from the data thus obtained it has been possible to check the readings of the recording gauge and to fill in the records for the periods that the gauge was out of commission.

Another recording apparatus is described by F. B. Sanborn. It is used in the City of Providence, R.I. The flow of sewage is about 24,000,000 gals. per day, about one tenth of which comes from a gravity system, the remainder being lifted 27 ft. at a point about 2,000 ft. from the disposal works.

The pumping plant consists of three Holly engines, each of which is connected with two centrifugal pumps, whose combined capacity is 43 million gallons per day.

The large size of these units necessitates a system of intermittent pumping during periods of small flow, as at night, or on Sunday, the sewage at such times being allowed to rise to a certain height in the large sewer leading to the pumping station, when the pumps are started, and operated until a certain low level is reached.

The discharge from the pumps, together with that from the gravity system, flows through an 88-in. conduit into a semi-circular open mixing channel, 150 ft. long and 16 ft. wide. In this channel are placed 20 slate baffles, set 6 ft. apart on alternate sides, and projecting 6 ins. beyond the centre line of the channel. From this channel the sewage flows directly to the four large sedimentation tanks.

Briefly, the conditions to be met were as follows:

The location of the weir was limited to the mixing channel, in which the baffles caused a very great agitation of the sewage.

The weir must be higher than the level of the sewage in the tanks, to be independent of variations in the method of operation.

It must be as low as possible, to avoid increasing the work of the pumps.

The opening of the weir must be sufficient to accommodate a flow of 120 million gallons per day.

The recording device must give an accurate record of the flow, without being so delicate as to be disturbed by momentary variations in height, due to currents in the mixing channel.

Owing to the sudden fluctuations caused by starting and stopping the pumps, the chart must be in terms of volume rather than of height, so that the total flow per day could be determined by the use of the planimeter.

Since the weir would not correspond to the requirements of any formula, the actual flow must be determined by experiment.

A location was chosen at the last baffle in the mixing channel, and a 10-ft. rectangular weir was placed at this point, having its crest 9 ins. above the level of the sewage in the tanks, and 1 in. above the top of the baffle. By placing the weir at this location and height, no change was made in the conditions at the mouth of the 88-in. conduit leading from the pumps. At a point 12 ft. upstream a 3-in. pipe was built into the wall of the channel, 3 ins. lower than the crest of the weir. This pipe was carried into a large manhole, and another pipe was laid from the manhole to a 12-in. standpipe. The large amount of water in the manhole prevented the making of a wide line on the chart, due to momentary fluctuations in height.

The weir was then calibrated by experiment, the flow being measured in the various tanks of the plant, while observations were made of the height at the weir.

The recording instrument selected was the weir-gauge made by the Hydro Manufacturing Company of Philadelphia. This instrument was intended to record height directly, and in order to get a record in terms of volume, the usual device was employed, of introducing, between

Fig. 3.

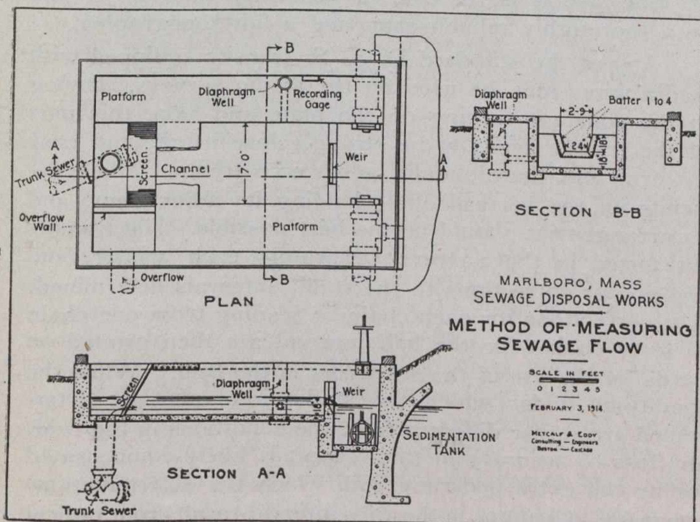


Fig. 3.—Arrangement of Apparatus in Use at Marlboro, Mass.

the float and the recording pen, a cam or spiral which should be designed according to the formula for this weir. An 8-in. float was placed in the standpipe, and connected by a cord to a counter-weighted drum, having a diameter of 5 ins.

On one end of this drum was fastened a sheet-iron disk, 30 ins. in diameter, and on the surface of this disk, raised on blocks ½ in. high, was placed a brass track, whose curve was such that the distance from the centre increased one-tenth of an inch for each million-gallon increase in the rate of flow.

On this track was made to travel a small wheel, whose axle was attached to the lower end of a vertical rod, on the upper end of which was fastened the pen-carriage of the recording device.

The drainage of Cobalt Lake has been completed, and mining operations beneath the lake bed can now proceed. This drainage project and the manner of supplying the concentrating mills with water from other sources was fully described in *The Canadian Engineer* in the issue of May 20th, 1915.

STADIA SURVEYS.*

By Rupert Neelands, D.L.S.

IN the first subdivision of the western townships, lakes smaller than twenty acres were not traversed, and marshy lakes with a shore line subject to variations of ten chains or more were dealt with by showing the legal subdivisions rendered worthless for farming.

Many changes in the size and character of the lakes in the West occurred from year to year, due to periodic variations in the climate, the cultivation of the ground, the clearing off of bush, and the diversion of the flow of springs and creeks. Many so-called lakes were merely shallow depressions filled with surface water, and these dried up wholly or in part. Others increased in size and depth, lakes of two hundred acres and upwards being found where at the time of the original survey there were only a few small ponds. In other lakes an increase in area due to the attrition of the bank was accompanied by a corresponding decrease in depth. In some cases marshy sloughs became small lakes, and open lakes became hay marshes.

As the land grew more valuable and the rate of taxation increased, many complaints were made by settlers who, having from five to fifty acres of water on their homesteads, were taxed for the full one hundred and sixty acres shown in their patent. Others desired to secure patents to land formed by the drying up of lakes, or to land formerly shown as being included in marshes worthless for farming. As patents were secured and sales of land became common, the presence of a body or bodies of water of unknown area hindered the sale of the land on which they were located.

To ascertain the area of these hitherto unsurveyed lakes, to revise former surveys where there had been a change in the outlines of the lakes or rivers, or in the character of the lakes, and to obtain this information quickly and at a moderate cost, is the purpose of the stadia surveys now in their second season.

The extent of the work of the stadia surveyors is a complete investigation of all bodies of water in the township. All rivers of one chain in width and upwards, all permanent lakes of five acres in area and upwards, and all islands are surveyed. All sloughs, marshes, bogs and muskegs are investigated, reported on, and, if necessary, surveyed. When in such investigation it is found that a section or quarter-section corner formerly left unmarked because of water, is now on dry land, the proper monument is erected at such corner and the witness monument, if any, is destroyed. A chain is used in measuring distances instead of a stadia rod in any resurveys necessary in this connection. The general condition of the monuments in the township is investigated and reported on, and if a resurvey is considered necessary, a petition for it is circulated among the settlers for their signatures if such resurvey is desired by them. Observations are taken in each township for magnetic declination.

Any changes or inaccuracies in the topography of the township, as shown on the original township plan, such as the correctness of the descriptive note, the diversion or disuse of old trails or the drying up or diversion of creeks are noted for correction. The pro-

*From a paper read at the annual meeting in January, 1915, of the Dominion Land Surveyors' Association, Ottawa, Ont.

gress and condition of the settlers and the resources of the township are also noted.

The personnel of a stadia survey party consists of, in addition to the surveyor, an articled pupil, two rodmen and a cook. For transport, two teams with light wagons and a collapsible canvas boat are provided. In open prairie townships one wagon may profitably be exchanged for a democrat. Both oars and paddles are provided for the canvas boat. Oars are generally found more satisfactory, as these boats, presenting a large surface to the wind and riding light on the water, are hard to manage with one man only, paddling, if there is any wind. The canvas boat if in use every day, and on lakes, the most of which are alkaline, will not last through one season without the exercise of considerable care and much repairing. Holes are closed with patches of duck, the seams being rubbed with wax. If the lakes or rivers on which the boat is being used are rocky and gravelly, the keel should be protected with patches of duck or tin from the first, as this part is difficult to repair and make water-tight once it is worn through, as it soon will be if not protected.

In reedy lakes it is difficult to use a canvas boat, and time will be saved by taking sounding by wading if the water is not too deep and the bottom is not too soft. The water in lakes completely covered with reeds is seldom over five feet deep.

The stadia traverse is commenced from a section or quarter-section corner, the transit being set up to read the bearing of the meridian or chord shown on the township plan. If the bearing cannot be obtained from the section lines, the instrument is oriented by means of the compass, the azimuth of magnetic north having been previously ascertained by the surveyor. When the compass is used to orient the instrument, an astronomical observation, either solar or stellar, is taken when the weather is favorable. If an observation is not taken the traverse is continued until it closes upon another section or quarter-section corner.

The needles supplied are sensitive and accurate, and on the prairie it is seldom that the compass bearing differs by more than two or three minutes from the bearing by observation, unless there is local attraction, such as wire fences or telephone wires.

In any case, as many ties as possible are made to adjacent monuments, and a tie must be made in at least every three miles.

In producing the traverse towards the lake, it is important that the stations should be carefully located. The majority of the lakes in the western townships can be traversed from one station if the lake is carefully approached and the final station well placed. Economy of stations can only be practised in the approach to the lake if the topography of the surrounding country is well understood. In Northern Saskatchewan and Alberta, lakes generally lie in chains or groups, and here the selection of the stations so that no lakes may be missed, and no time lost, is a more difficult matter. Unless the front rodman is an unusually good topographer, it is best that the surveyor should reconnoitre the ground and lay out the stations himself. A general reconnaisance before the close of the day's work of the ground over which it is proposed to run the next day's traverse should be made, if possible, in order to determine the amount of water and the best direction for running the traverse, taking into consideration the location of ridges and ravines, and in timber, of clearings and openings in the bush, and the direction of old logging roads and trails, or any other natural advantages that will save cutting.

In no other way can so much time be saved or lost in stadia traversing as in the placing of the traverse stations. The rear rodman gives backsights at the instrument stations. He also looks after the horses, and if the nature of the country permits, brings them up with him when he goes ahead. It is also his duty to take the necessary soundings, either from the canvas boat, with a lead and plumb-line, or in the case of shallow lakes, by wading out with a graduated staff. His stadia rod should not be used in either of these cases for taking soundings. In the case of large lakes, he may help the front rodman by giving side shots as he advances towards the transit, or if the lake is traversed from one station, he may proceed around it in the opposite direction to that taken by the front rodman. On some occasions, too, he may go ahead and put in the next station while the front rodman is completing the traverse of the outline of the lake. The two rodmen, if of equal intelligence, may thus be allowed to alternate in their positions. The rear rodman, while driving the team, may also investigate the surrounding country for more lakes. In this case it is, of course, necessary that he should be a thoroughly reliable man and a fair topographer.

Any of the standard D. L. S. transits equipped with stadia wires may be used on the stadia surveys. Owing to the constant turning on the plate and axis, this part of the transit needs to be strong, close fitting, and easy to turn, and there should be no eccentricity. Much depends on the vertical circle holding its adjustment, and its arrangement should be the best possible. The transits are tested in the Surveys Laboratory each winter, and the proper corrections to the stadia intervals determined. The corrections for each chain of reading from one chain to forty chains for the half interval are then printed on cards for the use of the surveyors in the field. While the conditions under which the stadia intervals are determined are rather different from the conditions in the field, any loss of accuracy in this respect is likely compensated for by the extra accuracy with which the determinations are made. Changes in the wire interval result from radical changes in the climate or seasons, as well as from physical changes in the wires themselves. Intervals should be tested every few months on a carefully measured base.

The standard stadia rod has been improved by having the hinges strengthened and by having a metal strap placed at the back. The level bubble, too, has been much improved and the color used in graduating the rod has been brightened. The rods are fourteen feet long, and are graduated to read in chains and tens of links, a total distance of forty-two chains, each group of ten being a different color.

