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MISSING

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

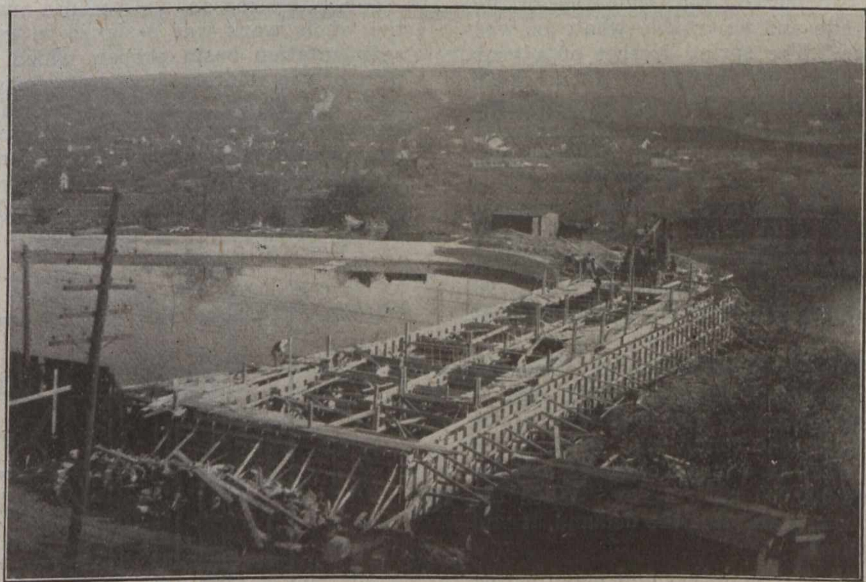
Dundas Has New Filter Plant on Gravity Supply

Expenditure of Only $30,000 Provides Progressive Ontario Manufacturing Town With Modern Filtration Plant of 700,000 Imperial Gallons Daily Capacity — Concrete Dam Forms Conservation Reservoir and Provides Ample Head for the 1½-Mile Pipe Line to Filtration Plant

By E. H. DARLING
Consulting Engineer, Hamilton, Ont.

DUNDAS, Ont., is situated at the base of one of the most precipitous points to be found along the Niagara escarpment. The limestone bluff rises like a wall on the north of the town to a height of 500 ft. At the other end of the town is the head of the old Desjardins Canal, where the water level is that of Lake Ontario, of which the canal is the extreme western limit. The escarpment at the west end of the town is broken by a deep, tortuous gorge, down which a small creek, known at this point as Dundas creek, flows from the tableland above, forming a cascade of about 100 ft. drop, called Websters' falls.

The town's first source of water supply was from certain small springs flowing out of the face of the escarpment at various points, which were piped to a reservoir 200 ft. above the town. As the demand increased the pipe line was extended to a mill dam on the Dundas creek, where sufficient head could be obtained to carry the water over the brow of the escarpment. It was conveyed by an iron pipe line to a rapid sand filter of 250,000 gals. a day capacity, situated at the reservoir.



FORMS IN PLACE FOR FIRST STORY OF FILTER BUILDING

About six years ago, the dam was carried out by a flood, and the whole question of water supply came up for reconsideration. There were three possible sources to choose from:—

(1) The creek from which the water had been obtained in the past.

(2) Desjardins Canal, the water of which was virtually the same as the creek water with the drainage of the town added to it.

(3) Lake Ontario. The only practicable way of obtaining water from this source would be by connecting with the city of Hamilton system, which would mean a pipe line about six miles long. And Hamilton, like all growing cities, has difficulty in meeting its own demand at present. Moreover, the cost of piping and pumping would make it a very expensive proposition under existing conditions. However, if Hamilton should have a surplus of water in the future, and there is a possibility that some day it may have, then this might prove an economical and satisfactory source of supply.

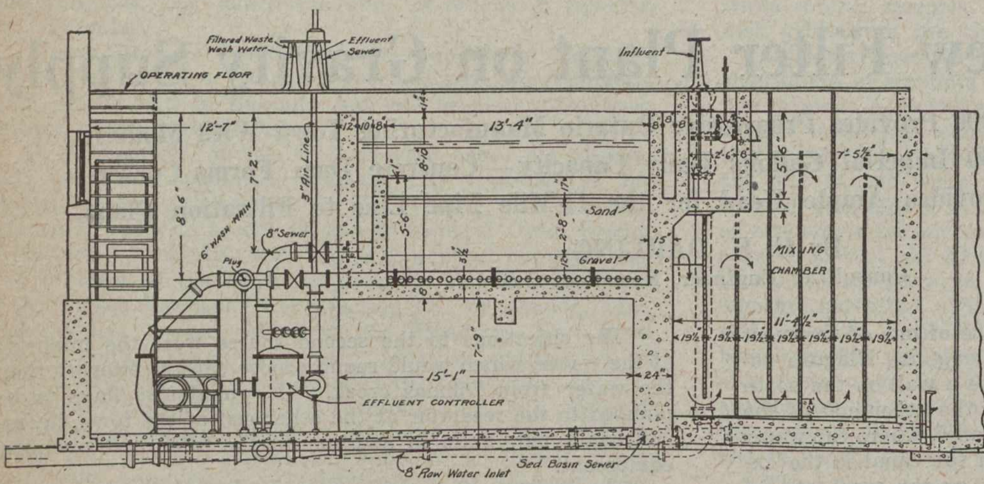
The objections to the second source were the impurity of the water, which would require more careful filtering than the water from Dundas creek. It would also have to be pumped to the reservoir at the other end of the town, necessitating a new main in addition to the filter and pumping equipment.

The possibility of obtaining satisfactory water from deep wells also received consideration, but this idea was abandoned in the absence of any definite information, the geological formation of the district not being promising in this respect. The medina shale which crops out along the base of the Niagara escarpment is the formation in which natural gas is found in the Welland and Haldimand fields to the south and west of Dundas, and at several points along the escarpment "sulphur springs" flow from it; so the probability is rather against the finding of pure water from deep wells in this district. The Public Utilities Commission of Dundas, which has charge of the water works system, therefore decided upon the development of Dundas creek as a source of supply.

Dundas creek has a watershed of about 50 square miles. The thick strata of limestone underlying it forms a shallow irregular basin which retains the rainfall and causes the formation of extensive bogs, once famous as beaver meadows and now known as Beverly Swamp.

The southerly part of the watershed is fairly well drained and cleaned of trees, and is under cultivation. The soil is light and rock comes to the surface in some places. The slope of the watershed is very slight, consequently the flow of the creek is sluggish except in flood time. These conditions result in a large volume of flow in the spring, and a very small volume during the summer, but at all other times the flow is well maintained. In the dryest year this minimum flow is many times the volume required by the town. However, in order to guard against any possible danger from an unusual drouth, the town has formed a conservation reservoir about two miles from the brow of the escarpment, at Greensville, by building a concrete dam at this point.

The original purpose of the dam was to give the necessary head to carry the water through the pipe line over the brow. It is 23 ft. high from the creek bed to the bridge floor and 100 ft. long over all. The crest is 17 ft. 6 ins. from the bed, and provision is made for stop logs by means of which the crest may be raised 3 ft. 6 ins. in the future. The banks and bed of the creek are limestone shale which was blasted out for a depth of one to two feet for the foundation of the dam. It formed an ideal site and no trouble whatever was encountered in construction. The spring freshet of a year ago, which was unusually high and carried ice 18 ins. to 2 ft. thick, took out three other dams on the creek but this dam came through safely, although the water at one time reached a height of five feet above the crest. Under ordinary circumstances the flood rarely reaches a height of 3 ft.



LONGITUDINAL SECTION THROUGH PART OF FILTER BUILDING

The supply pipe line is 12 ins. diameter for a distance of 500 ft., 8 ins. for 8,000 ft. to the brow of the escarpment, and 6 ins. from there to the reservoir. The grade of this 6-in. pipe is about 10%, the total drop to the reservoir being 200 ft., and the water flows down it as in an open channel and not under pressure.

The sill of the sluice gate of the dam is 10 ft. above the high point of the supply pipe line at the brow of the escarpment, which is just sufficient head to give a flow of about 400,000 gals. a day under present conditions. With sluice closed by stop logs, a head of 20 ft. 6 ins. is obtained, and the flow is increased to over 1,000,000 gals. a day. When the present pipe becomes inadequate to meet the demand, it will be rebuilt as occasion requires.

With the steady growth of population and manufacturing, the old filter plant of 250,000 gals. daily capacity became altogether inadequate, and its efficiency dropped so low in the fall of 1916 that the Provincial Board of Health insisted upon conditions being remedied despite war-time prices. In the meantime, as a safe-guard, a Wallace and Tiernan chlorinating apparatus was installed to treat the water after passing the old filter.

The commission favored a scheme for a sedimentation basin and filter having a capacity of one million Imperial gallons a day, and designs were worked up on this basis. This would have involved the building of a sedimentation basin to hold 170,000 gals., and alterations and additions to the old filter to increase its capacity to 900,000 gallons a day. When this filter capacity became inadequate, a new filter could be built equal to the capacity of the sedimentation basin.

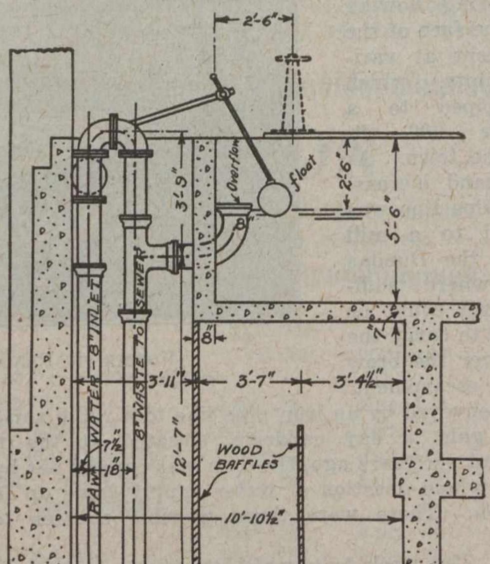
The cost, however, of this work, together with the difficulty of securing a suitable site at a reasonable figure, lead to a reconsideration of the scheme. It was finally decided to build an entirely new plant which would be a complete unit in itself and to which additional units could be added as required. The capacity of the unit was fixed at 700,000 gals. a day, which would probably meet all requirements for several years and yet would work in with a larger scheme without any part of it having to be scrapped.

The new filter is located close to the western edge of the old reservoir, which is utilized as a clear-water basin. A connection is also provided for running the filtered water directly into the town main if desired. This connection, together with the extension of the raw water pipe and the wash water drain for a distance of 270 ft. to connect with the new filter, was all the new piping required.

The new work had to be built on the side of the clay fill which forms the embankment of the reservoir. It was therefore necessary to drive piling to ensure a safe foundation; so 30-ft. piles were driven "to refusal" at 3 ft. centres under all walls.

In order to obtain the necessary head to operate, the sedimentation basin had to be built two-thirds out of the ground, as shown by the accompanying cross-section, and as a protection against frost it is enclosed in a 9-in. brick wall, leaving an air space which is broken up vertically at intervals to stop air circulation.

For this reason, and because available room was limited, the whole work was designed in reinforced concrete. The sedimentation basin proper, which is the most interesting part of the reinforced concrete design, is 16 ft. deep, 22 ft. wide and 60 ft. long, inside measurements, and is divided into two compartments by a longitudinal wall. This long, narrow shape is not usually the most economical to construct, but it gives a splendid section for sedimentation purposes; and the limitations of the site, having in view the unit principal, left no option in this particular.

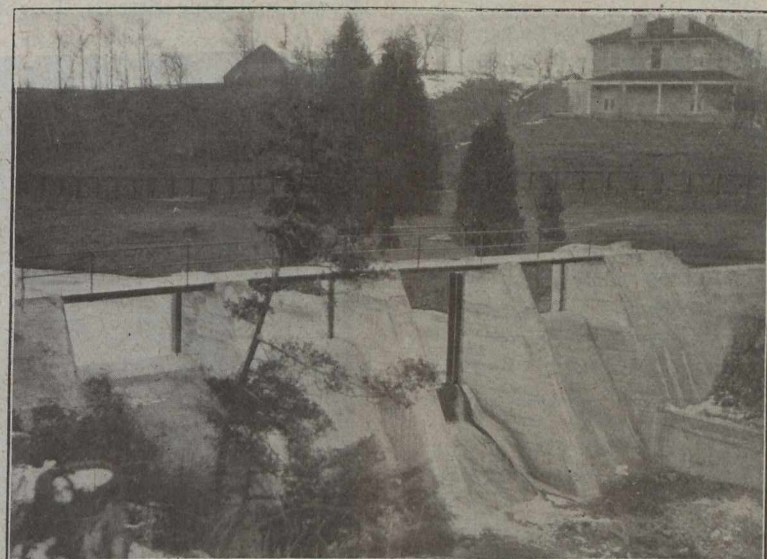


PART SECTION THROUGH MIXING CHAMBER, SHOWING RAW WATER INLET AND CONTROL VALVE

The problem of reinforcing these long vertical walls against hydraulic pressure was worked out as indicated by the accompanying cross-section. Horizontal ties were provided at the top of the basin and at a point about one-third from the bottom. These ties act as abutments for horizontal beams, so that the basin wall is virtually a vertical continuous beam over three supports and fixed at the lowest one. The basin was designed to resist distortion stresses rather than the theorical stresses due to water pressure, as cracks are more to be feared than actual failure.

The coarse aggregate for the concrete work was crushed limestone; and for fine aggregate, limestone screenings or dust from the crusher was used, to which was added sufficient sand to give a creamy mortar.

This limestone dust was used partly because of the high cost of sand in this locality, whereas the dust was readily obtained from a nearby quarry, and because of the dense, impervious concrete that it makes, density rather than hardness being desirable for this work. No waterproofing materials whatever were used, the action of the lime dust being similar to that of hydrated lime in making concrete waterproof. All concrete was mixed in proportion of 1 to 6.



THE GREENSVILLE DAM

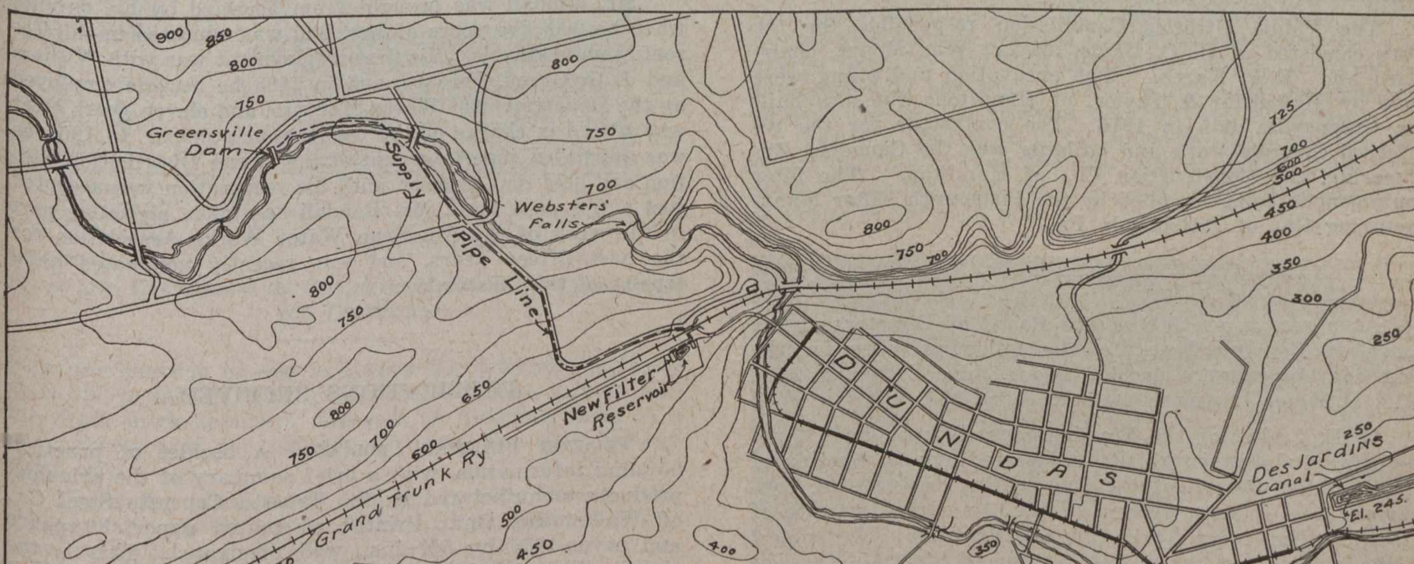
The filter is of the usual type of rapid sand filter, and so far as principle is concerned, has no unusual features. It is proposed to use crushed marble in the filter bed, in proportion of 1 to 2, a practice that has been adopted in several recent filters in Canada. The filter consists of two units, each 11 ft. by 13 ft. 4 ins., operating independently, and is designed for the usual rate of 1.66 gallons per square foot per minute. Each unit will be provided with a rate-of-flow controller and loss-of-head gauge.

The apparatus for back-washing the filter consists of an air-blower of 656 cu. ft. per min. capacity, connected directly to the clear water manifold, and an 8-in. centrifugal pump driven by a 25 h.p. motor. The hand-wheels for all valves used in operating the plant, together with the clutch levers for the blower and pump, are grouped together on the operating floor most conveniently for the operator.

It will be remembered that the raw water flows to the filter in what is practically an open pipe without pressure. The rate of flow is controlled at the Greensville dam two miles from the filter. This fact necessitates somewhat unusual methods of handling the water at the filter. It is admitted to the mixing chamber through a valve controlled by a float in the skimming trough. A constant head will thus be maintained in the filter beds, and any excess water runs to waste.

The sedimentation basin is divided into two sections by the centre partition wall, and by means of the 10-in. by-pass pipe it will be possible to operate either section independently. This will allow the basin to be cleaned without interrupting the town's supply. Under normal conditions, the filter will be run at a uniform rate throughout the 24 hours, the variation in demand being taken care of by the clear water reservoir.

In calling for tenders for the filter equipment, the specifications were made definite enough to ensure uniform tenders, and yet broad enough to permit manufacturers to tender on their own special equipment. Details of baffles and one or two other minor matters were altered in order to



MAP OF DUNDAS AND VICINITY, SHOWING LOCATION OF GREENSVILLE DAM AND NEW FILTER PLANT meet the contractor's requirements, according to his guarantee as to operation.

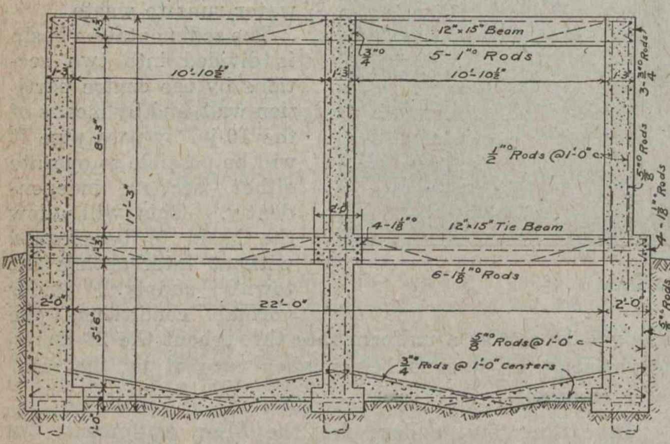
The raw water will pass through the mixing chamber in about 20 minutes, with a velocity of about 13 ft. per minute, and will remain 3 hrs. 40 mins. in the settling basin, when the flow will be about 6 ins. per min.

The cost of the plant was as follows:—

Excavation and piling, ...	$ 1,695
Building, ...	13,350
Equipment, filter company's contract, ...	9,060
Equipment and work supplied by commission,	2,200
Total, ...	$26,305

In addition, several pieces of apparatus will be transferred from the present filter, so that the total cost of the plant will be about $30,000.

This work was undertaken during the most severe war conditions; nevertheless Dundas will have, when it is completed, a waterworks system for an investment much below



Cross-Section Through Sedimentation Basin, Showing Only Concrete and Reinforcing

the average; and as no pumping is necessary, the operating expenses will be extremely low.

The Public Utilities Commission responsible for the work consisted of H. C. Davis, mayor; Wm. Mount, chairman; and R.W. Karch. The excavation and piling were done by McAllister & Taylor, of Hamilton, who also built the Greensville dam in 1916. The contractor for the reinforced concrete work and building was the Canadian Engineering and Construction Co., of Hamilton. The filter equipment is being supplied by the Pittsburgh Filter Manufacturing Co., of Pittsburgh, Pa.

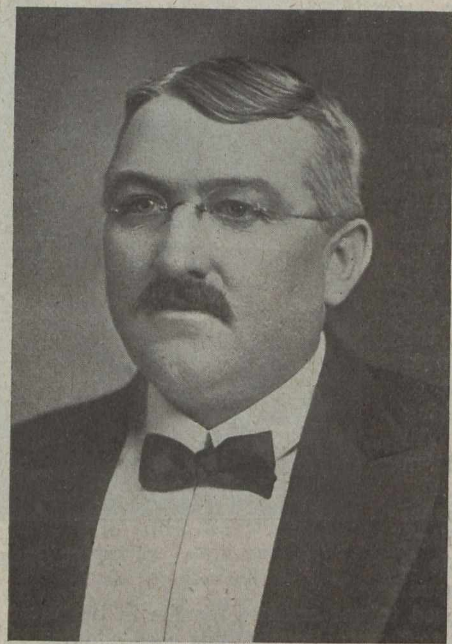
At a recent meeting of the Board of Directors of the American Concrete Institute, the following dates for the next convention were decided upon: June 27th and 28th, 1919, at Hotel Traymore, Atlantic City, N.J.

G. E. Stoltz, of the Westinghouse Electric and Manufacturing Co., Pittsburgh, Pa., addressed a joint meeting of the Hamilton Branch of the Engineering Institute of Canada and the Toronto Section of the American Institute of Electrical Engineers April 11th in Hamilton. The subject of the address was the "Electrification of Steel Mills." The speaker described, with the help of many lantern slides, the advantages of electric motors in every application of power in the manufacture of steel. The address was followed by an interesting discussion. The meeting, which was attended by over 150 engineers, was held in the auditorium of the new office building of the Canadian Westinghouse Co. On the following day, the visitors from Toronto, accompanied by a number of Hamilton engineers, visited the plants of the Dominion Foundries and Steel, Ltd., the Dominion Power and Transmission Co., and the Steel Co. of Canada.

NEPTUNE METER COMPANY ENTERS CANADA

Announcement was made last week that the Neptune Meter Co., of New York City, one of the largest manufacturers of water meters, has decided to have a Canadian branch plant and to engage W. H. Randall, of Toronto, as manager.

The company has obtained premises at the corner of Mowat and King Streets, Toronto, and will begin manufacture about June 1st. Mr. Randall is now in New York making the final arrangements.



W. H. Randall

The Canadian company will be incorporated under the name of the Neptune Meter Co., Ltd., of Canada. The present company has over two million water meters in use, of which about 10% are in Canada. The company manufactures the Trident meter and also the Webber deep well pump and the Fletcher carburetor for automobiles.

The chief officers of the Canadian company will be: J. Herbert Ballantine, president; J. B. Kirkpatrick, secretary; B. B. Vanderveer, vice-president; W. H. Randall, managing director. With the exception of Mr. Randall, these officers are the officials of the parent company in New York.

Mr. Randall was brought from England by his parents when he was five years of age, and was educated in the Toronto public schools. His first employment was with William and J. G. Greey, Toronto, and in 1888 he became employed by the Department of Works, Toronto, and eleven years later was placed in charge of the department's shops. In 1909 he was appointed superintendent of the Water Distribution Section and held that position until his resignation was accepted just a few days ago. Mr. Randall has taken an active part in the work of the American Water Works Association for the past fifteen years, and was recently nominated as a trustee of that association.