In reading a rod the chains and tens of links are counted and the fraction of ten links estimated. All the wires are read for precision and accuracy. The whole reading, being twice as accurate as the half readings, is always read up to distances of twenty chains, if possible. The slope of ground, and intervening reeds, grass, branches and leaves of trees often prevent the reading of the whole interval for distances less than twenty chains. The upper and lower interval reading should agree when reduced, and their sum should be equal to the reading with the whole interval. Where there is a difference between the upper and lower interval readings, the upper is preferable as there is less interference from refraction, which is greatest in the strata of air next to the ground, traversed by the lower line of sight, than it is in the strata a few feet above traversed by the upper line of sight. This causes a difference between the actual rod-reading to a reading in a perfectly homogeneous atmosphere. The reading varies during the day, the rod intercept being least at mid-day and greatest in the morning and evening.

The stadia field books are specially prepared for the work. At the top of the left-hand page, blanks are left for the date of the survey, and for giving the location of the lake. The remainder of the page is ruled into columns. In the first column is entered the designation of the point sighted on, numbers being used for stations and letters for side shots. The stadia interval read on the rod is put in the second column, the bearing in the third, the vertical angle in the fourth, and in the fifth column the corrected distances are entered. The rest of the page is left for remarks. The right-hand page is ruled in cross-section on a scale of ten chains to an inch, and is used for making sketches or rough plots of the body of water being traversed. The column of corrected distances is entered up at night, if there is not sufficient time in the field. Corrections for the stadia intervals are taken from the cards supplied by the Department. Distances read on the slope when the vertical angle exceeds 1° 30′ for station courses, and 3° for side shots are reduced to the correct horizontal distance by means of the stadia slide rule.

After the proper corrections and entries have been made in the field books, the traverse is plotted on specially prepared drawing paper. This is a smooth, heavy paper, cross-sectioned on one side on a scale of ten chains to an inch, and with horizontal parallel lines on the other, spaced one chain apart. The traverse is plotted on a scale of ten chains to the inch and the plotting is done by means of the stadia protractor, which is a semicircle of celluloid, having bearings marked from 0° to 180°, and in the same direction from 180° to 360°. There is a pin-hole in the centre of the circle, and the straight edge of the protractor has a scale of ten chains to the inch reading both ways from the centre to 43 chains.

The allowable closing error in a traverse is 1½ per cent. on the surveyor's own work, and 5 per cent. when closing on a section or quarter-section corner.

The stations are first plotted and the closing error, is not in excess of the above mentioned limit, is then distributed among the courses of the traverses.

In plotting the side shots the protractor is pinned by a fine needle to the corrected position of the station, the north and south points are marked, and the various recorded bearings are turned off, and at the same time the corresponding corrected distances are scaled off on the straight edge of the protractor. The outline of the lake in this way can be rapidly and accurately plotted.

It is necessary that the traverse should be plotted before leaving the locality in which it was made so that any mistakes or errors found may be corrected.

A full description is given in the field book, at each instrumental station of the lake, the lake shore, and the surrounding country, and at the end of the traverse notes a complete general description is given of the character and topography of the lake.

These descriptive notes form a basis for the classification of the lake into one of five general classes. These are:—

1st—Lakes that have entirely dried up.

2nd—Shallow lakes likely to dry up.

3rd—Lakes which do not dry up, but which have shore lines subject to large variation—say, 10 to 20 chains.

4th—Lakes which do not dry up, but which have shore lines subject to moderate variations—say, 5 to 15 chains.

5th—Lakes whose shore lines do not change. This class includes deep, permanent lakes with well defined shores.

These different classes are treated in different ways in compiling the township plans. No deduction of area is allowed for class 1 and 2 lakes. Class 3 and 4 are dealt with by selecting the aliquot parts of legal subdivisions which more nearly include the land more or less permanently covered by water. In class 5 lakes the areas are taken to the bank of the lake.

The accuracy of these stadia surveys is highly satisfactory, and is more than sufficient for the purpose in view, namely, the determination of the water areas. Errors of 1 per cent. in closing a traverse, even under unfavorable conditions, are rare. An extreme degree of accuracy that requires a slower rate of work is not desired in this class of survey. However, if conditions are favorable, the closing error in a long traverse is generally less than 1 in 1,000. The error in closing on section corners is seldom over 2 per cent., and is generally under 1 per cent. High closing errors are generally due to mistakes in the original survey. In townships recently subdivided, or in which resurveys have been made, the closing errors are usually small.

Under favorable conditions, a distance of half a mile can be read accurately to a fraction of ten links. Long courses give the best results, and short courses should be avoided as much as possible. Within the half-mile limit, the allowable distance for accurate reading depends on the conditions under which the reading is made. Forty chains may be read more accurately at some times than fifteen chains at others.

On bright days the rod cannot be read accurately against the sun for any distance. This distance is, of course, much shorter when looking across water than in looking across land. This should be carefully kept in mind in directing the course of the traverse. If possible, a lake should be approached from the south-east in the morning, and from the south-west in the afternoon. The side shots may then be read with the sun shining on the surface of the rod.

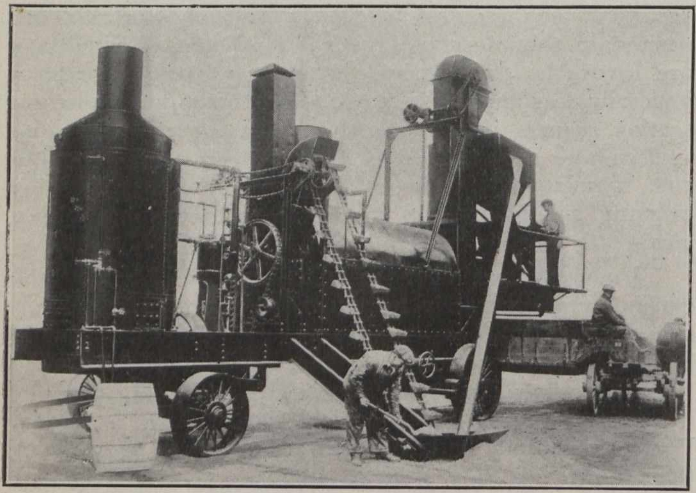
The main hindrance to accurate reading is "boiling," or heat waves in the atmosphere. When this is extreme, the rod, even at as short a distance as ten chains, has the appearance of an attenuated barber's pole, and it is impossible to get an accurate reading on either foresight or backsight.

Another common difficulty is "floating" or "dancing." Here the image of the rod, although clearly defined, floats in the object glass so that the stadia hairs cannot be fixed long enough to get an accurate reading. This is most common when looking across water. High winds spoil the accuracy of the readings, and wind storms on the open prairie are sometimes so violent that it is impossible to read the rod at all. Long readings taken with the sky as a background, or with a very dark back-ground, such as a sheltered bushy bay, are inaccurate. The greatest natural difficulties are high reeds on a soft mud bottom, and dense overhanging bush, and when these are found combined on the same lake, the mileage made that day will be small. The transit should be set up as far out from tht shore as possible, and the rodman, if unable to hold the rod steady in the air should support it on stakes. They should also wear a hat or shirt of some non-neutral color, as otherwise considerable time is often lost in locating the rod.

NEW PORTABLE ASPHALT MIXING PLANT.

A new portable asphalt mixing plant having a number of distinctive features has just been put on the market by the Iroquois works of The Barber Asphalt Paving Company, Buffalo. For a plant of its size and cost it is unusual in having a minimum capacity of 800 square yards of two-inch sheet asphalt topping per day of ten hours. The capacity for asphaltic concrete, Topeka mix, or asphalt macadam is much larger.

The mixing platform of the plant is so elevated that a wagon can be driven under it to receive the load from the mixer without elevating the plant on its wheels or excavating for this purpose. The platform is arranged



for one-man operation, the levers for controlling clutches and plant being within easy reach. The mixer is a two-shaft, pug-mill type, with removable side and end liners; provided with two full sets of blades, the binder blades being solid manganese. The sand-measuring box and asphalt bucket are supported on scales. A drying drum of special construction has been designed for this plant to obviate the difficulties so often encountered in heating a sufficient amount of sand and stone. Features that count in the economical up-keep of such plants as this are the removable steel wearing plates in the material chutes, and chilled rims for all chain sprockets.

As illustrated, the plant would be operated as two units, the second unit being the asphalt kettle. The mixing plant is also supplied, however, without boiler and engine. In other words, the contractor or municipality already provided with portable boiler, engine and kettles, can secure the mixing plant without making an additional investment for these units.

The plant is designed especially to meet the requirements of contractors and municipalities having new construction and maintenance work to perform in scattered territory, or in an amount insufficient to make a stationary plant economical.

During five years the total gold production of Porcupine, Ontario, has been $11,271,511, of which nearly one-half was produced in 1914, when the production reached a value of $5,203,229.

HOW A FAST OCEAN LINER CAN BE TORPEDOED.

By C. O. Thomas.

BEFORE the occurrence of the "Lusitania" atrocity, it was popularly supposed that a ship of the "Lusitania's" speed could not be sunk by a submarine. That this is not the case is now painfully apparent, but it can also be shown by a little calculation that high-speed ships are not at all immune from attack by a submarine boat.

Take the case of the "Lusitania," and give her the benefit of her full speed of 26 knots an hour. Assume the sea speed of the submarine, when submerged, to be 12 knots an hour, and let her periscope be just clear of the surface of the water. Taking the height of the "Lusitania's" funnels above the water line to be 130 ft., and allowing for the curvature of the earth and refraction, the submarine will sight the tops of the liner's funnels above the horizon at a distance of about 15 miles on a clear day. The speeds of 26 and 12 knots of the two vessels are equal to 30 and 13.8 miles an hour respectively. The distance the torpedo travels after being fired, being comparatively very small, may be neglected, and it is also practically offset by the great length of the liner.

In the diagram, let *A* be the position of the "Lusitania" when sighted by the submarine at *B*, and suppose the line *A C* to represent the intended course of the liner. The question is, what is the effective striking radius from

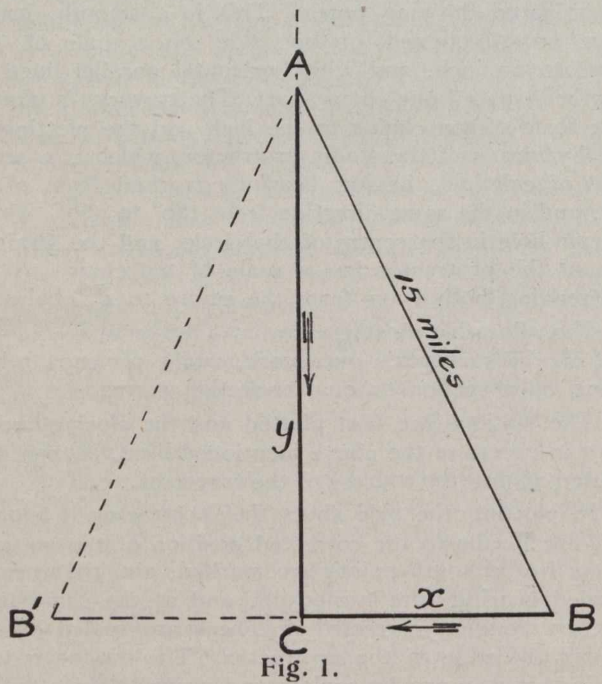


Fig. 1.

the position in which the submarine first sights the "Lusitania"? In other words, how far off the latter's course can the submarine stand by and still be able to effect her purpose? For this distance to be a maximum, *B C* must be at right angles to *A C*, and to find the position of the point *C*, since *A B* is known, and the distances *A C* and *B C* are proportional to the respective speeds of the two vessels, we have the simultaneous equations:—

$$\frac{x}{y} = \frac{13.8}{30}$$

$$x^2 + y^2 = 15^2$$

in which x and y represent *B C* and *A C*.