PUBLICATIONS RECEIVED

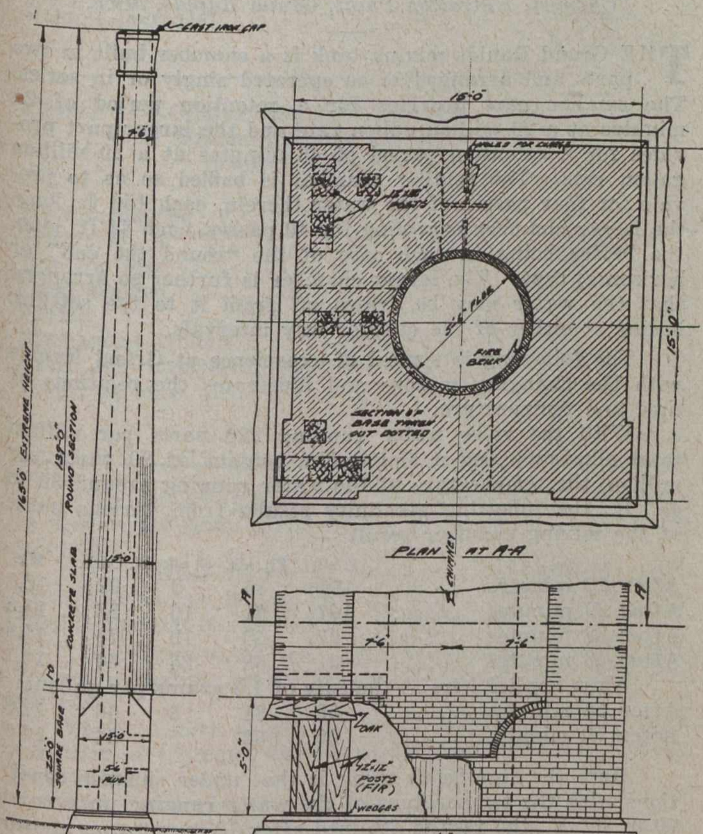
Truscon Building Products.—A booklet of practical building information, with a brief summary of the principal products manufactured by the Trussed Concrete Steel Co., of Walkerville, Ont. Printed on coated paper, 80 pages and cover, 3¼ by 5¾ ins., well illustrated. This is the eighth edition of this small but widely circulated catalogue. It describes and illustrates everything that the company manufactures in Canada. It is distributed gratuitously to engineers, contractors, architects and owners. The catalogue describes the Truscon line of adjustable inserts, casements, chemical products, column hooping, corner beads, curb bars, diamond mesh lath, edge protectors, elastic filler, factory sash, flat slab chairs, floretyles, hyrib, lorib, metal lath, pressed steel inserts, rib bars, road expansion plates, road mesh, slotted inserts, spot grounds, socket inserts, trussed bars, waterproofings, etc.

DEMOLISHING TALL BRICK CHIMNEY

By Hon. Ralph B. Chandler
C. D. Howe & Co., Consulting Engineers, Port Arthur, Ont.

WHERE the proximity of other structures defines the direction and limits the space into which a tall chimney must fall, there is present the hazard that it may deviate from the required line of fall and clear a path for itself to the ground. Consequently there is always a feeling of relief and satisfaction for those responsible for the work when the once tall and stately land mark is again a rugged pile of bricks, laid out along the ground in the space provided.

The universal practice of toppling chimneys from their bases may seem to the average observer to be merely a spectacular show provided by engineers. Such is not the case; the question of cost is always the determining factor as to the method in which work shall be done, and in taking down brick chimneys, the cost of dropping them is a mere fraction of the expense of doing the work in any other way.

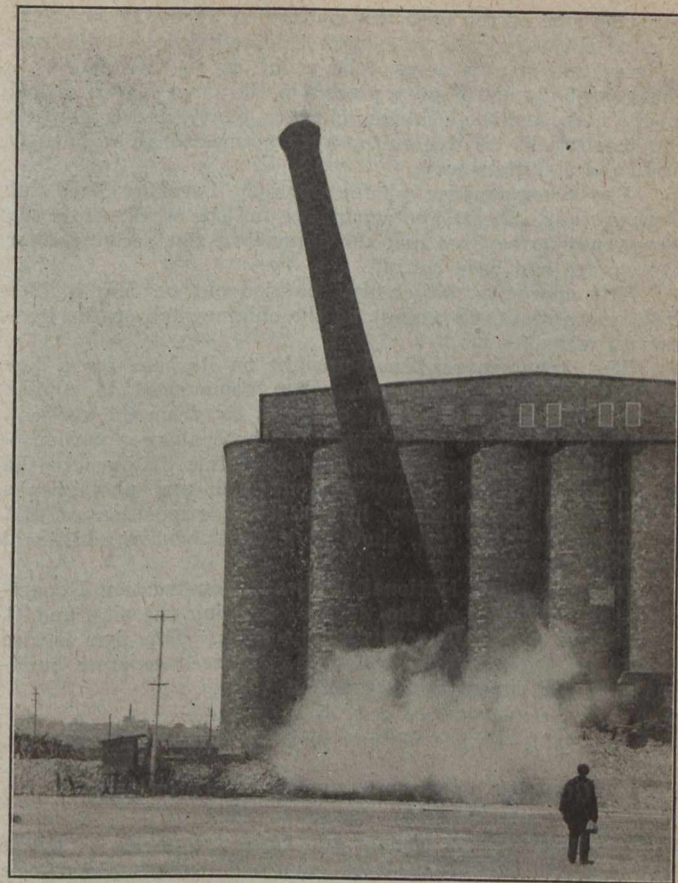


Plan and Elevations of Chimney, Showing Preparations for Demolition

The writer recently had occasion to take down a brick chimney, and for the benefit of those of the profession who have not witnessed the feat, a brief explanation of the method employed may be of interest.

The work was in connection with the demolition of the old "B" workhouse of the Canadian National Elevator at Port Arthur, Ont., erected in 1904, and now being torn down to provide a location for the new modern rapid transfer elevator to be erected on the same site.

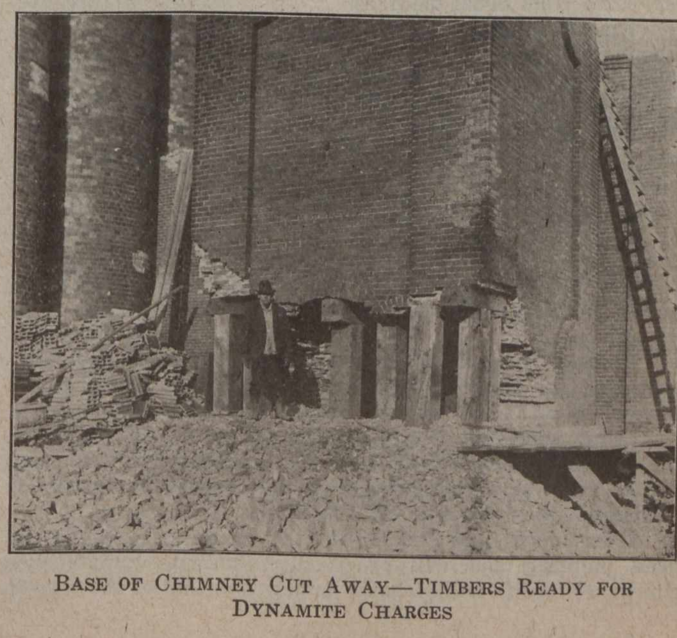
The old elevator was rope-driven and provided with a steam engine plant of its own. Steam was supplied by a battery of four 200 h.p. externally-fired, horizontal, tubular boilers, and for these the chimney in question did service. Its height was 165 ft. and it reached the level of the cupola roof peak.



Chimney Falling and in Position 15° from Vertical

The accompanying sketch gives the general dimensions of the structure and shows the extent of work done to undermine the base, and also the timbering provided to sustain the superstructure as the brickwork was removed. This work was carried on by drilling and blasting with dynamite. The bricks were laid in cement mortar and their removal with chisels and hammers proved most tedious, so that blasting was resorted to with excellent results. The charge found to give best action was about two sticks of 40% dynamite per hole, shooting three holes in succession on each side of the cleanout door in base of chimney.

The work proceeded to the stage indicated and then the supporting 12-in. x 12-in. timbers, eight in number, were bored about 12 ins. up from the base, and loaded with one stick of explosive for each post.



Base of Chimney Cut Away—Timbers Ready for Dynamite Charges

One side of the base was not cut away to the same extent as the other, and to remove this additional section and to give uniformity across the point of the wedge, three charges of dynamite were placed in the holes shown dotted on the plan, and the combined charges, eleven in all, totalling fourteen sticks of dynamite, were connected to a battery and fired simultaneously.

The accompanying photographs by Lovelady Bros., of Port Arthur, official photographers for the work, show the base ready to be fired and the chimney a few seconds after the charge had been set off.

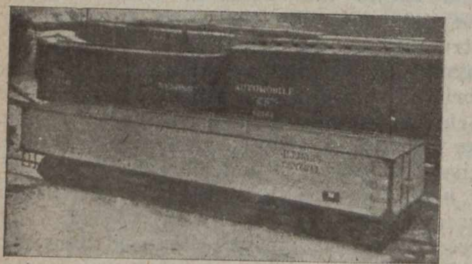
The operation, which was carried out on March 12th last, was a distinct success and the chimney fell on the location provided.

The structure remained upright on its base for a few seconds after the blast, and then commenced to topple. When it had reached a point of about 15° from the vertical, it sheared off about 30 ft. from the base along a perpendicular line, the upper section dropping this distance to the ground. The outward motion continued, and photographs taken when the chimney had reached a position of 25° around the arc of fall, show indications of five additional shearing sections.

The Canadian National Railways Construction Department are carrying on the work of clearing the site, and C. D. Howe & Co. are supervising the work. This firm is also preparing the plans for the new reinforced concrete building and will supervise its erection.

GONDOLA BUILT WITH CEMENT-GUN

NEW uses for the cement-gun come frequently to public notice. One of the latest, and one that promises to be far-reaching, is the "gunite" freight car. The beginning of practical plans for the manufacture of reinforced concrete freight cars dates from 1909, when a patent for such a car was granted to Joseph B. Strauss, Chicago.



On account of the war, construction of a trial car was delayed, and it was but recently that the first car, of the gondola type, was completed by the R. F. Conway Co., Chicago, and tested under service conditions. Not only in the material used, but in its design and the details of construction, it represents an interesting departure from usual methods.

The basic feature of the design is a steel skeleton body forming the outer boundary of the car, and mounted upon a steel underframe. The gunite walls and floor are contained within this frame and, together with the frame and floor reinforcement, are connected to, and interlocked with, the underframe. The steel frame forms the finishing and protecting edges, thus entirely shielding the gunite and also serving as a complete system of stress-bearing members.

The forms were placed on the outside of the car, and the gunite was shot against them from within. The outside of the car, that is, the surface against the forms, was given a smooth finish, but the interior was left much as it came from the gun.

Tests of the completed car, both empty and loaded, demonstrated its practicability for rough service. In the test without load, it withstood extremely rough handling in switching, and came through without injury. Subsequently, the car was loaded with 55 tons (10% overload) of sand and turned over to a switching crew for service handling. It withstood this test also without injury.

Other merits are claimed for the gunite car. It will not need painting and will practically eliminate maintenance charges. Its life will be much longer than that of the wooden car. It will have the important advantage, also, of being unaffected by its cargo, and will consequently be adapted better than the steel car for hauling slag and ashes.

Plans are already under way for the quantity manufacture of these cars. The fact that the first one was built with the sanction and co-operation of the United States Railroad Administration, and that the Illinois Central Railroad took an active interest in its construction and test, indicates that further production probably will not be long delayed.

LIME SOFTENING OF WATER AND THE USE OF SLUDGE AS AN AID*

By W. A. Sperry
Chemist, Filtration Plant, Grand Rapids, Mich.

THE Grand Rapids mixing tank is a chamber built in two parts and arranged to be operated singly or in series. The smaller part provides for a retention period of 22 minutes at a 20 million gallon rate and the larger part provides for a retention period of 45 minutes at a 20 million gallon rate. The smaller chamber is baffled so as to provide for four passes of the water therein, each 150 ft. long, the larger chamber providing for 49 passes, each 44 ft. long, the baffles being in each case of the "round the end" or horizontal type. The larger chamber is further so arranged that the water may be drawn off from it to the settling basins at either of the quarter way intervals.

The following is typical of experience at Grand Rapids with the changing seasons and illustrates the relations of time and temperature.