These equations give $BC = 6.27$ miles, and $AC = 13.6$ miles. In the same period of time, therefore, i.e., in slightly more than 27 minutes, the "Lusitania" and the submarine travel from A and B respectively to C, where the liner is torpedoed. The point B' represents an alternative position for the submarine, or for another one, in which case the distance between the two would be, roughly, 12.5 miles. As the minimum distance between the coasts of Ireland and South Wales is only 50 miles, it follows from the above that five submarines could effectively block the passage of St. George's Channel.

TREATMENT OF SEWAGE SLUDGE

A VERY interesting and comprehensive treatise on the methods of treatment of sewage sludge was the paper read by Professor P. Gillespie, of the University of Toronto, at a meeting of the Canadian Society of Civil Engineers in Montreal last December. The paper is a valuable resumé of the numerous processes involved in the treatment of sewage, with descriptions of typical plants in Europe and America. A summary of it appeared in *The Canadian Engineer* for December 24th, 1914, but the recently issued Transactions of the Society (Vol. 28, Pt. 2) contains the paper in full, with a very complete collection of illustrations, and an instructive discussion by Mr. R. O. Wynne-Roberts, which discussion we present in part as follows:

At present, sludge is derived from three sources: Degrossirs, tanks, and filters. Degrossirs include detritus pits or grit chambers, screens, float chambers and pump wells.

Detritus Chambers.—Mr. Gillespie states that detritus chambers are usually omitted in the case of separate systems. Separate systems, however, must receive a certain amount of water from yards and some grit will thereby be carried to the works. In the aggregate the quantity of grit will be appreciable and should be intercepted as it has a harmful effect on pumps, and also its specific gravity tends to cause it to remain in the tanks and retard the sliding of sludge. It is essential that the total capacity of the detritus chambers should be adequate to provide a velocity of one foot per second or less, and provision should be made to avoid scouring in the detritus chamber at times of maximum flow.

Screens.—Mr. Gillespie refers to screens which are kept clear by hand raking. There are many screens which are kept clear by rakes operated by undershot water wheels and other devices, and are operated in proportion to the flow of sewage. These screens obviate the constant employment of manual labor. Tanks will perform the work more cheaply than screens. Where sewage disposal is by dilution, fine screens are desirable to remove the particles which would otherwise float and be obnoxious to the eye, but so far as putrescibility is concerned they do not effect much change.

Flotation Chambers or Flotage.—When sewer outlets are enlarged, the velocity of flow of the sewage is reduced, and particles lighter than water will float. If baffle plates, scum boards, and suitable sloping screens are installed, the floating matter can be skimmed off the water surface.

Tanks.—It is submitted that the primary functions of tanks are: Degreasing; sedimentation of sludge, with due regard to economy; flocculation of colloidal matter and clarification of tank liquor; fermentation of sludge; disposal of sludge.

Degreasing.—Whatever process is adopted for the ultimate disposal of sludge, grease constitutes the bête noir of every sewage works' manager. The manurial value of sludge is reduced by the presence of fatty matters, because vegetation cannot assimilate them, and the soil will sooner or later become sick. Pressing, drying and other methods of removing the moisture in sludge are rendered difficult and expensive owing to greasy substances. Prof. Gillespie has described the Kremer apparatus, which is intended to act as a grease trap; there are other devices for the same purpose.

Sedimentation.—Sedimentation is controlled more by the period of detention than by the velocity of flow. The efficiency of the process depends somewhat upon the character and freshness of the sewage, and dilution appears to retard this action. Even the best designed tank will not eliminate all the settling solids, neither will it remove more than a very little of the colloidal matter.

Flocculation of Colloidal Matter and Clarification of the Tank Liquor.—The colloidal matter passes out of the tank and is oxidized in the filters, whereby its physical condition is changed. Fowler and Mumford expressed as their opinion that the cost and area of filters depended mainly upon the amount of colloidal matter in the sewage. As colloids are about 30 per cent. to 50 per cent. of the solids present, the duty imposed upon the filters is an important one.

Experiments having for their object the production of a clear, stable effluent without treatment by the usual filtration processes have already met with considerable success. At Manchester, Dr. Fowler and Mr. E. M. Mumford have found that by inoculating the settled sewage with a certain organism, adding a small dose of ferric salt to it and blowing air through it, a clear, stable effluent was secured, after precipitation of the coagulated matter.

Another interesting development is the result of an investigation by Messrs. Arden and Lockett, conducted at the Manchester sewage works, the results of which were published in April, 1914. A sample of sewage was placed in a two-quart bottle and aerated by means of a laboratory filter pump for five weeks, at the end of which time complete oxidation and nitrification had developed. The clear supernatant water was drawn off and the activated sludge applied to a fresh sample of sewage. This operation was repeated several times with the result that the quantity of sludge was increased and the time required for nitrification was gradually reduced, so long as the sewage was maintained slightly alkaline, this being an essential condition. It was found that to obtain the best results, the activated sludge had to be intimately mixed with the fresh sewage by blowing in air. In all these experiments, the volume of added sludge was one part to four parts of sewage. Judged by the accepted standards for satisfactory effluents, the results were particularly good.

In a more recent paper, Mr. W. H. Duckworth, of Salford, gives the results of experiments on a larger scale (130,000 gallons per day), with the activated sludge process. On the average of 25 samples, there was a reduction of 76 per cent. in the albuminoid ammonia, 90 per cent. in the four-hour oxygen absorption test, and the dissolved oxygen increased 0.46 parts per 100,000.

The action of the cultivated sludge is summed up as follows: (1) A quick flocculation of the colloidal matter; (2) a carbonaceous fermentation which reduces the figure for oxygen absorbed; (3) a breaking up of the albuminoid ammonia content with quick oxidation of this nitrogenous matter.

Continuous flow experiments are now in hand, but no results have as yet been published. This sludge is stated to contain three times as much nitrogen and twice as much phosphoric acid as ordinary sewage and only half as much fatty matter.

Mr. Edward Ardern, in a paper on this subject, stated that he believed that the reaction involved was similar to that in the best type of perco-filters. He obtained better results by introducing the air into the sewage through porous blocks or tiles than by blowing it in through pipes, and found that with the temperature constantly below 50° F., the purification was seriously diminished. It appears desirable to maintain a temperature of about 68° F., as this greatly facilitates nitrification. The quantity of air required for the process is stated to be about 0.20 cu. ft. per minute for each square foot of tank area.

Reduction of Sludge.—Mr. Gillespie has dealt very fully with the sedimentation of sewage and the reduction of sludge in the Emscher tank. Drs. Thumm and Reichle, of the Royal National Institute of Hygiene, of Berlin, reported on the separation of sludge, and it is interesting to note that in this connection they pointed out the advantages of separate sludge digesting chambers. They even recommended that earth ponds with large free surfaces might be thus used. Separate chambers are stated by them to be advantageous, as they afford a complete separation of the sedimentation tanks from the sludge tanks; they are easily enlarged, very accessible, easily inspected, the decomposition can be controlled to any extent, and in some cases the cost will be less.

Filters.—Before discussing the question of the disposal of sludge, it will be well to bear in mind that about one-half the suspended matter in sewage is carried to the filters in the tank effluent. Messrs. Fowler and Mumford expressed the opinion that filters are expected to do two things, *viz.*: (1) To oxidize, granulate and finally discharge as humus, colloidal matter, for which work an open grain deep filter is considered the most economical. (2) To oxidize and nitrify substances in true solution, for which process a shallow, fine grain filter is most favored on the score of economy.

There is much to be written on the subject of filtration, but this is not the topic under consideration.

Disposal of Sludge.—After the sludge is eliminated and digested, the next problem—which in many places is the most difficult—is to satisfactorily dispose of it. Its manurial value depends upon the proportion of nitrogen, phosphoric acid and potash compared with other manures, its price, and the extent to which it has been degreased and dehydrated. Sludge is charged with varying quantities of fatty matters, which are difficult and costly to treat. There are some processes which are in actual use for removing grease and drying the sludge, which have not been mentioned by Mr. Gillespie.

Sludge obtained by the activated sludge process is said to be different from that produced by ordinary tank treatment. It is quite flocculent and inoffensive in character, has a low specific gravity, and rarely contains less than 95 per cent. of moisture. It can be readily drained on fine grain filters, leaving a stiff jelly-like residue.

At Oldham (population 147,000) sewage works, the sludge is treated by Dr. Grossman's patent method, which involves concentration by settlement in special tanks, after which it is dried and treated with superheated steam and sulphuric acid to absorb the grease, which is recovered by condensing the vapor, and is sold to soap makers. The solids are sold for manure. The process and the by-products are said to be inoffensive, and the cost of operation is covered by the revenue from sales.

At Norwich, England, the sludge is first treated by the Eckenburg wet carbonizing process, then pressed, dried, and the grease recovered by the use of benzine as a solvent. After the benzine is distilled off, the grease is refined and sold, and the residue is also sold for fertilizer.

The Kremer apparatus is claimed to be able to remove 30 per cent. to 70 per cent. of the sludge and grease. At Frankfort the amount of grease averages 3.58 kg. per inhabitant per annum. At the Boston, Mass., sewage works, experiments show that by the use of sulphur dioxide the grease is cracked or coagulated and so made recoverable much more completely than in any other way. The effluent from the treatment is practically odorless and sterile.

The S.O.S. method, as applied at Wimbledon, England, consists of the use of fine carbon instead of lime for precipitating sludge and pressing. The carbon is obtained by carbonizing the sludge.

In the Degener lignite process, as used at Potsdam, Spandau, etc., the pressed and dried sludge is burned under boilers.

Drying sludge is done by: Use of drying beds; pressing; heating; fermentation, as in the yeast process at Dublin and the compost process of Germany and Holland; separation, as in the electro-osmose process; mixing with absorbent; centrifuging.

The disposal of sludge is comparatively a simple matter when there is a good demand for manure of this quality. The writer, when in Great Britain, was able to dispose of large quantities of sludge mixed with screened town ashes. Dr. Fowler stated that Manchester and other cities are "able to sell dried sludge at a profit in Canada," and that "Bradford had concluded a contract for its dried sludge with the intensive gardeners of Northern France." Where, however, there is no demand, or where it is not possible to transport it by rail at a price competitive with other manures, the problem is not such an easy one. Very little manure is used in Western Canada, and consequently the prospect of disposing of large quantities of dried sludge there, is a remote one. Drying the sludge by any of the means named and allowing it to accumulate is out of the question. Burying it in stiff glacial till (clay) is not feasible during many months in the year.

At Ealing it was mixed with town refuse and burned in refuse destructors. Latterly, the sludge has been pressed and then mixed with town refuse and burned. Huddersfield, Bradford, Bury and Charlottenburg burn the sludge cake mixed with refuse. Sludge is also briquetted at the Bradford works by means of a Yeadon and Sons ovoid type machine. The moisture is reduced to 15 per cent. or 20 per cent., in which condition the sludge can be readily briquetted without the addition of any agglomerants and can be burned under boilers to generate power. Sludge containing 40 per cent. to 60 per cent. of moisture has been found in Germany to have a calorific value of about 6,000 B.t.u. Sludge made on the Degener lignite process with 40 per cent. moisture is reported to have a heat value of 8,600 B.t.u. It is stated that sludge containing under 60 per cent. moisture can be burned. Mr. G. M. Wisner, when reporting on the Chicago sewage disposal question, stated that trials on a large scale will undoubtedly show the feasibility of burning the sludge. To do this, thorough drying will be required. Experiments have shown that there is enough combustible matter in dry sludge to burn the volatile portion.

The destructive distillation of sludge is another process which has been tried. The 1910 report of the Massachusetts State Board of Health gives some interesting figures showing the average products of the dry distillation of sludge from seven sewages compared with Wyoming lignite. The great drawback to the destructive distillation of sludge is the quantity of heat required to convert the moisture into steam. Assuming that dry sludge contains from 6,000 to 8,000 B.t.u.'s per pound, the moisture content must be less than 50 per cent. to obtain anything like workable conditions.

Non-Bacterial Life.—The possibility of cultivating an aquatic sewage farm is an interesting one. Prof. Lett's investigations of the nitrogen absorbing powers of seaweed and fresh-water algæ, and Clark and Adams' study of algæ suggest that there are possibilities along this line.

ANALYSES OF FILTER SAND AND GRAVEL.

THE dependence for efficiency of the sand filter upon the size, or range of sizes, of the sand grains composing the filtering material, has been recognized for some time. Some suitable means of analyzing the filter sands for comparative purposes had to be devised, however. Back as far as 1892, a very satisfactory method came into general use, one described in the report for that year of the Massachusetts State Board of Health. A paper read by Mr. Philip Burgess, at the recent convention of the American Waterworks Association brings out the great extent, however, to which the engineering field requiring accurate analyses of sands and gravels has broadened since then. A comparatively new type of filter, called the rapid sand filter, has been developed and has been found to meet the average requirements more efficiently than does the slow sand filters. Experience indicates that the size of the sand required for a rapid sand filter differs materially from that generally used in the construction of a slow sand filter, While the methods of analysis employed for sand used in the slow sand filter may readily be adapted to the analysis of sand required in the rapid sand filter, the usual method of expressing results in terms of effective size is not entirely satisfactory, because the range of size of sand permitted in rapid sand filters frequently is very much less than is commonly used in the filtering material of slow sand filters.

Another important use for mechanical analysis of sands and gravels arises in the selection of materials required for concrete mixtures. It is recognized that arbitrary standards or proportions for mixing the aggregates required to form waterproof or dense concrete are no longer satisfactory nor are they to be recommended because of local differences, especially in the size and ranges of sizes of grains or particles composing the large and small aggregates.

A still further use of mechanical analyses of sands is in the preparation of asphalt mixtures such as are required for certain types of street pavements.

The matter of standardizing methods of making analyses of sands is of importance to all waterworks men who have to do with water purification problems. If contractors and waterworks superintendents understood more about the matter, it would frequently be possible to construct and maintain filtration plants at much less expense than is now required. The matter of obtaining satisfactory filtering material frequently is extremely simple, but has been made difficult by the methods of analysis commonly employed, and by the requirements as to size described in engineering specifications. There is no probability that the engineering profession as a whole will adopt the terms now used in the mechanical analyses of filter sands for the analyses of sands and gravels used for other purposes, such as proportioning concrete, paving mixtures, etc., so that uniformity and standardization of the results of such analyses can be obtained only by a revision of present methods.

On account of the lack of suitable standards it is not surprising to note that specifications covering the use of such materials frequently are extremely weak and ambiguous. Such weaknesses, of course, tend to increase the cost of work and frequently result in a very unsatisfactory quality of material.

Manufacturers of apparatus required to separate materials into specified sizes, or range of sizes, now find it extremely difficult to satisfy the specifications and requirements of engineers in this respect. This is particularly true in regard to the preparation of sands required for filtering material. It is seldom that a local community does not have available, within reasonable distances, satisfactory material as required for the preparation of a filter sand, but, on account of lack of knowledge on the part of local contractors or on the part of the engineers in charge of a particular piece of work, such local sands seldom are used and filter sand is nearly always imported, perhaps from considerable distances and at large expense.

It is believed that some of the confusion which has resulted in the matter has been from the adoption in specifications of such terms as "Effective Size" and "Uniformity Co-efficient," which are applied to sands used for filtering material. These terms, of course, have little or no significance to an ordinary contractor or to the dealer who is in the business of screening and sizing sands and gravels.

A further confusion has arisen from the endeavor to use the actual size of the sand grains rather than the sizes of the openings in the screens. Because few engineers have available the equipment required to standardize sieves, the results of analyses have often been reported in terms of numbers of meshes or wires, per inch. This method of expressing results, of course, is indefinite and inaccurate, because wire cloth used in the manufacture of sieves frequently varies both as regards sizes of wires and the number of meshes per inch.

Within recent years this difficulty has been appreciated by manufacturers who in some instances have endeavored to clear up the matter by producing standard testing sieves made in accordance with recent standard specifications and with certain arbitrary intervals of spacings between the individual units. By such means it is hoped to fix definitely the diameter of the openings in testing sieves. Recently, moreover, the Bureau of Standards at Washington has adopted standard specifications covering the manufacture of certain testing sieves; also, when solicited, this department stands ready to rate and standardize testing sieves at a nominal cost with a view of determining the actual average diameters of the openings.

Possibly that feature which would tend most to clear up the situation would be to change the standard of measurement from the size of the sand grains to the size of opening in a sieve. In view of the fact that the coarser testing sieves such as are required for sand analyses can now be obtained with wires of very nearly uniform sizes and accurate spacings, in both directions, it follows that such sieves will, within reasonable and sufficient accuracy, contain openings of certain definite sizes. Testing sieves which do not come within such requirements as are contained in the specifications of the Bureau of Standards should be rejected.

Table I. shows ratings of different nests of sieves with which the speaker has from time to time been familiar.

Table I.—Sizes of Separation of Representative Testing Sieves for Sand Analysis.

Meshes per in.	Sizes of separations in millimeters A-1.	A-2.	B.	C.	D.	E.
4	.....	.....	.....	5.6	.....	5.77
10	2.00	2.00	2.19	2.15	.....	2.09
14	.....	.....	.....	1.45	1.45	.....
18	1.04	1.05	1.07	.....	.....	.....
24	0.79	0.81	0.81	.....	0.86	0.78
30	0.58	0.60	0.61	0.57	0.58	0.57
40	0.45	0.46	0.48	0.46	0.40	0.45
50	0.31	0.33	0.34	0.37	0.30	0.34
60	0.24	0.30	0.30	0.23	0.27	0.39
80	0.187	0.197	0.190	0.195	0.195	0.193
100	0.153	0.161	0.168	0.160	0.150	0.156
140	0.121	0.117	0.126	0.115	0.120	.....
200	0.085	0.087	0.104	.....	.....	.....

The sieves indicated in column "A-1" and "A-2" were used in the office of Hering & Fuller of New York. The ratings in column "A-1" were obtained by counting and weighing the sand grains. The ratings in column "A-2" are of the same set of sieves and were made subsequently by the speaker by measuring the diameters of the openings in the screens and applying the factor 1.10 to the sieves Nos. (10-100) and 1.18 to the sieves Nos. 140 and 200. The ratings in column "B" were made by Mr. A. E. Kimberly at the Sewage Testing Station of the city of Columbus, Ohio. The sieves of columns "A" and "B" were made by the same manufacturer at the same time, under the same specifications. The ratings in columns "C" and "D" were obtained by the speaker for two nests of sieves used at Philadelphia. The ratings in column "E" were determined by Mr. J. W. Ellms for the sieves used in testing the sand required for the Cincinnati Water Purification Plant. Mr. Ellms rated these sieves by measuring the diameters of the openings and applying the above mentioned factors to determine the sizes of separations.

Table I. serves to illustrate some of the reasons why it is believed that the subject of standard apparatus and standard methods for analysis of sands and gravels is of great importance to the engineering profession at this time.

Attention is drawn also to the marked differences in engineering specifications and requirements for the preparation of sands used for filtration purposes. Frequently such specifications are limited to an expression of the maximum and minimum effective size and maximum and minimum uniformity coefficient. These terms mean nothing to the ordinary contractor who must furnish the material. It is obvious that the whole question of obtaining satisfactory material would be very much simplified if the specifications would read that a satisfactory sand would be one which contains not more or not less than certain specified quantities as separated by certain standard sieves. Such standard sieves would be available for the contractor, or manufacturer of the material, as well as for the engineer in charge of the work who, under present circumstances and conditions, has the matter almost entirely in his own hands. This is true in regard to specifications for sand required not only for filtering material, but also for any other purpose.

It is believed that the adoption of a standard nest of sieves by the engineering profession would help very materially in securing uniformity in the expression of results of mechanical analysis of sands.

It is also believed that there would be a great advantage in simplicity of expression of results of analysis or in the form of specifications covering the preparation of filter sands to the effect that 10 per cent. of the sand passes, or shall pass, say, a standard sieve No. 35, or a standard sieve having an opening of 0.417 millimeter diameter, as compared with the usual statement that a sand has, or shall have, an "Effective Size" of 0.46 millimeter. Moreover, the term "Effective Size" has no significance whatever outside of its application to a filter sand, and of itself alone, the term is of doubtful value as applied to sands such as are frequently used for rapid sand filters. The range of sizes is believed to be much more significant.

ASPHALT COATINGS FOR PROTECTION OF METAL BRIDGES.

In 1908 the Massachusetts Avenue bridge over the Boston and Albany Railroad was re-built as a deck plate girder structure with a paved street surface. It consisted of eleven girders spanning four tracks. The floor beams are 12-inch steel I-beams with thick webs. Frederic H. Fay, M.Can.Soc.C.E., of Fay, Spofford & Thorndike, consulting engineers, Boston, and formerly division engineer in charge of bridges and ferries, in a paper before the Engineers' Society of Western Pennsylvania, describes the asphalt coating which was used.

The asphalt protection was put in place at the bridge shop. The steel work was first painted with two priming coats, heated moderately—to less than 100°. The surfaces which were to be in contact in the field connections were then covered with wooden templates in order that they should not be coated with asphalt. The metal work then received two heavy mopping coats of asphalt, applied at between 400 and 450° F. Before the last coat was entirely cooled the surface was swept over with dry Portland cement to facilitate handling and keep it from being sticky. The thickness of asphalt was about ⅛ inch.

No particular difficulty was experienced in erecting these asphalt-coated bridge members, as shown in the illustration. Care was taken to use lagging under all chains. If for any reason the asphalt was knocked off, the spot was gone over in the field with a fresh application of hot asphalt. After riveting, all field connections were likewise coated with hot asphalt.

Before deciding upon the use of asphalt as a protective coating, some experiments were made to determine its consistency at low temperatures. Samples were placed in a cold-storage warehouse at a temperature ranging from 2 to 6° F. below zero. After several days' exposure to this temperature the asphalt was found to be reasonably soft, so that it could be easily dented with the thumb nail. After six years' service the asphalt coating was found to be in good condition.

Recently published statistics relating to the number of electric furnaces in Italy up to 1913, show that they are in use by four establishments engaged in iron smelting and 10 in other industries. Of the former, the Dalmiene works at Bergamo have an output of iron piping of 30 tons yearly.

BERLIN INCINERATOR IN OPERATION.

A MUNICIPAL incinerator of extremely interesting type was formally put into operation at Berlin, Ont., on May 28th. Some of its chief features we were able to describe in our issue of April 15th, while it was still in the course of construction. The following data and illustrations bring out some further details that show the plant to be simple, unique and efficient.

The incinerator building is of fireproof material, the first story being built of concrete, the dumping floor above the furnaces of reinforced concrete and the second story of steel and corrugated iron. The chimney is of brick. For starting the furnace, fuel oil from a tank of 480 gallons capacity, feeds through an oil pump to four burners, two of which heat the animal chamber and a single burner each of the garbage chambers. The proportion of fuel consumption is 1 gal. of oil to about 1,000 cu. ft. of air, each burner consuming oil at the rate of about 5 gal. per hour. Excellent results have been obtained, the furnace registering 1,400 degrees F. in less than ten minutes, and 1,800 degrees in a quarter of an hour. When the furnace is thus heated, a forced draft, produced by motor-driven suction fan, and pre-heated to about 400 degrees F. is admitted, and the oil burners turned off, enabling the furnace to maintain a very high degree of heat until the refuse is entirely consumed.

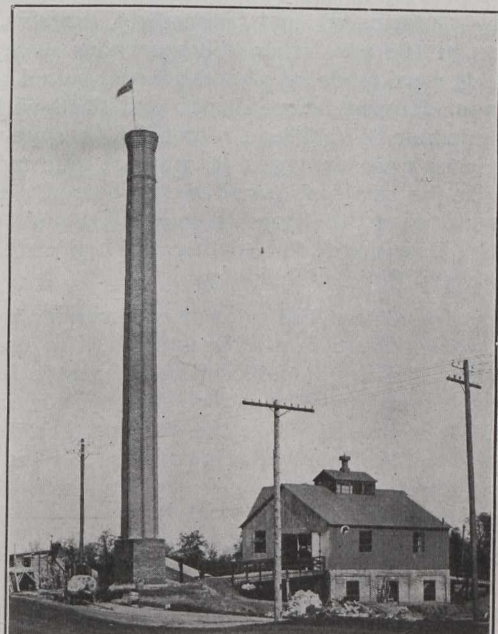


Fig. 1.—Exterior View of Berlin Incinerator.