With the river water running 220 parts per million total alkalinity and a magnesium content of 20 parts per million, the temperature of the water ranging around 32 to 45° F., the following alkalinity results from various parts of the mixing chamber result:—

	T. alk	Ph. alk	C. alk	N. Carb.	Mg.
After 23 minutes	101	55	9	92	15.1
After 29 minutes	107	61	19	88	15.8
After 38 minutes	97	58	19	78	15.8
After 48 minutes	91	58	25	66	15.1
Alum applied here at the rate of 1.5 grains per gallon.					
After 54 minutes	59	31	3	56	11.8
After 70 minutes	59	32	5	54	10.9

Here the significant thing is that under summer conditions with the temperature of the water ranging up around 70 to 80° F., the results attained after 70 minutes, as shown above, would be attained at the 23 to 29 minute point with the alum dosage ranging 1 grain per gallon less and with greater rates of pumpage.

The essential feature of chemical application that seems to have crystallized into definite practice for lime softening at Grand Rapids is that the lime should be added at the earliest possible moment to the water under treatment:—

(a) To insure as far as possible complete precipitation of calcium as carbonate.

(b) To maintain sufficient caustic alkalinity or excess of lime that there may be 5 to 10 parts per million remaining in the water at the point of discharge into the settling basins, that the magnesium may be carried through the more soluble carbonate state to the less soluble, colloidal hydrate state.

(c) To delay the application of the coagulant as late as possible to the mixing chamber to still be assured of its thorough mixing with the water before discharge to the settling basins, the alum playing a part not so much chemically to reduce alkalinity as physically to scour out and precipitate colloidal matter.

*Abstract of a paper presented March 25th at the eleventh annual meeting of the Illinois Section of the American Waterworks Association.

The application of this water to the filters and city mains has resulted, through a somewhat insufficient period for "curing" or "maturing" in the settling basins, in a very moderate amount of after reaction trouble which has:—

(A) Much incrusted the filter sands, though the extent to which this has occurred lessens by that much, trouble in the distribution system.

TABLE I.—CONDITION OF THE SAND, 1912-13 AND 1918

	Sand as placed, 1912	Sand as found Aug., 1918
Effective size	0.27 mm.	Above 1.05 mm.
Uniformity coefficient ...	1.61	1+or—
Acid soluble	6.5%	84.7%
Approximate thickness of coating	None	0.255 M.M.
Sp. gravity	2.651	2.173
Volume increase	1 vol.	1 vol. sand, 6.5 vols. coatings

TABLE II.—CLASSIFYING THE TROUBLES FOUND WITH THE 3,827 METERS SHOPPED BETWEEN JUNE 1 AND JUNE OR JULY 1, 1917-18

	Per cent.	
No information	4.9	189
Meters O. K.	0.1	3
Out for test	0.2	7
Sand clogged	1.5	57
Frozen	8.1	310
Mechanical trouble	19.3	738
Lime and mechanical trouble	12.1	461
Limed up only	53.9	2,062
	100	3,827

(B) Limed up about 10-11 per cent. of the 22,000 meters in service per year, Grand Rapids being some 97.8 per cent. metered.

(C) Coated the service mains to a thickness of 1/16th to 3/32nd inches in the last six years, and causing some trouble thereby in the opening of valves and gates.

(D) Given some more or less persistent trouble with hot water heating apparatus, gas heaters, furnace coils and the like.

Tables I and II give in some detail the comparative condition of the sand and the history of the meters for the year 1917-18.

This represents 17 per cent. of the total number of meters in use, 66 per cent. of which were lime coated enough to cause their shopping, an item of considerable expense.

Trouble With Heating Systems

During the winter of 1912-13, the first year of operation, there was a rather intensified period of trouble with the hot water heating systems. Steam coil heated tanks would become "furred" 3 to 4 ins. thick in a week's time. Instantaneous gas heater coils would become completely choked up, as would the furnace coils, later burning out. We are convinced, however, that much of this trouble could have been avoided by better design in the way of more ample pipe sizes, and in the simplifying of design by the elimination of many unnecessary ells, and other reductions, all of which seemed favored places of deposit for the lime coatings.

This trouble was the more aggravating in that it occurred at such a time as to make concurrent the most difficult water to treat with the greatest demands for hot water heating.

Laboratory tests seemed to identify this with the per cent. of magnesium removed, such that when the removal effected was 25 per cent. or more the trouble from this source was reduced materially. Operation in the succeeding years, therefore, became controlled by the per cent. of magnesium removed, in that with magnesium removed to the extent of 33 to 46 per cent. troubles due to after deposits were apparently diminished and complaints arising from trouble with hot water heating apparatus decreased.

Within the last year continued efforts to cope with the small but persistent troubles arising from after deposits, coupled with reasons of an economic nature arising out of the increasing costs for alum, have led us to change somewhat our ideas as to the exact role played by the magnesium in lessening such troubles, in that whereas formerly, we believed our troubles due almost entirely to colloidal magnesium and bent all efforts towards its removal, through increases of the amount of alum used and the rigid maintenance of residual caustic alkalinity, the fact that magnesium was not a predominating characteristic in the coatings deposited, there being but 8 to 15 per cent. therein, did not seem to "square" with our theory, even though it was a pronounced fact that removal of magnesium was consistent with reduced after reaction troubles.

Change of Theory Regarding Cause

We are beginning to suspect that in reality the major cause of our more stable effluent lay in the fact of a reduced normal carbonate content of the water going to the city mains. That while it was true that increase of alum and maintenance of caustic alkalinity increased the amount of magnesium removed proportionately, it also not only reduced the normal carbonate content of the water, but in addition maintenance of caustic alkalinity tended to prevent deposit to some extent of that portion of normal carbonate that may have been present in a supersaturated state.

Table III is interesting as throwing some light on this fact.

In 1912-13, occurred our worst period of after deposit troubles. For that year our magnesium removal was but 25 per cent. and the normal carbonate alkalinity of the city water for that period was greater than for the average of the succeeding years by 51 per cent., being 65 parts per million as against an average of 43 for the five succeeding years.

There was a constant seeking for some method of operation that would compensate for our rather insufficient settling basins for lime softening operations such that would save to ourselves all the desirable and economic features of a soft water without a continuance of the various troubles discussed and without the expenditure of increasing amounts of alum, the cost of which was mounting.

TABLE III.

Year	Normal carbonate, city mains	C. alk water, city mains	Per Cent mag. removed	Grains alum applied
1913	65	1	25.0	1.0
1914	44	5	33.6	0.7
1915	48	3	37.6	0.9
1916	43	3	43.7	1.2
1917	39	5	46.7	1.7
1918*	41	6	42.2	1.2

*To August 1st.

Results stated in parts per million and representing the yearly average.

The experiments were largely inspired by what was being done with the use of air and sludge in the treatment of sewage and the possible feasibility of pumping back in like manner the settling basin sludges into the mixing chamber to intensify the removal of colloids, to save alum if possible, and at the same time to so accelerate the "curing" of the water as to stabilize the effluent to a point of possibly eliminating entirely the after reaction troubles and their attendant annoyance to the hot water user, the expense of cleaning limed meters, and the elimination of sticking gates and valves.

The sludge in question is a mixture of some 85 per cent. calcium carbonate, 4 per cent. magnesium hydrate, aluminium hydrate, mud, organic matter, etc., and is produced in enormous amounts. It collects to the extent of covering our settling basins, which are approximately 110 ft. by 210 ft., by 12 to 15 ft. deep, with a layer of sludge from 1 to 10 ft. deep, with 1/3 to 1/2 the area covered to a depth of 8 to 10 ft. deep every one and a half to two months, and aggregates 6,000 to 7,000 tons a year, based upon an average pumpage of 12.2 million gallons per day, and a reduction of the raw water in total hardness through the use of lime of from 225 parts per million to 95 parts per million for the water passing to the city mains as the average for six years, a reduction of 60 per cent.

Preliminary laboratory experiments indicated:—

(A) That time of contact was not a factor beyond the time required for thorough inter-mixing.

(B) That the volume of sludge in contact was of exceeding importance.

(C) That the sludge was most effective when applied to water from the mixing chamber taken at a point just after the alum addition, i.e., at a point where the normal lime reactions were most nearly completed.

(D) It seemed most effective, therefore, not so much to hasten the chemical reactions as to remove the products of the reaction.

(E) That the sludge did not seem so effective, at least in the volumes attainable by the pumps at hand, when applied to water treated under summer conditions as when applied to water treated under winter conditions.

Table IV. is typical of some of the laboratory results and illustrative of points A and B above.

In each case the amount of air applied was such as to just keep the sludge well up in suspension, the result of which was to form the sludge into large, ragged, feathery flocks as large as the end of one's little finger that fairly seemed to fall from suspension like sand.

These experiments looked so promising that during the winter of 1916-17 arrangements were made to carry out a plant-sized experiment.

Arrangement of Plant

At the point of discharge of the mixing chamber into the settling basin a 6-in. centrifugal pump was set up coupled to a spare 10 h.p. motor. Its suction was dropped into the settling basins at a point where the sludges accumulated to the greatest depth and connected to a line running lengthwise of one section some 100 to 120 ft. long, bored with 1-in. holes on alternate sides of the horizontal diameter and spaced so as to be 1 ft. apart on alternate sides of the pipe, i.e., a hole every 2 ft. apart on either side. The pump was further arranged to discharge into the mixing chamber at a point some four to six passes from its place of discharge into the settling basin.

Several runs were made with this pump so arranged, the results of which proved largely confirmatory of the preliminary laboratory experiments, especially as regards its effectiveness in the winter months versus the summer months as regards the importance of the volume of sludge in contact with the water under treatment to realize marked results.

It was one of the expectations of such a treatment that with a water so reduced in alkalinity and normal carbonate content there would be a diminishing of the drop in alkalinity on passing the filters that would be strong evidence of the stable character of the water so produced and be strongly in contrast with our usual experience.

TABLE IV.—WATER TAKEN FROM NEAR THE END OF THE MIXING CHAMBER AFTER THE APPLICATION OF THE ALUM AND AT A TEMPERATURE OF 32-35° F.

		T. alk	Ph. alk	C. alk.	N. carb.	Mg.
Water unsludged	....	61	28	0	56	16.3
5% sludge by vol.	3 minutes	32	15	0	30	13.4
5% sludge by vol.	10 minutes	29	12	0	24	12.4
10% sludge by vol.	3 minutes	27	12	0	24	11.0
15% sludge by vol.	3 minutes	23	11	0	22	9.6
20% sludge by vol.	3 minutes	20	9	0	18	9.6
25% sludge by vol.	3 minutes	19	9	0	18	8.6

To this extent the process was encouraging but proved unfavorable on the following considerations:—

(A) Because of the difficulty of getting a constant supply of sludge and of getting it in sufficient amounts.

It was assumed that the sludge could be made to travel somewhat as a belt, that it could be lifted into the mixing chamber, where it would do its work, only to deposit rapidly again, the suctions being laid in a place thought to be most favorable for such abundant redeposit, especially in view of the fact that it was constantly being added to by the newly treated water. Actual pumping, however, soon showed our inability to supply sludge at a rate greater than to get an application of more than 5 to 7 per cent. by volume of the sludge and for a period of more than 1 to 1½ hours at a time, when in the midst of plenty we would run out of sludge entirely.

Some Other Device Needed

Sludge could be pumped each time till there had been produced about each suction hole a more or less cleared area, after which the sludge would cease to come and the experiment for the day would have to be terminated till such time as the sludge had again been built up. The sludge absolutely refused to flow to the pump suctions and the permanent adoption of such a scheme seemed dependent on the use of some device that would either bring sludge to the suctions or through the use of a Dorr Thickener or else the devising of some type of traveling or flexible suction that would follow up the sludge. Neither of these schemes seem impossible of solution.

(B) The production in the water of a finely divided suspended matter both difficult and expensive to remove by the use of alum—procedure hardly to be considered in view of the fact that the whole object of the scheme would be defeated in that it was the desire to conserve our alum.

The production of this finely divided suspended matter was at variance with the laboratory experiments, and is somewhat difficult to explain, unless the mechanical action on the sludge, as it was drawn through the many suction holes and thrashed about in the pump impeller, was responsible, though there is to be set against this idea the fact that water dipped from the mixing chamber just at its time of discharge showed the same large ragged flocks that were produced in the laboratory with air agitation, and the same tendency to rapidly settle. It was also impossible to get sludge runs long enough to gain an idea of just how such a water would act on the filters, either to rapidly increase the loss of head, the amount of wash water, or how it would interfere with the quality of the effluents.