The furnaces themselves are of fire-brick interiors with asbestos packing and of brick and concrete on the outside. Each works independently of the other, enabling the plant to be in constant operation, if desired, and enabling also ease and rapidity of cleaning, as one may be cleaned while the other is in operation.

Garbage and refuse are hauled to the approaches and deposited on the dumping platform, whence the material is fed through manholes into the drying hearth below. This slopes toward the furnace grates and is in a direct line with the heat and the course it takes to the combustion chamber. At this point all combustible material is rapidly destroyed and moisture effectively evaporated. When dry, the material is raked over the fire grates and reduced to ashes and incombustible clinkers. The feeding doors above are water-sealed. The clinker door gives easy access to the entire grate area, a necessity when forced draught is employed. It is operated by counterweights. A pull-down is located in the centre of the door and provides a means of stoking the fire.

Fig. 2.—Dumping and Feeding Floor Showing Ventilating Airduct Leading to Pre-heater and Furnace.

All smoke, dust and foul air arising from the charging floor and furnaces are drawn by motor-driven fan into a regenerator and heated by waste and gases. They are then conducted to the ash pits under the grates and burned in the combustion chamber. This means a great saving of fuel and adds to the rapidity and efficiency of construction. The combustion chamber and flue have been carefully designed to burn all the gases. There is a second combustion chamber connected with the animal furnace to insure efficient combustion. A pre-heater is constructed inside the flue, the function of which has already been explained, and dust pockets, paper screens, dampers, etc., the uses of which are obvious.

Fig. 3.—Clinkering Doors and Type of Car Used.

The incinerator's capacity for destroying dead animals was well demonstrated upon the occasion of the formal opening mentioned above. The complete reduction to ashes of the carcass of a horse occupied seven minutes from the time it was deposited in the furnace. The incinerator is guaranteed to consume 15 tons of garbage in 24 hours. At the official test performed by Mr. Herbert Johnston, city engineer of Berlin, some 31,000 pounds of garbage of all classes were consumed in less than 8 hours.

The Ideal Incinerator and Contracting Company, of Toronto, installed the furnace. It is their Type B, which is an independent cell furnace, differing in many respects from their connecting cell furnace, Type A, an example of which is in operation at Fort William, Ont.

SAND AND COARSE MATERIAL AND PROPORTIONING CONCRETE.*

By John A. Davenport, M.Sc., and S. W. Perrott, M.A.I.

IN correctly made concrete the amount of sand should be just sufficient to fill the voids in the coarse material, and the amount of cement just sufficient to fill the voids in the mixture of sand and coarse material and to coat all the particles with very thin jointing layers. It is a rational assumption that such concrete will give a maximum strength with the minimum of cost, and if such assumption be justified by experimental results it follows at once that the proportioning of concrete-forming materials is of the utmost importance. Greater strengths can be obtained by the use of excess of cement as in the case of the ordinary mix of 1:2:4, but the increase in strength is less than the increase of cost of materials, and is therefore only justified in particular cases.

The strength of any concrete will depend not only upon the materials and their proportions, but also upon the method of using those materials. Any void in a mass of ¾-in. coarse material may be filled in many ways. First, it may be filled with cement and sand mortar as in the 1:2:4 concrete; secondly, it may be filled with a piece of stone which practically fills the whole space; and thirdly, it may be filled with a number of stones which vary in size with a minimum amount of cement and sand mortar shown in black. The first filling is composed almost wholly of joints, and on that account is weak; the second filling is strong, owing to the absence of joints, but it is impracticable; but the third is a compromise which is not only impracticable but also strong. It will be seen that the amount of the variations in size or the grading will depend upon the nature and quality of the work required. On the one hand, there will be good but costly filling, and on the other, a cheap but still good filling, and whether the gradation be large or small the filling will be better than one of cement and sand mortar only.

With a view to testing the effect of "proportioning" upon the strength and other properties, and also the cost of concrete, the authors drew up a series of experiments, the intention being to test compressive strength, modulus of rupture, specific gravity, water resistance, and fire resistance. Various difficulties arose in the course of the work which not only prevented the paper being presented on the original date, but prevented also the inclusion of specific gravity, water resistance, and fire resistance tests. The series involve 216 test pieces, to which must be added others prepared for water and fire resistance and specific gravity tests, but which could not be tested in the time available. The voids were measured in a patent apparatus designed by Mr. Davenport, which gives results to one-fifth of 1 per cent., and which was found to be independent of the observer. The preliminary data comprised tests on Portland cement, size of granite chips, volume of chips per batch, percentage volume of voids in chips, sizes of river sand used, volume of sand used per batch, percentage volume of voids in sand, and the volume of cement used per batch. Regarding the latter item, it must be noted that no allowance was made for the excess cement required for jointing, only the amount required to fill the voids being used. Had time permitted it, the correct allowance in each case would have been ascertained and additional tests made therewith. The limited time made it impossible to test the cement before using it for the concreted test pieces, the brand only suggesting its probable good qualities.

The batches were hand mixed by engineering (senior honors) students, and as no special means of testing the thoroughness of the mix were adopted the resulting concrete will probably compare favorably with machine-mixed so far as uniformity of results go. Every care was exercised, however, in the mixing to get all the materials thoroughly intermixed and apparently uniform. This proved to be the case when the specimens were tested. The moulds were made of planed boards, bolted together with gangs, damped before using, and lined with paper on the underside to facilitate removal. In spite of this, several pieces were damaged in removal, due more particularly to the relatively small sections used. Immediately after mixing, the moulds were filled and left in a tool shed till required for testing. They were wetted regularly every three or four days.

It was found that the ratio of compressive to tensile strength varied more in the one-month than the three-month tests, and is not sufficiently uniform to base any conclusions upon beyond the fact that such ratio is not constant. It is considered by the authors, however, that this ratio should be more or less constant, as the failure, whether compressive or tensile, depends upon the adhesive strength of the cement.

The ratios strength at three months to strength at one month were more or less uniform, more particularly in the case of compressive strengths. In the case of 1:2:4 concrete the modulus of rupture appears to increase more rapidly than the compressive strength, while in the other series with cement accurately proportioned the compressive strength increases more rapidly than the modulus of rupture, as out of six series only one runs the other way, probably due to rather dry mixing of those three-month test pieces.

Although the cement tests are unsatisfactory, it will be possible to compare the strengths and costs of the concrete in the different series, as they will probably all be affected to the same extent. The most important point brought out by such comparison is the fact that for accurate proportions the ratio $\frac{\text{cost of cement}}{\text{total cost}}$ is practically constant for all gradings taken in the tests, so that when the graded coarse materials is used the total cost need only be further considered. Of course, the total cost is always the final criterion as regards economy, and it may be suggested that the ratio cost of cement to total cost need not be considered. But the relative values of total cost obtained may be altered when additional tests are made at other ages, and it is difficult to say whether they will be affected by the ratio, so that if it can be shown conclusively that this ratio is constant or nearly so the total cost, age, and proportions need only be dealt with.

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* Summary of paper read before the Concrete Institute of Great Britain.

Editorial

NATURAL AND FUNCTIONAL DEPRECIATION.

The question of depreciation of plant and property is one which enters largely into affairs pertaining to engineering construction and maintenance. It is always a factor for consideration in estimates, public utility valuations, and the like. It is defined, somewhat unclearly, as a fall in value, a reduction of worth. Property in the normal course of service deteriorates, due to wear and tear and other causes, and, if left alone without repairs, it will gradually become unfit for service. While it cannot be kept "brand" new, there is much to be done to keep it in efficient service condition and to prolong its useful life.

Without dilating here upon methods of estimating and determining depreciation, it is important to note that there are two distinct kinds of depreciation. There is natural depreciation, due to mechanical or physical deterioration, i.e., wear and tear and losses resulting from the forces of nature, such as oxidation by rotting and rusting, abrasion, distortion, crystallization, etc. There is also functional depreciation, resulting from a variety of causes. One of these is termed obsolescence, due to changes in practice or invention of new and improved devices. A machine is economically obsolete when a new type of machine will perform the same function at a lower unit cost of production. It is inadequate when the increased output of the plant makes it more economic to use a larger machine of the same type. Another cause is lack of utility, due to inability to meet the increased and changed demands of the service, although fully capable of performing the service for which originally installed. There are other causes, such as decreased use owing to impaired demand, or drop in price.

A point always worthy of careful consideration by engineers who have valuations to make is that these two kinds of depreciation, to be estimated intelligently, must be considered separately. This is not always done, but it is the better practice and assures closer determination of depreciation.

COAL-TAR RESIDUALS.

A subject that is of special interest at this time is that dealing with the importance, waste and use of coal gas residuals. This is largely on account of the effect of the war on the industries dependent on aniline dyes and because the English lyddite and French melinite explosives are made from carbolic acid, a coal tar derivative. A new explosive, trinitrotoluene, is attracting even more attention. It is made from toluene, which is found in the benzol obtained by distillation from tar or in ordinary coal or coke-oven gas.

Coal gas residuals form the bases of many industries. Owing to the great development of by-product coke ovens and gas plants in Germany and the application of modern chemistry to the utilization of their by-products, these industries have largely been controlled by that country. In the readjustment of industrial and trade conditions after the war, it is desirable that as many of these industries as possible be established in Canada and in other parts of the British Empire.

There are two large by-product coke ovens in Canada which produce 67 per cent. of our coke output. These plants are situated at Sault Ste. Marie, Ont., and at Sydney, N.S. Since the outbreak of war, the latter plant has been installing a benzol recovery plant, but in western Canada, there are numerous beehive coke ovens which do not save any by-products whatsoever. Again, while large quantities of tar are recovered from local gas plants, no industries have been established for the refining, separation and use of the products obtainable from it.

Not only is the saving of the by-products from the coking or carbonization of coal a measure of conservation but the sale of these residuals is the means of reducing the cost of production in a degree corresponding to the efficiency of the recovery methods adopted and the market value of the products.

That the United States are cognizant of the far-reaching importance of the coal-tar industry is evidenced by a recent Consular report, which observes that adequate steps have been taken to assure an abundant supply of all the coal-tar crudes needed by a well-rounded American coal-tar industry as fast as the demand develops. A strong effort is being made to establish upon a firm basis the manufacture of a wide range of coal-tar intermediates. The manufacture of a limited number of staple coal-tar dyes is being pushed with remarkable energy, and the number of these dyes promises to increase steadily.

Numerous interviews with those who have participated in these preliminary steps in the evolution of a national industry have brought to light a marked confidence on their part in the final success of the undertaking, provided the capital invested is exposed to no more danger than that involved in fair and open competition with foreign manufacturers of dyestuffs.

Capital hesitates, continues the report, under existing conditions to embark heavily in an undertaking where there is a strong probability, if not a certainty, that upon the return of normal conditions an incipient, half-developed American industry would be exposed to prolonged and relentless underselling by foreign competitors possessing almost boundless resources, financial and technical.

"There is a very strong conviction among those experienced in the industry and among those just entering it that the majority of the coal-tar intermediates required in making dyes, and the great bulk of the coal-tar dyes now imported from Europe can be profitably manufactured on American soil under existing tariff rates if there is adequate statutory protection against the so-called 'dumping' of foreign wares; or, in other words, protection against unfair competition in restraint of trade by persons or firms outside of American jurisdiction.

"Whether public opinion will recognize general legislation in this direction as of urgent necessity remains to be seen. There seems, however, to be no question but that ample capital is available for the needs of an American coal-tar chemical industry, and that a large measure of enterprise and technical skill is ready to enter the new field, provided this one serious obstacle is definitely removed."