No agitation was used in the plant-sized experiments other than that afforded by the normal baffling of the mixing chambers, this point again checking the laboratory findings of the comparative importance of the volume of the sludge used rather than the length of time in contact.

Exact Explanation Difficult

It is difficult to state with sureness any exact explanation of these phenomena. It would appear that they are largely mechanical in that the sludge made use of contains no residual chemical activity, in that the sludge apparently acts to scour out colloidal matter, as evidenced in the reduction of the magnesium content of the water, as was further evidenced in the apparently greater efficiency to so do when applied to the water that has its lime reactions most nearly completed, and finally as evidenced in the fact that the reduction in the normal and total alkalinity must come about through the introduction of the many crystals of calcium carbonate that act as foci for the more rapid formation of such crystals than normally takes place.

Contracts have been awarded for the construction of an incinerator at Sarnia, Ont. Thos. Grace, of Sarnia, will construct the building; the Rust Engineering Co., of Cleveland, the chimney; the Jarvis Engineering Co., of Boston, the furnace. Estimated cost is about $25,000. James, Loudon & Hertzberg, Ltd., Toronto, consulting engineers.

STEAM RAILROAD ELECTRIFICATION

A Glimpse at Both Sides of the Problem—Some of Electrification's Possibilities as Affecting Future Railroading Policies—Demand Will Exceed Supply

By Calvert Townley
Assistant to President, Westinghouse Elec. & Mfg. Co.

ELECTRICITY now performs every railroad service previously rendered exclusively by steam locomotives and in every case does it better than it was done before. But in order to use electricity, a large investment in equipment and installation must be made and electrification has proceeded slowly because railroad executives were not convinced that the advantages to be gained are always worth the cost.

The progress of electrification has also been impeded, first, before the war by the difficulty in financing, due to conditions other than the merits of electrification, and second, during the war because every one was too busy to consider any work that could be deferred and because the government's taking over the railroads created an unsettled situation not conducive to the investment of new capital for future returns. Now, however, there seems to be ground for hoping that these bars to progress will be removed in the not distant future, so that electrification can be again studied on its merits; therefore our consideration of the subject is timely.

A Fundamental Mistake

In reviewing the past twenty years' history of this question, I cannot escape the conclusion that we electrical men, and not our steam road colleagues are responsible for the slow progress made. We have not known enough about either the science or the art of railroading. Our belief in, and our zeal for, our own profession has led us, albeit with entire honesty of purpose, to make more or less extravagant claims as to what we could do and to underestimate the cost of doing it. The inevitable reaction of mind which followed an accurate determination of facts of course disturbed confidence in our judgment. But if at times we have injured the cause of electrification by claiming too much, strange as it may sound, we have injured it a great deal more by not claiming enough.

Electrical engineers, not having always been railroad men, have been unable to study railroad problems as they should have been studied; that is to say, with only real and not with any arbitrary limitations before them.

It has been natural for the electrical man to ask the railroad man for a statement of the conditions he was expected to meet. It was equally natural for the railroad man to prescribe the conditions upon which his steam service was predicated. Under these circumstances, the problem became largely one of replacing one sort of locomotive with another, and of balancing hoped-for economies in operation and maintenance on the one hand, against fixed charges for the additional investment required, on the other. Right there comes the mistake,—a perfectly natural but yet a fundamental mistake, for which no individual or class should be censured but for which the unusual development of the art is responsible. We cannot blame railroad men for not being electrical engineers, nor electrical engineers because they are not railroad men, but the progress of electrification has to lag until both should be able to see, each with the eyes of both. It is only by combining the railroad man's knowledge of the fundamental requirements of his service with the electrical man's skill in applying electricity to perform that service, that all the possibilities of any specific problem may be developed.

Not Merely a Substitution

The electrification of a railroad is not simply the substitution of one kind of locomotive for another. It is far more than that. It is the adoption of a fundamentally different method of train propulsion. It is conservative to say that, within the bounds of ordinary practice, electricity can furnish every train with all the pulling power that can be used. The limitations of the steam locomotive in this respect disappear and ruling grades rule no longer. A strictly limited motive power is replaced by one that is practically unlimited.

There are a number of so-called "systems" of electric traction and heavy emphasis has been laid by the advocates of each upon its points of difference from every other. So much has been said about these differences and so little about the points of similarity as to create an entirely misleading impression. It is a fact that there are more kinds and types of steam locomotives in use many times over than there are electric systems. It is a fact that except for the storage battery locomotive, which has but a limited field of application, all electric systems have many more common features than differences. It is a fact that they agree on fundamentals and differ in detail only. Their costs may not be the same, their efficiencies may vary, but they all do their work and do it successfully and well.

Unlimited Power

The possibility of unlimited electric power is a characteristic not of any one system but of all. It is due to basic differences between steam and electric equipment. A steam locomotive is a complete independent unit which not only generates but also utilizes its power. The electric locomotive generates no power at all. It is only a translating device receiving energy from an outside and a remote source. The electric power house, always having much greater capacity than any one locomotive, can supply ample power for the heaviest train on the steepest grade. The steam locomotive, which carries its own power house with it, is limited to its boiler capacity.

By the multiple-unit principle, as many electric locomotives as may be needed can be coupled together and operated in synchronism by one crew from any cab. Any required tractive effort can thus be exerted without slipping the wheels, without imposing undue strains on the rails or bridges and without increasing the number of engine crews.

The business of a railroad is to transport freight and passengers. I put freight first because on the average it produces 73% of the revenue. Unlimited motive power permits longer trains and higher schedule speeds. On the Elkhorn grade of the Norfolk & Western, the schedule speed was doubled. It cuts the operating cost by hauling more cars with the same or a smaller crew. The Norfolk & Western uses two electrics to do the work of three Mallets. These new opportunities at one fell swoop banish many of the railroad's time-honored traditions. The traffic possibilities must be studied from a new angle, and advantage taken of every facility. It is a new thought to realize that train length is limited not by motive power but by the yard tracks and length of sidings, or that all the trailing tonnage that the draw bars will stand can be hauled. Nor are these new limits fundamental. Sidings can be extended, draw bars can be made stronger, if it pays to do it. In a word, electrification opens up tremendous possibilities of increasing the freight capacity of a road and without it being necessary to build additional tracks.

Enhances Real Estate Values

While not as important as freight, passenger traffic likewise comes in for its share in the widened horizon and the vanishing tradition. Unlimited power, of course, is available; but the absence of combustion is another basic advantage. Smoke and cinders disappear. Tunnel operation loses its terrors. Unobscured signals permit normal speeds with undiminished safety. Projects like the Pennsylvania terminal in New York, depending entirely on submarine tunnel operation and previously impracticable, become immediately possible. Railroads owning valuable realty in cities, can erect buildings thereon, where smoky locomotives previously made any structure above the ground level impracticable. The aerial rights are now valuable. Multiple unit operation has in fact made suburban traffic. The rapid acceleration made possible by electric traction has directed attention to the equal value of rapid retardation, and has quickened the study of braking accordingly; also of modified coach design to bring about the more efficient loading and discharge of passengers.

These combined possibilities secure increased schedule speeds and attract patronage. The people not only get over the line in a shorter time but, as a corollary, more people get over it in the same time. Again it is seen, therefore, that in passenger as in freight traffic, the ability to do something that could not be done before, rather than to do the same thing at a lower cost, is the most valuable attribute of electrification; and again we find a greatly augmented capacity without the need of additional tracks.

How Far Will It Lead Us?

It is not my purpose to make an exhaustive comparison of the relative advantages of steam and electric operation. That has been done often and well by others. What I have said about the expanding opportunities for electrified service is by way of illustration to emphasize my plea that the question should always be viewed in its broader aspect and not hampered and restricted within any narrower limitations than properly belong to it.

I am going to assume, then, the broadest possible treatment and to suppose that every electrification project is to have its pros and cons most fully examined. The real and vital question then is, "How far will this lead us; to what extent may we expect complete electrification of all our roads?"

Parts of a number of them have already been equipped. Many of these are numbered among our prominent roads, successful corporations which have had the advice of the most highly skilled executives and engineers, and which are progressive. The service performed on the electrified sections comprised practically every kind of railroad transportation. The Bluefield division of the Norfolk & Western, in West Virginia, is an example of an important coal road operating through the mountains. The Chicago, Milwaukee & St. Paul 440-mile main line, through Idaho and Montana, demonstrates what can be done by a transcontinental carrier on a large scale with through traffic, both freight and passenger. The New York, New Haven & Hartford 73-mile stretch between New York and New Haven shows how through freight and a heavy passenger traffic can be taken care of on the most congested four-track section of an important eastern carrier, and what is possible for complicated freight yard operation; while the New York Central and the Pennsylvania out of New York City are splendid examples of our greatest modern passenger terminal electrifications.

All Present Electrifications Successful

There are, of course, many other electrifications, but even if there were not, those named are of a character to command the respect and attention of the railroad world. Now, every one of these projects have been successful. Every one has justified itself. Nearly every one, in its present scope, represents an extension of the zone initially electrified, the most convincing evidence possible as to what views the operating companies hold regarding these several projects.

Railroad officials are generally glad to give others the benefit of their experience so it is reasonably safe to say that operating statistics are available covering long enough periods so that the results to be expected from any proposed undertakings may be predicated upon established facts and not upon theories. In the light of present day knowledge, therefore, what answer can we make to the question, "Should all railroads be electrified?"

Taken together, in 1910 there were in the United States 240,000 miles of railroad main line, regardless of the number of tracks. Of this mileage, approximately 1,250, or one-half of 1%, has been electrified or is to-day in process. The remaining 99.5% comprise, of course, roads performing every variety of service. They range from the back country branch line built by some over-enthusiastic promotor and now, perhaps, operated as part of a large system only because operation cannot be avoided (and regularly contributing its annual deficit), up to the most important through arteries of travel upon which the commerce and industry of the nation depend.

Every sort of community is served; every kind of railroading has its place in this vast aggregation of effort, and the variables in the problem are so multitudinous and their nature often so profound, as to well daunt the courage of one who seeks to formulate them for incorporation in a general statement.

Fortunately or unfortunately, depending on the point of view, it has been my lot to have to deal with this electrification problem from both sides: At one period from the standpoint of an intimate affiliation with the development and manufacture of electric apparatus, and at another from that of one charged with official responsibility on the railroad's behalf. I am a thorough believer in the virtues of electrification and an enthusiast about the wonders which it can accomplish, but I also have a keen appreciation of the almost infinite variations in the railroad problem, and a very wholesome respect for the dollar.

Complete Electrification Impossible

I do not believe that all railroads will ever be electrified. I am not sanguine even that all the tracks of any one really big system will be so equipped in our time.

It is a question of economics, and the results will not justify the expenditures even when considered with such broad vision as that which guided the Pennsylvania in spending millions to put their passenger terminal in New York City without the prospect of a direct return. Electrification will increase the track capacity. But there are thousands of miles of railroad that have sufficient capacity now, frequently several times over, and where the wildest stretch of imagination fails to picture a future need of this kind.

Electrification works wonders in suburban and interurban passenger service. I have ridden for hours across the western prairies without seeing a sigle town, much less a city, where these advantages would count.

Electrification effects marked economies in fuel, in maintenance, in labor and otherwise through a long list; but electrification calls for a heavy investment, and unless these economies bulk large enough, the interest on such investment will wipe them out and turn the enterprise into a losing venture.

I do not believe the cause of electrification is helped by undue optimism on the part of its advocates. Rather should there be an enlightened partisanship, enthusiastic where enthusiasm is justified, but tinged with the sober conservatism of the man who has to put his own dollars to work.

There need be no discouragement to the electrical engineer in the views just given, nor to the railroad man who has looked toward the new motive power for salvation. There are so many cases where electricity should be used, where its advantages are clear and conclusive, that once the railroads escape from the financial slough of despond in which they are now wallowing, and are again able to get capital for their needs, there will not be enough engineers, there will not be enough electric factories in the country, to serve them.

Generalities Are Misleading

Every big system has need of electricity somewhere. For some small roads it may mean the difference between solvency and bankruptcy. I electrified a short derelict line for the New Haven Road, between Meriden and Middletown, long before given over into the one-train-a-day-annual-deficit class, and turned it into a good earner.