Canadian Society Members at the Front

The following is a list of the names of members of the Canadian Society of Civil Engineers who have enlisted for overseas services. We publish it through the courtesy of Professor C. H. McLeod, Secretary of the Society. It is believed to be complete up to the end of May.

Doubtless some of our readers are aware of other members than those listed below, who have since answered the call. If so we would be grateful for being informed of their names, and in what capacity they are serving.

MEMBERS

Name.	Rank.	Regiment.
Armstrong, C. J.	Lieut.-Colonel	Div. Engrs., 1st Can. Contingent
Beullac, M. C. J.		French Army
Creighton, F. A.		1st Canadian Contingent
Daw, H.	Captain	Div. Engrs., 1st Can. Contingent
Donnelly, C. O'C.	Captain	Div. Engrs., 1st Can. Contingent
Dufresne, J. C.	Lieutenant	48th Battalion, C.E.F.
Gaudet, F. M.	Colonel	Officer Command'g 22nd Batt'n.
Girdwood, E. P.	Corporal	30th Battalion
Greenwood, H.S.	Colonel	1st Canadian Contingent
Hesketh, J. A.		1st Canadian Contingent
Janin, George	Major	Div. Engineers
Lamb, H. J.		1st Canadian Contingent
Le Fevre, A. T.	Major	Can. Ry. Construction Corps
Leonard, R. W.	Major	Corps of Guides, England
MacPhail, J. Alex.	Major	Div. Engrs., 1st Can. Contingent
Manchester, C. S.		3rd Canadian Contingent
Meurling, H. F.	Lieutenant	5th Canadian Mounted Rifles
Mitchell, C. H.	Colonel	Corps of Guides, 1st C. Cont'g't
Montizambert, H. St. J.	Lieutenant	29th Battalion
Parks, J. H.		
Ramsey, C. W. P.	Lieut.-Colonel	O.C. Can. Ry. Constr. Corps
Rolston, J. M.		29th Battalion, 2nd Can. Con.
Roy, A. V.	Major	2nd Canadian Contingent
Shillinglaw, W. H.		45th Canadian Infantry
Wilkin, F. A.		1st Canadian Contingent

ASSOCIATE MEMBERS

Name.	Rank.	Regiment.
Aitken, A. B.	2nd Lieutenant	121st Pioneers, I.A.
Alport, F.	Sergeant	No. 3 Sec., 6th Field Co., C.E.F.
Anderson, T. V.	Major	Div. Engrs., 1st Can. Contingent
Baker, H. C., Jr.		Royal Fusiliers, 2nd Regiment.
Ball, J. C.	Lieutenant	7th Battery, 3rd Brig., C.F.A., [1st C. C.
Begg, J. M.		Royal Engineers
Bidwell, L. M.		28th Battalion
Bodwell, H. L.	Adjutant	47th Battalion
Bogart, J. L. H.	Major	Royal Canadian Engineers
Cameron, John A.		1st Canadian Contingent
Cantley, C. L.	Lieutenant	5th Royal Highlanders, 1st C.C.
Charton, P.	Lieutenant	French Military Engrs. Corps.
Cosgrove, J. R.	Lieutenant	Div. Engrs., 1st Can. Contingent
Daniel, W. T.	Lieutenant	1st Canadian Contingent
Davis, G. H.		1st Canadian Contingent
Dawes, A. S.		21st Battery
Delancey, J. A.		
Delaute, F. J.		
de Lestang, P. L. G.		French Army
Landry, P. A.	Lieutenant	48th Battalion
Layton, S. T.	Lieutenant	C.F.A., 2nd Can. Contingent
Leckie, R. G. E.	Colonel	16th Battalion, 1st Can. Contgt.
Lecointe, P. L. P.		
Livingston, D. A.		2nd C.M.R., 2nd Can. Cont'g't
Lott, H. C.	2nd Lieutenant	8th Royal Sussex (Pioneers)
MacDonald, Campbell	Lieutenant	Engr. Corps, 1st Can. Cont'g't
Malcolm, L.	Major	Div. Engineers
Manisty, H. S.	2nd Lieutenant	Royal Engrs. (Special Reserve)
Meade, A. deC.		Royal Engineers
McCuaig, G. E.	Captain	13th Battalion, 1st Can. Contgt.
McNaughton, A. G. L.	Major	Can. Field Artil., 1st Can. Con.
Michie, V.		1st Canadian Contingent
Mieville, A. L.	Captain	Div. Engineers
Moodie, W. H.		102nd Regiment, R.M.R.
Mudge, R.		McGill Co., 38th Batt'n, C.E.F.
Muirhead, Thos.		
Mullon, L. G.		French Army
Mulock, R. H.	Flight Sub. Lieut.	Officers' Mess, Naval Air Stn., Eastchurch, Eng.

Donaldson, J. M.	Captain	King's Royal Rifles
Donnelly, H. H.		
Du Cane, C. G.		
Dulieux, P. E		French Army
Dupont, Geo.		French Army
Dupré, H. A.		
Edgar, J. H.		24th Battalion, 2nd Can. Contgt.
Ellis, J. G. St. J.		
Evans, A. E.		50th Gordon High., 2nd C. Con.
Everall, Wm. M.		1st Canadian Contingent
Garner, A. C.		
Goldie, E. C.		1st Canadian Contingent
Gordon, M. L.		
Grant, LeR. F.	Adjutant	Can. Ry. Construction Corps.
Harcourt, R. H.	Lieutenant	Dis. Ammu'n Col., 1st C. Con.
Harris, A. D.		
Harvie, E. N.		6th D.C.O.R., Vancouver
Hick, H. C.	Lieutenant	King's Liverpool Regiment
Holdcroft, J. B.	Sergeant	6th Field Co., Div. Engineers
Houliston, J.	Lieut.-Colonel	Div. Engineers
Hughes, G. B.		1st Canadian Contingent
Hughes, H. T.	Major	1st Canadian Contingent
Hunt, W. H.		
Irving, T. C., Jr.	Captain	2nd Field Co., Div. Engineers
Nowlan, A.	Lieutenant	Div. Engrs., 1st Can. Contingent
Oborn, S. M.		1st Canadian Contingent
Oxley, A. C.		2nd Field Co., Div. Engineers
Perry, K. M.		1st Canadian Contingent
Pinget, R. C. L.		
Randolph, T. G.	Lieutenant	6th Batt'n., S. Wales Engineers
Revell, G. E.		Div. Engrs., 1st Can. Contingent
Rime, L. M. H.		French Army
Rowley, H. G.		Royal Engineers
Simpson, Rupert	Captain	Imperial Army Service Corps
Smith, A. P.	Captain	14th Batt'n, Co. of London Rgt.
Smith, D. A.		Corps of Guides, 1st Can. Con.
Stavert, W. D.	Lieutenant	7th Field Co., Royal Engineers
Stewart, A.		29th Battalion
Stirling, R. A.		12th Battalion, 1st Can. Con.
Stronach, R. S.		
Symes, J. A.	Lieutenant	56th Battalion
Taunton, A. J. S.	CO.Qtr.-Mas.Sergt.	44th Battalion, 3rd Can. Con.
Tuzo, J. A.	2nd Lieutenant	Res. Cyc. Batt'n, Royal Sussex
Tweedie, A. G.	Captain	37th Battalion, 3rd Can. Con.
Vansittart, G. E.		Canadian Artillery
Wilson, J. A. G.		1st Canadian Contingent
Young, A. A.		2nd Canadian Contingent

JUNIORS

Anderson, A. A.	Lieutenant	2nd Signal Co., 2nd Can. Con.
Anderson, G. F.		
Adams, W. D.		1st Canadian Contingent
Allan, H. D.	Lieutenant	3rd Batt'n, A. & S. Highlanders
Allen, L. E.		Div. Engrs., 1st Can. Contingent
Bauset, M. E.	Lieutenant	22nd Battalion
*Bell-Irving, D. P.	Lieutenant	Div. Engrs., 1st Can. Contingent
Blue, W. E.		1st Canadian Contingent
Booth, C. D.	Sergeant	13th Battery, C.F.A.
Campbell, T. C.		
Child, C. G.	Lieutenant	Cycle Corps, 1st Can. Cont'g't
Clarke, C. R.		Div. Engrs., 1st Can. Contingent
Clendinning, Jas.		
Cowley, F. P. V.	Captain	No. 1 Co., 48th Battalion
Dawson, S. G.		Can. R.E. Corps, 1st. Can. Con.
de Cardaillac, G.		1st Canadian Contingent
Dodd, G. J.	Corporal	Signal Section, C.E.F.
Ellis, D. S.	Lieutenant	Division Engineers
Ewart, D. M.		Can. Engineers, 3rd Contingent
Fairn, A. S.		1st Canadian Contingent
Ferguson, James	Corporal	Div. Engrs, 2nd Can. Cont'g't
Ferris, C. B.	Sergeant	2nd Co., Div. Engrs., 1st C. C.
Fisken, A. D.		20th Battalion, 2nd Can. Con.
Greening, O.		1st Canadian Contingent
*Helliwell, J. G.	Captain	1st Batt'n, 1st Brigade, 1st C.C.
Hertzberg, H. F. H.	Lieutenant	2nd Field Co., Div. Engrs.
Junkin, R. L.	Lieutenant	Division Engineers
Kohl, G. H.		McGill Overseas Co.
Lamb, S. R.		
Laurence, W. S.	Lieutenant	Royal Canadian Engineers
Lefebvre, H. A.		1st Canadian Contingent
Mackenzie, John A.	Captain	"A" Co., 26th Batt'n, 2nd C. C.
Mackinnon, K. R.	Corporal	2nd Signal Co., Div. Engineers
McDonald, H. F.		1st Canadian Contingent
McEwen, A. B.		1st Canadian Contingent
McFarlane, W. J.		26th Battalion
McKnight, A. W.	Lieutenant	Division Engineers
McKnight, R. C.	Signalling Officer	29th Battalion
Merrylees, L. F.		
Monkman, G. H. N.		Can. Overseas Ry. Constr. Co.
Morrisey, T. S.		1st Canadian Contingent
Morrison, H. K.		6th Co., Div. Engrs, 2nd C. C.
Middleton, Jas. R.		1st Canadian Contingent
Milot, J. A.	Major	1st Canadian Contingent

*Killed in action.

(Continued on next page.)

JUNIORS—*Continued*

Name.	Rank.	Regiment.
Parker, S. D.	Captain	Can. Engineers, 1st Can. Con.
Peters, H.		1st Canadian Contingent
Pook, R. A.	Corporal	20th Battalion
Powell, R. W.	Lieutenant	Division Engineers
Ramsey, J. H.		
*Rosher, J. H.		1st Canadian Contingent
Shackell, S. W.	L. Corporal	Division Engineers
Shanly, C. N.		
Shaw, J. B.		1st Canadian Contingent
Stewart, J. C.		1st Canadian Contingent
Theriault, A.	Captain	Division Engineers
Tingley, F. H.	Lieutenant	1st Canadian Contingent
Turner, G. R.	Sergeant	3rd Co., Div. Engrs, 1st C. C.
Watson, M. B.		1st Canadian Contingent
Wetmore, F. W. C.	Trooper	6th Regiment, C.M.R.
White, D. A.		
Worthington, A. N.	Lieutenant	10th Royal Gren., 1st Can Con.

*Killed in action.