There can be no rule established. Generalities are sure to be misleading, but electrification is now firmly entrenched and successful. It is recognized by railroads generally as an effective agency with great possibilities, and one which is particularly valuable for certain specific purposes. Time alone will tell how broad its application is to be, but I am confident that we can await developments with tranquility, assured that the art is in a healthy condition and that progress will be along the right lines.

Letter to the Editor

ELECTRIC HEATING A CRIME?

Sir,—Will you kindly grant me space in your next issue to protest against the spreading of such propaganda as that contained in a February issue of one of your contemporaries, in which appeared an editorial entitled, "A Practical Illustration of Domestic Electric Heating," and an illustrated article with the following heading:—

"Heating our Homes With Electricity. A Pioneer Installation in Toronto which Proves that Electric Heating is Entirely Practical. Cost not Prohibitive for the Well-to-do Citizen."

In the first place, may I point out that while the installation in question may be the "pioneer in Toronto," it is an exact duplicate, apart from automatic control, of one in McCormick's Drug Store on Sparks St., Ottawa, "just 20 years ago." The latter installation was very successful in-so-far as maintaining agreeable temperatures was concerned; but it was, of course, abandoned as soon as the misguided enthusiast who bore the cost of the work, woke up to an appreciation of the facts surrounding the problem of electric heating.

In Italy, during the war, it was indictable offence to *use* any electric heating device between the hours of 4 p.m. and 10 p.m. daily; and it was also an indictable offence to *sell* any electrical heating device whatever. May I ask, were conditions so very different in Toronto that domestic electric heating *in the winter of 1917-18* was so "entirely practical" as to deserve the commendation which your contemporary heaps upon it? Surely, many besides myself heard of the efforts made to prevent the wasting of electrical energy in and around Toronto on account of the *power shortage* in that vicinity? Darkened streets and windows were intended to remind thoughtless ones that we were at war.

One of the illustrations accompanying the article, which is the cause of my complaint, contains, in my opinion, a record of a most flagrant case of wanton waste in war-time. What is the nationality, may I ask, of the individual in Toronto, and what was his connection with the electrical system from which he was at liberty to keep on taking 24 kilowatts for electric heating throughout the winter of 1917-18? Where was the editor during that winter; how could he praise such conduct? Where were the officials of the system in question?

I am tempted to speak with vigor upon the above subject, because I am one of that multitude who sacrificed time and energy, as well as such money as I had at my command, to help the cause of humanity; and my very hardest work and most trying experiences were connected with the effort to get kilowatt-hours released from non-essential undertakings, so that they would be continuously available for badly needed war-work, in the very district where this electric-heating crime was being perpetrated. Were there many other such installations as the one so highly praised? Are there any other extravagent persons in Toronto who spent $480 for the luxury of electric heat when coal costing only (?) $144 would have done the same heating during the war when electrical energy was so scarce?

The crime in question would not have been so heinous if the electrical energy used in that heating installation came from an absolutely independent hydro-electric plant, but, as is common knowledge, old steam plants in Ontario and elsewhere were pushed to the limit at that very time, and the United States authorities graciously, none too willingly, allowed coal to come into Ontario for producing power, in order that the outputs of the overloaded Niagara hydro-electric plants might be supplemented by steam power; in this manner further aid was rendered to the production of munitions.

But just think of the criminally farcical nature of this tragic state of affairs: A Torontonian drawing electrical energy which he uses for *heating* out of a system during periods when from five to ten times as much coal had to be burned (to put that same amount of electrical energy back into the system) as would have heated his house! All this at a time when coal was costly and scarce and when electrical energy was never so badly needed in this world.

Your contemporary says the stupidity of the engineer has retarded the development of electric heating; but, as I understand my duty to the public, to the engineering profession and to myself, I would be guilty of something much worse than "stupidity" if those statements were allowed to go unchallenged.

At the March, 1918, meeting in Toronto of the Engineering Institute of Canada, electric heating was clearly and unquestionably shown to be *practically* impossible. At that meeting, with the needs of the Allies in plain view, and with the horrible Niagara power shortage before us, I protested not only against using electrical energy for heating, but also against the putting into force in Ontario, a short time before the meeting, of a secondary or tertiary rate for the use of electrical energy which tended to encourage wasteful electric heating loads.

If my memory serves me, I asked the meeting if such tactics—which would surely interfere with war work—were for the purpose of "making the Kaiser grin"? The Hun did not want us to help to win the war. He did everything in his power to block us and, even now, he does not want us to conserve, to make proper use of, our resources. Electric heating is too wasteful to be allowed. Why help the Hun, with praise, even at this late day?

JOHN MURPHY,
Electrical Engineer, Department of Railways and Canals.
Ottawa, Ont., April 7th, 1919.

NEW PRODUCT FOR STERILIZING SMALL QUANTITIES OF WATER

As the result of a study by Dr. Henry A. Dakin, the English chemist, a new product has been found for disinfecting such small quantities of water as used by the soldier or the engineer in their water bottles. The experiment conducted by Dr. Dakin indicates that the substance will sterilize an ordinary heavily contaminated water (e.g., containing coli, typhoid or cholera organisms) in about 30 minutes. It imparts a perceptible but not disagreeable taste to the water. The disinfectant is put up in the form of tablets, which if properly made are stated to be quite stable enough for all practical use. To ascertain the effectiveness of the tablets on a heavily polluted water, a series of tests was made recently in the water laboratory of the Bureau of Engineering of the Florida State Board of Health. The water used was obtained from a stream heavily polluted with surface wash and receiving considerable sewage. In the test one tablet was applied to each 250 cc. sample. The raw water contained 5,000 bacteria per cubic centimeter. After the tablet had been in the water 15 minutes the count was 500 bacteria per cubic centimeter; after 20 minutes, 160, and after 30 minutes, 50, which is a 99 per cent. reduction in 30 minutes. A second series of samples from the same source was tested, a tablet and four drops of lemon juice being added to each 250 cc. of water. In this test the bacteria count was reduced to 120 in 15 minutes, to 90 in 20 minutes, and to 50 in 30 minutes. These results, states the official bulletin of the State Board of Health from which this note is taken, indicate mainly that the tablets effectively disinfect small quantities of heavily polluted water within 20 to 30 minutes with a complete disappearance of gas-forming organisms and colon forms as well as a great diminution of bacteria. The addition of lemon juice apparently hastens the effectiveness to a degree. The chemical name for this disinfecting agent is Parasulphondichloraminobenzoic acid. Its common name is halazone. Halazone tablets are prepared in a convenient form by several large laboratories—small vials of 100 to 1,000 being on the market.

METHODS AND COST OF DRIVING A 10 x 12 FT. MINING TUNNEL AT COPPER MOUNTAIN, B.C.*

VERY rapid progress was made in the driving of the main haulage level at the Copper Mountain Mines of the Canadian Copper Corporation, Ltd., Princeton, B.C. Methods employed in this work were described by Mr. Oscar Lockmund, in a paper presented last fall at the Chicago meeting of the American Institute of Mining Engineers, from which the matter in this article is abstracted.

Conditions were unfavorable for economical operations. The cost of power was high, for the fuel was of poor grade; besides, during the time the work was in progress, very little other power was needed so that most of the power cost was charged against the footage. The transmission line consisted of No. 4 galvanized iron wire with the result that the line loss was considerable. The voltage transmitted was about 30,000. The plant was operated under a lease, which was due to expire about the same time this work was supposed to be completed; an extension was refused; therefore speed was most important.

Three Eight-Hour Shifts

The plans called for a straight adit 2,900 ft. in length. At a point 2,800 ft. from the portal, two raises were to be put up to the next nearest workings, a difference in elevation of about 800 ft. One of these was to be a 2-compartment hoistway and the other a zigzag ore pass, or muck run. A location for these raises had been determined by a number of diamond-drill holes, but the material to be penetrated by the adit was not known. It seemed imperative to get the tunnel work completed as rapidly as possible, in order to allow for delays in the raising program, which were certain to occur. To show how closely these operations were timed, it is interesting to note that the date of expiration of the power-plant lease was September 1st, 1918, and the last round, making the connection between the upper and lower workings, "broke through" in the night of September 3rd, 1918.

The plans called for a tunnel 9 ft. high by 11 ft. wide; but owing to the "blocky" nature of some of the rock a considerable "over break" occurred. This enlarged the tunnel cross-section to 10.4 ft. by 12 ft. indicated by measurements taken at 200-ft. intervals after the work was finished and slowed up the work on account of the extra waste handled, besides increasing the cost per foot of driving. Several regions of geological disturbance were crossed and the heavy ground encountered called for timber supports. More than 350 ft. of heavy timbering was necessary at various points along the course of the tunnel; this also retarded the work to the extent of about 6 ft. per day for each set of timber placed. Once the working force was organized and the work well under way, three shifts were put on, working eight hours each.

Firing Done by Hand

The drills used were the dreadnought No. 60. They were mounted four on a horizontal bar, from which position all but the four bottom holes or "lifters" were drilled, the miners working on the muck pile. Upon completion of the upper part of the round, most of the muck had been removed; that which was left was rapidly thrown back from the face, all hands helping on this work. The horizontal bar was then torn down and dropped to the lower position, from which the lifters were drilled. The change of the bar from the upper to the lower position, together with drilling the lifters, loading, and firing the entire round, was frequently made in 50 minutes. The holes were pointed to pull a 7-ft round and average about 9 ft. in depth. The centre, or "cut holes" were fired first, after which followed the side holes, then the back holes, and finally the lifters. The drift round commonly used in this work is illustrated in the accompanying figure.

The blasting was done by hand, the fuses being "spit." The timing of the shots was regulated by cutting the fuse in different lengths; the shortest for the centre holes, the next longest for the side holes, and so on. The lifters were loaded with extra heavy charges of powder, so as to throw the muck back from the face as much as possible. This was sometimes helped by placing charges of explosive outside and beneath the lifters; these were called muckers, and were set to go off after the rest of the round had been fired.

The powder used was a non-freezing kind, varying in strength from 40 to 60 per cent. nitroglycerine, depending on the hardness of the rock at the face.

Quick Return to Heading

The rock was handled in small, V-shaped, hand-dump cars of about 1,000-lb. capacity. Tramming was done by hand until the distance from heading to dump became too great, when horse haulage was substituted; later this was replaced by an electric installation. Steel plates were laid on the bottom for a distance of 30 to 40 ft. from the face, to facilitate shoveling, also to permit shunting empty cars past the loaded trains and thereby eliminating the need for double track.

The cars, being light, were easily pulled from the track and, with bodies tilted, were passed on the steel plates, alongside of the loaded cars and then pushed back on to the track at the muck pile and loaded. Temporary track was laid close up to the face before firing a round. The T-rails were laid on their side, allowing the flanges of the car wheels to run on the grooves thus formed.

The foul air and gases were removed, after each round was fired, by a Connersville rotary blower, of 10 cu. ft. capacity, stationed at the portal of the tunnel. Later, a similar machine was placed about halfway in the adit and worked in tandem with it. The blowers were set to exhaust toward the surface through a 12-in. wire-wound, wooden stave pipe. The men were able to return to the heading within 15 minutes after firing.

Quantities and Costs

The mucking crew was divided into three gangs, on each shift, averaging 11 men per shift. The work was divided so that one gang was shoveling muck, another was picking down from the muck pile, while the third was bringing up empty cars and forming them into trains after they were loaded. This latter work did not take up the entire time, so that this gang had an opportunity to rest. As soon as a train was loaded, the gangs changed jobs; that is, the pickers went at shoveling, the car handlers tooks the picks, and the shovelers took the easy work, and so on. Greater efficiency was maintained in this manner, as the change of work tended to rest the men and they were able to work continuously.