STUDENTS

Name.	Rank.	Regiment.
Avery, C. R.		
Birchard, E. R.		Eaton M. G. Battery, 2nd C. C.
Black, A. P.		
Bremner, F. E. A.		1st Ryl. Montreal Rgt., 1st C.C.
Browne, E. F.	Sapper	Canadian Division Engineers
Chadwick, F. G.		1st Canadian Contingent
Collins, W. S.		Div. Engrs., 1st Can. Contingent
Downie, R. W.		Div. Engrs., 1st Can. Contingent
Drummond, L.	Lieutenant	Can. Engrs., 1st Can. Cont'g't
Duggan, K. L.	Lieutenant	Canadian Mounted Rifles
Duguid, A. F.		
Eaton, H. T.		Div. Engrs., 1st Can. Contingent
Erskine, J. A.		1st Canadian Contingent
Ewing, W. A.	Scout Engineer	20th Battalion
Fowlds, E. S.		Div. Engrs., 1st Can. Cont'g't
Fyshe, F.	Lieutenant	1st Canadian Contingent
Gage, C. E.		
Gervan, C. F.		8th Canadian Mounted Rifles
Glanville, J. C.		1st Canadian Contingent
Glover, T. S.	Private	Signal Sec., 3rd Batt'n, 1st C.C.
Greene, L. K.	Lieutenant	5th Canadian Mounted Rifles
Guy, R. W.		2nd Canadian Contingent
Hammer-Schou, J.		2nd Canadian Contingent
Harkom, J. F.	Gunner	5th Battery, 2nd Brig., 1st C.C.
Harris, R. W.		1st Canadian Contingent
Hewson J. H.		1st Canadian Contingent
Hodgins, F. O.	Captain	Div. Engrs., 1st Can. Contingent
Hughes, B. H.	Sapper	Div. Engrs, 6th F. Co., 2nd C.C.
Humphrey, A. E.	Captain	2nd Canadian Contingent
Jacquemart, R.		French Army
Layne, G. F.		1st Res. Batt., 6th Brig., C.F.A.
Lindsay, C. C.	Sapper	Can. Engrs., 2nd Can. Cont'g't
Macaulay, C. A.		
Macheras, J. P.		1st Canadian Contingent
Malloch, N.	Lieutenant	Division Engineers
McFarlane, M. L. D.		
McIntosh, E. D.		21st Battery, 6th Brigade, F.A.
McMordie, H. C.		
McPhail, D. S.		
Meyerstein, W. C.		
Miller, W. M.	Lieutenant	R.E. Hdqtrs., Sig. Co., 1st A.C.
Montgomery, C. S.		
Munro, A. H.	Sapper	6th Co., Div. Engrs., 2nd C. C.
O'Leary, F. J.	Lieutenant	53rd Battalion
Patterson, A. L.		5th Battery, 2nd Brigade, C.F.A.
Perry, C. V.		Eaton M. Gun Batt., 2nd C. C.
Powter, A. L.		1st Canadian Contingent
Pym, J. S.	Corporal Signaller	R.C.D., 1st Can. Contingent
Raley, W. E.		3rd Canadian Contingent
Rankin, F. S.	Lieutenant	Can. Engrs, 1st Can. Contingent
Redman, W. B.	Sapper	Div. Engineers, 1st Can. Con.
Ritchie, W. W.	Sergeant	"A" Co., 35th Batt'n., 3rd C.C.
Robertson, A. M.		21st Battery, 6th Brigade F.A.
Rosenorn, P. E. M.	Lieutenant	3rd N.B. Regt., Can. Artillery
Ross, C. F. D.		Div. Engrs., 1st Can. Cont'g't
Rowan, J. C.		1st Canadian Contingent
Rutherford, F. S.		Div. Engrs., 1st Can. Cont'g't
Scott, M. A.	Lieutenant	No. 1 Battery, Auto Machine Gun Brigade, 1st Can. Con.
Scott, W. D.		
Shannon, R. E.	2nd Lieutenant	Army Service Corps
Spears, D. C.		5th Co., Div. Engrs., 1st C. C.
Storms, D. H.	Lieutenant	8th Battery, C.F.A., 1st C. C.
Tait, V. H.		Div. Engrs., 1st Can. Cont'g't
Tillson, L. B.		Eaton M. Gun. Batt., 2nd C. C.
Tilston, J. A.		Can. Overseas Ry. Constr. Corps
Urie, H. R.		2nd Field Co., Div. Engineers
Wallace, Hugh		
Williams, J. N.		26th Battery, C.F.A.

ENGINEERS' LIBRARY

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

CONTENTS.

BOOK REVIEWS.

Heating and Ventilating Buildings. By Rolla C. Carpenter, M.S., C.E., M.M.E., Professor Experimental Engineering, Cornell University. Published by John Wiley & Sons, Inc., New York City; Canadian selling agents, Renouf Publishing Co., Montreal. Sixth edition, 1915. 605 pages; 290 illustrations; 6x9 ins.; cloth. Price, $3.50 net. (Reviewed by John E. Burns, B.A.Sc., Toronto.)

The first edition of this work appeared in 1895, and since then it has been the best, almost the only, comprehensive book in the English language on the general subject of the heating and ventilating of buildings. The present revision leaves it in much the same position. It is virtually an encyclopedia of heating and ventilating, setting forth in a concise but lucid manner the facts of physical science that find application in the art, together with a more or less comprehensive review of the modern practice and apparatus.

As stated in the preface, it is distinctly a work of reference, for the engineer and contractor occupied with the design and installation of heating systems, or for the superintendent of such construction. And it serves this purpose admirably. Naturally, though, in a work of such broad scope the specialist in any branch is likely to find the treatment of his chosen subject disappointing. As, for instance, the subjects of Dust, Humidity, and Air-washing, that might well fill a volume of good size, are disposed of in eighteen pages. The same objection may be taken to the chapter on "Pump Return Steam-heating Systems."

For the most part, the author confines himself to descriptions of the apparatus on the market in as impersonal a manner as is possible under the circumstances. This is as it should be in view of the fact that the subject is being developed almost entirely by men who are interested in it commercially. In this connection it may be noted that recommendations made by the author regarding the hot-air furnace will hardly prove acceptable to the men who are familiar with Canadian practice at least.

The subject matter of the book by paragraphs is as follows: The Nature and Properties of Heat; Principles of Ventilation; Amount of Heat Required for Warming; Heat Given Off from Radiating Surfaces; Flow of Water, Steam and Air; Pipe and Fittings Used in Steam and Hot-Water Heating; Radiators and Heating Surfaces; Steam-heating Boilers and Hot-water Heaters; Mechanical Ventilators; Hot Blast Heating; Heating With Electricity; Temperature Regulation; Schoolhouses, Shops, and Greenhouses; Specification Proposals and Business Suggestions; Air Conditioning; and an appendix containing Literature and References, Current Literature of the Day, Explanation of Tables, Tables, and an index.

Perhaps the most interesting thing about Professor Carpenter's book is the fact that it has held an undivided sway for twenty years and through six editions, and at the present time has only one competitor (a handbook) at all worthy to be put in the same category. Comment under these circumstances seems superfluous.

Lathes, Their Construction and Operation. By George W. Burley, University of Sheffield. Published by Scott, Greenwood & Son, London, E.C. First edition, 1915. 231 pp.; 200 illustrations; 5x7 ins.; cloth. Price, $1.00.

This is a general and descriptive survey of modern lathe construction and operation for mechanical engineering students and apprentices. It does not go into details or technical mechanics. It reviews the evolution of the machine, classification of modern types, enlarging upon the latter with special reference to engine, turret and special lathes. There is a chapter on lathe accessories and cutting tools and another generally descriptive of lathe work. The closing chapter on cutting speeds and feeds is followed by an appendix relating to screw-threads and change gear wheels for screw-cutting English and metric threads.

The Railroad Taper. By Lee Perkins. Published by John Wiley & Sons, New York; Canadian selling agents, Renouf Publishing Co., Montreal. First edition, 1915. 356 pp.; 41 illustrations; 4½ x 7 ins.; flexible leather binding. Price, $2.50 net.

This hand book is devoted to the theory and application of a compound transition curve based upon 30-ft. chords. It is intended to simplify the use of the taper and to lessen the work of the man in the field. It begins with an explanation of the paper, its purpose and development. A chapter is devoted to a number of location problems with simple and compound curves. Chapter III. is headed "Field Work," and alludes to the selection of the taper, laying out a tapered curve and passing obstructions on the curve. The next chapter, on office work, relates to plotting right-of-way descriptions, etc. Chapter V. is on tapering old track and methods of inserting tapers in circular track for both simple and compound curves. These chapters occupy 62 pages of text and the balance is devoted to tables of tapers, logs, curve functions, etc. In addition to the usual notation, the taper tables have also been calculated for metric curves for use where the latter is used, such as in Mexico and South America.

Briefly, this transition curve is a series of compound curves based on 30-ft. chords and the main curve increasing in direct arithmetical progression. The tables presented in this work enable one to run in this series of compound curves with the ease of running in a simple curve and from a single setting of the transit. It is an extension and elaboration of the work of Mr. William Hood, chief engineer of the Southern Pacific, who devised a compound transition curve a number of years ago and developed several tables for it.

Tunneling. By Eugene Lauchli, C.E. Published by McGraw-Hill Book Co., New York. First edition, 1915. 238 pp.; 197 illustrations, including several folding plates; 6 x 9 ins.; cloth. Price, $3.00 net.

The book deals with short and long tunnels of small and large prospection driven through hard and soft materials. It has been written specially for practicing engineers and contractors, and deals in a logical way and in simple language with the underlying principles governing the solution of tunnel driving for various purposes. The author's simple and direct method of explanation is known to readers of *The Canadian Engineer* through two comprehensive articles on tunneling that appeared in these columns throughout the past year. The book is written in a similar style, is easily read and full of practical information on such subjects as drilling machinery and equipment, explosives, compressor and ventilating plants, haulage methods, timbering and lining, etc. Attention is to be called to the adequate manner in which the various subjects have been illustrated. The photographs have been taken from actual practice.

Tunneling methods and machinery have improved wonderfully in the past decade and many long and deeply overlaid tunnels have been driven, some under very adverse conditions. It is obvious that a practical book on tunneling will find many interested readers on this continent.

Experiences in Efficiency. By Benjamin A. Franklin. Published by Engineering Magazine Works Management Library. 166 pp.; 5 x 7 ins.; cloth. Price, $1.00.

(Reviewed by R. O. Wynne-Roberts, C.E.)

This small book is a general survey of the work of efficiency engineers, and affords the reader subjects for meditation.

The first chapter deals with the study of workmen's tendencies, and it is appropriate that workmen should receive consideration. It must not be assumed, however, that workmen include only those who earn their livelihood by the use of their hands in manual labor; it should apply equally well to all who earn a livelihood. Workmen of all classes deserve consideration, and when this is paid to them they repay the confidence in many ways. But the author considers the workmen's tendencies from the point of view of waste and loss, and how to effect changes.

Quality of workmanship is ordinarily a standard of business, and if ignored it sooner or later brings ill-repute and disaster. The standard of quality must be maintained, and this book deals with the question in its many phases.

Waste prevention is an exceedingly important function in all business, and the author shows how savings were effected by paying bonuses. The introduction of gang piecework is not new. It is employed in large quarry work and has given general satisfaction. It means paying a gang of men according to results of their own labor used in a co-operative manner.

Problems of clerical labor, cost-keeping and reorganization are discussed.

Although the author does not deal with any particular problem in a specific manner so that the value may be realized of the schemes introduced at certain leather and paper-pasting factories, he gives some indication of the methods adopted to benefit by workmen's tendencies, gang piecework, etc.

The book is well written, interesting, and is worthy of a careful perusal.

PUBLICATIONS RECEIVED.

Board of Railway Commissioners, Canada. Ninth annual report. 559 pp.; 6 x 9 ins.

The Radium-Uranium Ratio in Carnotites. Technical paper 88, U.S. Bureau of Mines. 28 pp.; illustrated; 6 x 9 ins.

The Nakimu Caves Glacier, Dominion Park, B.C. A 28-page illustrated booklet issued by the Dominion Park Branch, Department of the Interior.

Glaciers of the Rockies and Selkirks. A handsomely illustrated and printed 29-page booklet prepared by Dr. A. P. Coleman under the direction of the Minister of the Interior.

National Transcontinental Railway. A booklet illustrating the stations on the line, their exact location and mileage from Moncton. Prepared by A. S. Cook, assistant to chief engineer.

American Wood Preservers' Association. Report of eleventh annual meeting, containing constitution and by-laws, list of members, committee reports, papers read, discussions, etc. 527 pp.; 6 x 9 ins.

Express Statistics, Canada, 1914. Report by A. W. Campbell, C.E., Deputy Minister, Department of Railways and Canals, Ottawa, containing statistics for year ending June 30th, 1914, relating to the nine express organizations operating in Canada.