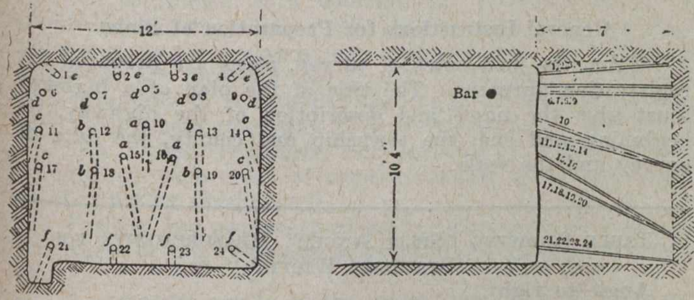
A bonus system was also a large factor in keeping the men up to the mark. This was based on a daily advance of 9 ft., upon which the then "going" wages were guaranteed; for all advance over 9 ft., $6 per foot was added as bonus. For each set of timber placed, an allowance of 3 ft. was made, which applied on the bonus. Current wages at the time were $4.50 for miners, $4 for helpers, and $3.50 for common labor. The bonus distribution brought these amounts up to $5.91 for miners, $5.25 for helpers, and $4.59 for muckers. The foreman and the shift bosses also shared in the bonus, the distribution being made by pro-rating the bonus in the same ratio as the amount of regular wage received by each man. Everybody seemed satisfied and no difficulties were experienced as far as the labor situation was concerned.

The work was begun on October 9th, 1917, and the tunnel was finished March 11th, 1918, a total of 154 days. The actual working time was 150 days, four days being lost on account of a break in the power line.

The length of the adit is 2,903 ft. and the daily average progress was 19.3 ft. for each working day. The greatest advance in any one month was in December, 1917, when a total of 645 ft. was driven. The amount of rock handled is estimated at 185 tons per day. The material penetrated was granodiorite, for the greater part of the distance. The total cost of driving the tunnel was $103,242, which brings the cost per foot of tunnel to $35.56. Certain equipment

*From Engineering and Contracting, Chicago.

and supplies were charged against the work that should have been carried in a suspense account, as most of these had a certain salvage value because it was intended to use them in the future operation of the mines. For reasons already mentioned, such as expensive power, the cost given does not really represent the actual expense of driving. Had



DRIFT ROUND IN MAIN HAULAGE LEAD, COPPER MOUNTAIN, B.C.—LETTERS IN FIRST FIGURE INDICATE ORDER OF FIRING

speed not been so important, no doubt the work could have been done more cheaply. A few of the cost items are as follows:—

	Totals.	Per ft.
Total driving cost:		
Labor	$ 25,517	$ 8.80
Explosives	16,616	5.72
Drills, parts and repairs	2,767	0.95
Steel, sharpening and replacement	3,979	1.37
Miscellaneous supplies	1,908	0.66
Power	8,410	2.90
	$ 59,197	$20.40
Rock disposal:		
Labor	$ 21,843	$ 7.52
Supplies	1,685	0.57
Power	558	0.20
	$ 24,086	$ 8.29
Timbering:		
Labor	$ 1,335	$ 0.46
Timber and supplies	2,513	0.86
	$ 3,848	$ 1.32
Indirect expense:		
Air and water lines	$ 5,439	$ 1.88
Electric lighting	1,018	0.35
Ventilation	3,198	1.10
Dump, tracks and trestles	503	0.17
Depreciation on drills	970	0.33
Depreciation on cars	301	0.11
Surface hoisting and hauling	3,468	1.19
Miscellaneous supplies	1,208	0.42
	$ 16,105	$ 5.55
Total cost	$103,236	$35.56

Timbering details:

53 sets timber installed, cost per set	$72.62
354 ft. of tunnel timbered, cost per foot	10.83

Drilling details:

Actual drilling hours	8,022
Actual working days	149 11/12
Average drilling hours per day	53.50
Cost of upkeep per drilling hour, in cts.	22.53

The credit of working out the plans and details of this work belongs to F. S. Norcross, Jr., at that time superintendent of mines of the Canada Copper Corporation, now a captain in the 27th Regiment of Engineers, the mining regiment, at present in France. Captain Norcross was unable to complete the job, as he enlisted in December, 1917, but the work was carried out by his successor and former assistant engineer, P. E. Crane.

PROVINCIAL HIGHWAY SURVEYS

BY JOHN T. RANSOM
Surveyor, Department of Public Highways, Ontario

(Continued from last week's issue)

WOODEN posts, 2 ins. x 4 ins. x 4 ft. 6 ins., dressed on all sides, shall be firmly planted at each mile of survey upon the right of line of survey and as close to existing fence as possible, the mileage and chainage to be painted with black paint upon each post.

Owners' Names

One man is made responsible for the procuring ahead of the actual staking out of limits of road, the names of all owners whose lands abut the highway, with their address, lot and concession and any other information re ownership of such lands. It is his duty also to ascertain the position of the dividing line between such owners and to leave sufficient marks so that as survey progresses, these property lines can be readily picked up.

As the names are obtained, they are entered in a field book kept for owners' names, and when stakes are being planted on the new limits of highway at these property limits, the names of owners are entered in their proper place in the "Field Book of Survey."

Oath of Chainmen

Before a chainman commences upon his duties, he shall take the following oath and shall sign same before a witness (forms will be supplied):—

Place............Date.........

I, ... do solemnly swear that I will discharge the duty of chaining and measuring with exactness according to the best of my judgment and ability, and that I will render a true account of my chaining and measuring to ...., Ontario Land Surveyor, by whom I have been appointed to such duty, and that I am absolutely disinterested in the survey in question and am not related or allied to any of the parties interested in the survey within the fourth degree according to the computation of the civil law,—that is to say, within the degree of cousin-german. So help me God.

(Signed).........................

Field Notes

The field book of the surveyor in charge of the survey is to contain all the information relative to the survey. Any other field books, with the exception of the levelman's books, are kept merely for purposes of assisting in compiling or recording of information and to have the information in good form and at hand at the proper time for inserting in the field book.

Notes are entered commencing at bottom of page and working up; one page only to be used for field notes, the opposite page for computations and particular remarks. The date should be entered in the notes upon commencing each day's work. Notes should not be cramped, but plenty of space should be allowed.

Levelling

Lists of established bench marks are provided, upon which check levels must be made. It is assumed that the given elevations of established bench marks are correct on authority of the Department of the Interior, Canada.

Levelling will commence from an established bench mark of known elevation and every possible opportunity will be taken during the course of survey to check on convenient, established bench marks as passed.

An error of one-tenth of a foot per mile of line run between established bench marks is allowed. Errors are not to be cumulative and in leaving an established bench mark the absolute elevation as shown in the list shall be used. The error of closure and length of line run from last bench mark shall be shown in the field notes wherever a line of levels is closed at an established bench mark.

Departmental bench marks will be located at distances not greater than one-half mile apart along the course of the survey, and the letters D.P.H.O., and the actual elevation of the bench mark, shall be painted in white close to the above bench mark. Bench marks will be left on objects that should remain in place for some years, such as stone foundations of buildings, close to the road, bridge or culvert abutments or concrete work. Bench marks will not be left on trees, poles or other wooden objects.

For departmental purposes bench marks shall be left at every culvert and bridge along the course of the survey, and where such culvert or bridge is concrete or stone, the bench mark shall be left on end walls or abutments. A neat and legible system of making notes shall be used.

Departmental bench marks shall be cut in stonework or concrete carefully with a chisel and made as follows:—

An arrow pointing upward with a horizontal cut at point of arrow, cuts to be 3 ins. long, ½ in. wide and ¼ in. deep and as regular as possible.

At bridges and culverts, the elevations of top of ballast walls, bridge seats, floor level at each end of bridge, water level on day of survey, high water level, low water level, bottom of culvert and top of culvert at each end of barrel are noted, and complete data of all bridges and culverts, such as clear width of roadway, kind of floor, kind and number of stringers, length of span centre to centre of bearings, distance face to face of ballast walls, distance of abutments under coping, and distance face to face of footings. At culverts, give size of opening, nature of construction, length of barrel, character of foundations, present condition of head walls, and note if present sized opening is sufficient.

Level shots will be taken at the 100-ft. stations and at all breaks in grade of road and cross sections to fence will be taken at each station. Shots will be taken on crown or at stake on real centre line of road for profile, and further shots shall be taken at edge of road in bottom of side ditch, on top of outside edge of ditch, and at fence. For each shot the distance from centre line as staked shall be noted.

Level books shall be marked on outside of cover with "Description of Survey and Date. Levels from Station.... to Station ....," and the books shall be numbered consecutively, commencing with number one. The pages of each book shall be numbered consecutively with neat figures. A pencil no softer than 2 H shall be used for entering notes in field books.

Monumenting

Standard survey monuments are to be planted at the points of intersection of each side road allowance limit, concession road allowance limit and any other public road allowance limits with the limits of the provincial highway, and at each ankle and at each B.C. and E.C. of each curve in the limits of the highway.

It is important that these monuments be carefully and correctly placed with respect to the limits of the highway, and responsibility for such rests entirely with the surveyor in charge.

The distance from the said monuments planted upon side road and concession road allowance limits to the nearest township lot, corners measured along said limits shall be measured and recorded.

It is understood that although these monuments are planted as closely as can be satisfactorily ascertained to their correct position, they do not necessarily mark or define the position of the side road or concession road allowance limits or other public road limits, but are intended to define only the proposed final limits of the provincial highway. The monuments are to be planted 4 ft. below the surface of ground, heavy end down.

Each monument must be so set in the necessary excavation that before any earth is backfilled, and with the top in its proper position, there is no tendency for the monument to fall in any direction. The top must then be kept in place while the earth is being backfilled and thoroughly tramped.

A monument set carelessly by just dropping it into the excavation, filling around it irregularly and finally pushing the top of it to one side or another to bring it to its right position, is very likely to settle out of place after rains or frost. No one but a thoroughly reliable man familiar with the work should be trusted to set these monuments without supervision.

General Instructions for Preparation of Plans

From the field notes of survey, plans are prepared for registration purposes. The title of the plan of a highway must give the name and description of the highway, its beginning and end, the township and county, the date of survey and the scale.

TABLE SHOWING "SPLIT ANGLE" MEASUREMENTS FOR STANDARD WIDTHS

Angle to right.					
180°	180°	39.5	43.0	45.0	50.5
177°-30′	182°-30′	39.51	43.01	45.01	50.51
175°-00′	185°-00′	39.54	43.05	45.05	50.55
172°-30′	187°-30′	39.58	43.10	45.10	50.60
170°-00′	190°-00′	49.65	43.16	45.17	50.70

EXAMPLE OF METHOD OF REDUCTION OF AN AZIMUTH OBSERVATION

Date, November 22nd, 1916. Brighton, Ont.
Taken at Sta. 2267+53
Sighted St., 2270+07.9

Pt. Sighted.	Cir.	Hor. Cir. Rdg.	Watch.
Ref. point	L.	341° 43′	
Polaris	L.	359° 18′ 30″	2 h. 57 m. 00 s.
Polaris	R.	179° 17′	2 h. 59 m. 05 s.
Ref. point	R.	161° 43′	

O Tauri Declin., N 8° 44′ 24.6″
O Tauri R. A., 3 h. 20 m. 22.5 s.
Watch time of transit of O Tauri, 3 h. 13 m. 25 s.

Latitude, 44° 02′
Convergence,—0′ 30″, referred to Mer. Long. 77° 45′

Formula for reduction:—

$$A \frac{p \sin \Upsilon}{\cos \alpha} (1 + p \sin 1'' \tan \alpha \cos \Upsilon)$$

Watch 2 h. 58 m. 03 s.
Correction 6 m. 57 s.
Θ = 3 h. 05 m. 00 s. (Sidereal time of observation)
α = 1 h. 31 m. 00 s. (R. A. of Polaris)
Υ = 1 h. 34 m. 00 s. (Hour angle of Polaris)
Therefore, $\Upsilon = 23° 30'$

log p = 3.6105537	log 1st term = 3.3545634
log sin Υ = 9.6006997	log p = 3.6105537
3.2112534	log sin 1″ = $\bar{6}$.6855700
log cos α = 9.8566900	log tan α = 9.9853428
log 1st term = 3.3545634	log cos Υ = 9.9623978
	log 2nd term = $\bar{1}$.5984277

1st term = 2262.4″
2nd term = 39.7″

A = 2302.1″
= 0° 38′ 22.1″

Convergence = 00′ 30.0″
Bearing of Polaris, 359° 21′ 08″
H. C. R. on Polaris, 359° 17′ 45″
Corr. to H. C. R., + 0° 03′ 23″
H. C. R. on Ref. Line, 341° 43′ 00″
Bearing of Ref. Line, 341° 46′ 23″

The date of survey is the date on which measurements were completed on the ground and is to be obtained from field books.