A Study of Boiler Losses. By A. P. Kratz. Bulletin No. 78, Engineering Experiment Station, University of Illinois. It outlines the purpose of the test, method of conducting, discussion of results, summary and conclusions. 72 pp.; 6 x 9 ins.; illustrated.

Topographical Surveys Branch, Department of the Interior. Annual report for year ending March 31st, 1914, including reports of surveyors, schedules, statements and the report of the Surveyor-General. 245 pp.; 6 x 9 ins.; numerous maps, profiles and illustrations.

Corundum, Its Occurrence, Distribution, Exploitation and Uses. By Alfred Ernest Barlow. Issued as Memoir 57, Geological Survey, Department of Mines, Ottawa. 378 pp.; 6½ x 10 ins.; fully illustrated. (This is one of the last works of Dr. Barlow, who was lost in the "Empress of Ireland" disaster in May, 1914.)

Geological Series Nos. 23, 24 and 25. These are respectively "Physiography of the Beaverdell Map-Area and the Southern Part of the Interior Plateaus of British Columbia," "On Eoceratops Canadensis, gen. nov., With Remarks on Other Genera of Cretaceous Horned Dinosaurs," "The Occurrence of Glacial Drift on the Magdalen Islands."

Treated Wood Block Paving. By W. G. Mitchell, M.Sc. Issued by Forestry Branch, Department of the Interior as Bulletin No. 49. It is a compilation of the information that is at present available from researches made in different countries in regard to the use of wood for paving. 40 pp.; 6x9 ins. Sent free on request, by the Director of Forestry, Ottawa.

Petroleum and Natural Gas Resources of Canada. (In two volumes.) Vol. 1, by F. G. Clapp and others, Mines Branch, Department of Mines, Ottawa. This voluminous report deals with the history, geographical occurrence and production of natural gas, the properties of both, the preparations for their development, methods of obtaining, pumping, storage, transportation, utilization and conservation of resources. 378 pp.; illustrated.

CATALOGUES RECEIVED.

Steel Tanks. A booklet descriptive of the exhibit at San Francisco of the Pittsburgh-DesMoines Steel Co.

Pelton Water Wheels. An illustrated leaflet describing the exhibit of the Pelton Water Wheel Co., San Francisco and New York, at the Panama-Pacific International Exposition.

The Knox Tractor. A 16-page illustrated catalogue of the Knox Motors Co., Springfield, Mass., describing the tractor from an engineering viewpoint, and illustrating its characteristic features.

Automatic Starters for Alternating Current Motor. A 20-page illustrated leaflet issued by the Canadian General Electric Co., Toronto, describing automatic control devices, compensators, governors, float-switches, self-starters, etc.

The Cement-Gun Process. Bulletin No. 101 of the Cement-Gun Co., New York, describing the use of the apparatus in repairing coke ovens. Also Bulletin No. 91, a reprint from "The Engineering News," concerning tunnel waterproofing with cement and clay mortar.

Montezuma Asphalt. A handsomely illustrated booklet of 56 pages, prepared by Warner-Quinlan Asphalt Co., New York, giving views of streets paved with this material and letters from prominent engineers regarding it. Some useful tables and specifications are included.

Surveying Instruments. The 1916 catalogue of Buff and Buff Manufacturing Co., Boston. It is a 124-page, 6x9, illustrated book, fully descriptive of this make of engineering and astronomical instruments and parts. The material is concisely arranged, the illustrations are from actual photographs and the information is useful.

Concrete Reinforcement. A very useful 24-page illustrated booklet issued by Canada Wire and Iron Goods Co., Hamilton, relating to their cold-drawn crimped-steel wire reinforcement for concrete. The Brochure contains much useful data concerning bending moments, slab design, weights and quantities of materials, ground-bearing power, wind pressures, wire gauges, etc.

Gas Producer Plant. Twenty-six-page illustrated catalogue issued by the Dowson and Mason Gas Plant Co., Limited, Manchester, describing gas producers and gas-fired furnaces. Another 22-page illustrated, describing pressure and suction plants for gas engines and heating, and a 7-page leaflet reprinting from "Engineering" the results of tests at Chingford of Dowson gas plant.

COAST TO COAST

London, Ont.—A quantity of the rolling stock for the London and Port Stanley Railway has been delivered.

Vancouver, B.C.—The Georgia-Harris Viaduct, the cost of which approximates $500,000, was completed last week. It has been under construction for two years.

Glacier, B.C.—Over a thousand men are at present engaged in tunneling operations in the C.P.R. tunnel under Roger's Pass. It will be finished in the fall of 1916.

Edmonton, Alta.—It is expected that grading on the Edmonton, Dunvegan and British Columbia Railway will be completed to Spirit River and Peace River crossing by October.

Sarnia, Ont.—The county judge commenced an investigation on June 14th into the construction of the $250,000 waterworks plant, which has fallen short of expectation.

Toronto, Ont.—The Godson Contracting Co. is suing the city for extras in connection with the construction of the high level interceptor. Action has been entered to recover $64,540. The Commissioner of Works and the city solicitor refute the claim.

New Toronto, Ont.—The New waterworks plant will be in operation in a few days. All the street mains have been laid, machinery installed, and forces of men are at present engaged in completing the intake, which is about ¾ of a mile out in the lake.

Montreal, Que.—The Angus shops of the C.P.R. are being almost entirely transformed as regards equipment for the manufacture of war munitions. It is stated that about 12,000 men will shortly be employed, and that the plant will work 24 hours a day.

Welland, Ont.—The Canadian Billings-Spencer Co. commenced last week on a $30,000 addition to their plant. It will house six new drop hammers and increase the output of the plant by 50%. The new building is 80 ft. x 70 ft., and will be completed in about three weeks.

Edmonton, Alta.—On Sunday, June 20th, the Canadian Northern Railway took over from the contractors four new pieces of line, part of the main line from Edmonton west to Peace River Junction, 35.6 miles; from Edmonton to Camrose, 48 miles; from Melfort to Ste. Brieux, 21.5 miles, and from Wakopa to Deloraine, 32.6 miles.

Toronto, Ont.—The Don destructor, which is being built by the Department of Street Cleaning, will have a capacity of 150 tons of refuse a day. Construction has commenced, the contractors for the foundations, John E. Russell & Co., having started the driving of 45-ft. piles this week. The Canadian Griscom-Russell Co. will install the furnaces.

Ottawa, Ont.—According to a report from the contractor, J. D. McArthur, grading gangs are now within fifty miles of Port Nelson, on the Hudson Bay Railway line. The first bridge over the Nelson River, which has been delayed owing to the sinking of some trestle work, is now under construction, the approaches having been practically completed.

Montreal, Que.—At a meeting of the Board of Control last week Mr. Fuller, of Hering and Fuller, New York, suggested that an addition be made to the 50,000,000-gallon-per-day filtration plant now under construction, in view of the fact that the city sometimes uses 60,000,000 in a day. He recommended a mechanical filter system, and it is stated that the board adopted his recommendation. The cost is placed at $900,000 as a preliminary estimate.

Toronto, Ont.—The Canadian Stewart Co. has a new steel tug under construction at Grand Haven, Mich., to be used for towing barges in connection with their waterfront development contract. The tug is 82 ft. long, 20-ft. beam, and 10 ft. deep. She is equipped with a fore and aft compound engine 16-34 x 26. Her steam will be furnished with a Scotch boiler 10.3 ft. in diameter and 11 ft. long.

St. John, N.B.—The Board of Trade has adopted resolutions directed to the Dominion and Provincial governments anent the connection of the Transcontinental with the City of St. John. The city is working energetically to secure the best possible connection with the railway, which to them, in consideration of the improvement of the I.C.R. and the construction of new terminals at Halifax, is taking on the appearance of favoring the latter city unduly.

Victoria, B.C.—About 13,000 sq. yds. of pavement work, a part of the city engineer's programme for 1915, have been completed. Work on the construction of the outfall for the northwest sewer system at Macaulay Point has been delayed by reason of the prevalence of winds, the rough water preventing the work being carried on. The necessary materials are on the ground, and as soon as weather conditions permit, the work will be rushed ahead.

Victoria, B.C.—The Dominion Government has a model of the new Victoria telescope now under construction, on view at the Panama-San Francisco Exposition. This is the largest telescope in the world. A description of it appeared in *The Canadian Engineer* for Dec. 10, 1914. It is for the Dominion observatory to be constructed on Little Saanich Mountain. The contract for the building itself has just been awarded to the McAlpine-Robertson Co., of Vancouver.

Montreal, Que.—The widening of the city aqueduct by the Cooke Construction Co. is being continued. There had been some idea of stopping the work for the present, but the Board of Control decided otherwise at a meeting last week. The whole scheme, first launched in 1913, takes in not only the widening of the canal—which is five miles in length—to give means for generating power for the electric lighting which Montreal will need for a long time, and thus effect the elimination of the steam pumps except as auxiliaries, but it also provides for boulevards on each side of the aqueduct; all this in addition to the erection of the electrical plant and a filtration plant.

PERSONAL.

L. S. COCKBURN, B.A.Sc., has been appointed heating engineer for the Glass Garden Builders, Limited, Toronto.

E. J. HOLLAND, city engineer of Guelph, Ont., is resigning to engage in private engineering work in several western Ontario towns.

W. J. DICKSON, graduate of Manitoba University in electrical engineering, has joined the Signal section of the Manitoba University Company.

A. GRANT, superintendent of the service department of the Manitoba Government Telephones, has received a commission in the 61st Infantry Battalion.

S. R. PARSONS, president of the British American Oil Company, Limited, has been elected second vice-president of the Canadian Manufacturers' Association.

THOMAS L. CANTLEY, general manager and second vice-president of the Nova Scotia Steel Co., has been elected first vice-president of the Canadian Manufacturers' Association.

O. LEFEBVRE, C.E., chief engineer of the Quebec Streams Commission, has also occupied the position of secretary since Mr. H. L. de Martigny resigned the position in October last to enlist for active service with the Second Contingent.

OBITUARY.

Recent lists of Canadian casualties at the front record the death in France of Capt. Joseph G. Helliwell, a graduate in civil engineering (1910) of the University of Toronto, and a member for four years of the engineering staff of the Canadian Bridge Company, Walkerville, Ont. Capt. Helliwell, who was 26 years of age, went with the first overseas contingent in command of a company in the First Battalion.

The name of another Canadian engineer is added to the roll of honor, that of Capt. Thos. E. Morrison, who was killed in action on June 15th. He was a graduate of the Royal Military College, Kingston, and was a captain in the Canadian Engineers Corps, leaving with the first contingent.

Another Canadian engineer in the person of Ray Gilhuly, of Selkirk, Man., was killed in action at Ypres. He was in the 2nd Field Co., Canadian Engineers, and was formerly employed in the Canadian Northern draughting office at Winnipeg.

Mr. Joseph Sharenks, a well-known Levis contractor, died suddenly last week, aged thirty-three years.

REGINA BRANCH, CANADIAN SOCIETY OF CIVIL ENGINEERS.

A branch of the Canadian Society of Civil Engineers has recently been organized at Regina. At a largely attended initial general meeting, the following gentlemen were elected as officials and members of the executive committee: Chairman, O. W. Smith; secretary, L. W. Wynne-Roberts; executive committee, A. J. McPherson, F. McArthur, and I. N. De Stein.

COMING MEETINGS.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Annual meeting to be held in Atlantic City, N.J., June 22nd to 26th. Secretary, Prof. E. Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—Annual convention to be held in San Francisco, Cal., September 16th to 18th, 1915. Secretary, Charles Warren Hunt, 220 West 57th Street, New York.

INTERNATIONAL ENGINEERING CONGRESS.—To be held in San Francisco, Cal., September 20th to 25th, 1915. Secretary, W. A. Catell, Foxcroft Building, San Francisco, Cal.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.—Annual convention to be held in San Francisco, Cal., October 4th to 8th, 1915. Secretary, E. B. Burritt, 29 West 39th Street, New York.