Plans must show:—

The location of new centre line of road and new limits of highway, with respect to original or old established limits of road.

All markings, with descriptions, markings made or planted, land ties, etc. All measurments and bearings necessary to show clearly the land required for widening purposes, the direction and length of all lines or courses and necessary to re-establish the limits of the highway at any point where they may become obliterated or lost.

The names, frontages, and amount of widening and acreage (in each case) of owners affected by the widening or abutting on the highway.

Position and ownership of poles, railways, houses, sheds, structures or improvements of any kind, wells, fences, trees, etc.

A complete profile of the centre line of road with all information re levels of culverts, bridges, buildings, structures, bench marks, etc.

Traverse Book

Sta.	Angle Measured to Right	Astro. Bearing	Corrected Astro. Bearing
0 00		107° 19′ 50″	No check obtained as yet
13 00	177° 51′	105° 10′ 50″	No check obtained as yet
26 53.7	183° 35′ 10″	108° 46′	No check obtained as yet
40 89.5	184° 04′	112° 50′	112° 50′
53 64	137° 45′	70° 35′	70° 35′
54 81.5	215° 57′ 30″	106° 32′ 30″	106° 32′ 30″
63 36	174° 48′ 50″	101° 21′ 20″	101° 21′ 10″
70 76.4	186° 52′ 10″	108° 13′ 30″	108° 13′ 20″
77 14.5	269° 11′ 30″	197° 25′ 00″	197° 24′ 50″
84 28.2	92° 20′ 30″	109° 45′ 30″	109° 45′ 20″
98 34.0	176° 59′	106° 44′ 30″	106° 44′ 20″
111 54.5	178° 16′ 40″	105° 01′ 10″	105° 01′
124 30.0	184° 34′ 50″	109° 36′	109° 35′ 40″
137 83.5	175° 26′ 20″	105° 02′ 20″	105° 02′
151 11.6	179° 51′ 30″	104° 53′ 50″	104° 53′ 30″
164 57.0	182° 43′ 50″	107° 37′ 40″	107° 37′ 20″
178 52.0	180° 04′	107° 41′ 40″	107° 41′ 10″
220 87.4	175° 28′ 40″	103° 10′ 20″	103° 09′ 50″
234 97.4	188° 17′ 40″	111° 28′	111° 27′ 30″
249 45.8	178° 44′ 10″	110° 12′ 10″	110° 11′ 40″
263 56.1	177° 55′ 30″	108° 07′ 40″	108° 07′
279 26.5	180° 46′ 10″	108° 53′ 50″	108° 53′ 10″
		109° 00′ 40″	109° 00′ 00″
308 13.9	179° 31′ 20″	108° 32′	108° 31′ 20″

Plans or profiles are to be made to horizontal scale of one-inch to 100 ft., and one inch to 10 ft. for vertical scale of profiles.

The origin of the bearings must be stated on the plan.

When the bearings on a plan are referred to more than one meridian, the point of change of reference meridians must be clearly shown on plan. This change must not be made at an angle. One course must be shown with two bearings, one referred to the easterly and one referred to the westerly reference meridian.

The following rules are to be followed in preparation of plans:—

(a) Centre line run on ground is in vermilion; (b) new boundaries or limits of provincial highway are in full black lines; (c) boundaries where ascertained on ground of original township surveys or registered plans are shown in full black lines; (d) fences and lines which are not surveyed boundaries are shown in broken black lines; (e) centre line, frontage measurements and profile measurements are in feet and decimals; (f) other plan measurements are in feet and inches; (g) bearings are in degrees, minutes and seconds; (h) wooden stakes planted are indicated by square black marks, thus ■ ; (i) standard survey monuments are indicated by black marks, thus ⊡.

Example Showing Application of Surveyors' Tables

Taken Thursday, Dec. 12th, 1918, approx. 10 p.m., stand. time
Instrument at Sta. 53+64
Sighted station, 40+89.5
Latitude, 43° 14′
Longitude, 79° 48′=5h. 19m. 12s.
Convergence 1.65 miles × .815 (con. for 1 mi.)=1.34, referred to Mer. of Long. 79° 50′

Pt. sighted.	Cir.	Hor. Cir. Rdg.	Watch.
Ref. Point	L.	292° 51′	
Ref. Point	R.	112° 50′ 30″	
Polaris	L.	359° 12′	3h. 33m. 07s. *
Polaris	R.	179° 11′	3h. 35m. 35s. *
Polaris	R.	179° 09′ 30″	3h. 40m. 25s. †
Polaris	L.	359° 08′ 30″	3h. 43m. 10s. †
Ref. Point	L.	259° 51′	
Ref. Point	R.	112° 50′ 30″	

*First set. †Second set.

α Ceti, R., 0° 00′	2h. 57m. 20s.
α Ceti, R.A.	2h. 58m. 05s.
Watch correction, Dec. 12th, 1918	+45s.

Computation, First Set

Mean watch times	=	3h. 34m. 21s.
Watch correction	=	+45s.
Θ	=	3h. 35m. 06s.
Tab. Az. for 3h. 30m., Lat. 42°	=	359° 14.7′
Variation for 5m. 06s.	=	— 1.8′
Variation for 1° 14′ Lat.	=	— 1.0′
Convergence ref. to Mer. of Long. 79° 50′	=	— 1.3′
Bearing of Polaris	=	359° 10.6′
H.C.R. on Polaris	=	359° 11.5′
Correction to H.C.R.	=	— 0.9′
H.C.R. on Ref. Line	=	112° 50.8′
Bearing of Ref. Line	=	112° 49.9′

Computation, Second Set

Mean watch times	=	3h. 41m. 47s.
Watch correction	=	+45s.
Θ	=	3h. 42m. 30s.
Tab. Az. for 3h. 40m., Lat. 42°	=	359° 11.3′
Variation for 2m. 30s.	=	— 0.9′
Variation for 1° 14′ Lat.	=	— 1.0′
Convergence	=	— 1.3′
Bearing of Polaris	=	359° 08.1′
H.C.R. on Polaris	=	359° 09.0′
Correction to H.C.R.	=	— 0.9′
H.C.R. on Ref. Line	=	112° 50.8′
Bearing of Ref. Line	=	112° 49.9′
This bearing taken to be		112° 50′

Example of Method of Vertical Circle of Polaris

Astronomical Observation, Weds., Sept. 26th, 1917

Inst. at Sta., 3847+90.
Sighted Sta., 3843+01.2
Bearing of line as given by traverse, 27° 23′ 40″
Lat. at point of observation, 44° 34′
Convergence—1.1′, referred to Mer. Long. 75° 45′
Watch correction not known.

Point Sighted.	Cir.	Hor.Cir. Rdg.	Watch.
Polaris	R.	0° 00′	21h. 25m. 45s.
Polaris	L.	180° 00′	21h. 27m. 05s.
B. Aquarii	R.	0° 00′	21h. 30m. 40s.
Polaris	R.	179° 58′	21h. 33m. 40s.
E. Aquarii	L.	179° 58′	21h. 36m. 50s.
Ref. Point	L.	26° 15′	
Ref. Point	R.	206° 15′	

	R. A.	Decl'n.
Polaris	1° 31′ 39.2″	88° 51′ 58″
B. Aquarii	21° 27′ 16.0″	5° 55′ 51″S.
E. Aquarii	21° 33′ 25.0″	8° 13′ 15″S.

p=4082.0 secs.

Formulae:—

$$\Delta=(a_1-a)-(T_1-T)$$

$$A=\frac{p\sin\Delta}{\cos\alpha}(1+p\sin 1'' \tan S\cos\Delta)$$

Computation, B. Aquarii

a_1= 1h. 31m. 39.2s. T_1=21h. 27m. 05s.
a—21h. 27m. 16.0s. T=21h. 30m. 40s.
(a_1-a)= 4h. 04m. 23.2s. (T_1-T)=23h. 56m. 25s.

(a_1-a)= 4h. 04m. 23.2s.
(T_1-T)=23h. 56m. 25.0s.
Δ= 4h. 07m. 58.2s.
=61° 59′ 30″

Computation, E. Aquarii

a_1= 1h. 31m. 39.2s. T_1=21h. 33m. 40s.
a=21h. 33m. 25.0s. T=21h. 36m. 50s.
(a_1-a)= 3h. 58m. 14.2s. (T_1-T)=23h. 56m. 50s.

(a_1-a)= 3h. 58m. 14.2s.
(T_1-T)=23h. 56m. 50.0s.
Δ= 4h. 01m. 24.2s.
=60° 21′ 00″

		B. Aqu.	E. Aqu.
log sin Δ	=	9.94590	9.93905
		3.61087	3.61087
log p	=	3.55677	3.54992
log cos α	=	9.85275	9.85275
log 1st term	=	3.70402	3.69717
log p	=	3.61087	3.61087
log sin 1″	=	6.68557	6.68557
log tan S	=	9.01650	9.15980
log cos Δ	=	9.67170	9.69434
log 2nd term	=	0.68866	0.84775
First term	=	5059.0″	4979.0″
Second term	=	—4.8″	—7.0″
A	=	5054.2″	4972.0″
	=	1° 24′ 14″	1° 22′ 52″
Convergence	=	—1′ 06″	—1′ 06″
Bearing of Polaris	=	01° 23′ 08″	01° 21′ 46″
H.C.R. on Polaris	=	00° 00′ 00″	359° 58′ 00″
Corr. to H.C.R.	=	01° 23′ 08″	1° 23′ 46″
H.C.R. on Ref. Pt.	=	26° 15′ 00″	26° 15′ 00″
Bearing of Ref. Line	=	27° 38′ 08″	27° 38′ 46″

To Find Watch Correction

log A	=	3.70364
log sin (α—S)	=	9.88741
		3.59105
log cos S	=	9.99767
log ϒ	=	3.59338
∴ ϒ	=	3921.0″
	=	1° 05′ 21″
	=	0h. 04m. 21s.

α=21h. 27m. 16s. (R.A.)
Θ=21h. 31m. 37s. (Sideral time)
Watch=21h. 30m. 40s.
Watch correction=+1min.

Contract for 24-in. intake and for protection wall at New Toronto, has been awarded to R. C. Huffman & Co., at $49,750. James, Loudon & Hertzberg, Ltd., Toronto, consulting engineers.

$5,000,000 FOR ONTARIO'S ROADS

In the Ontario Legislature this week, the sum of $5,000,000 was set aside for highways improvement. An amendment submitted by J. C. Elliott, of West Middlesex, insisting that the minister furnish the House with a map of the proposed route, plans, specifications and estimates of cost of the various kinds of road construction, was defeated, and the original motion carried.

Hon. Mr. Macdiarmid stated that construction of the Provincial highway will be extended over a period of several years. He intmated that 200 miles of the road would be built of concrete; 175 of bituminous macadam, and the remainder of gravel, which he believed would prove suitable for many years to come.

The vote of $5,000,000 covers not only expenditure on the Provincial highway, but also provincial government grants to the various counties of Ontario, all but one of which are now working under the county road scheme. Their average expenditure is $100,000 a year, or a total of $8,700,000 for the 37 counties. The government contributes 40 per cent. of this amount, or approximately $1,800,000. J. C. Elliott inquired whether this included expenditures on the Provincial highway.

"Not west of London," replied the minister.

Mr. Elliott reiterated the opinion that the House should know the plans and specifications for the road.

CORRECTION

In reproducing the nomogram on page 364 of last week's issue of *The Canadian Engineer*, the relative position of the two vertical scales was inadvertently altered, thus destroying the accuracy of the nomogram, as the angles formed by the straight-edge would not be correct. Those who are interested in obtaining a copy of the nomogram that is correctly spaced and therefore of practical use, should apply to W. H. Herbert, of the Topographical Survey Branch, Ottawa, who prepared same for his department.

The 505-ft. revetment wall built at the Port Burwell, Ont., harbor, by the F. E. Tifft, contractor, was completed April 12th. This was a Dominion government contract.

James, Loudon and Hertzberg, Ltd., Toronto, have been appointed consulting engineers to prepare plans and specifications for pavements for the town of Mimico, Ont. Estimated expenditure, about $75,000.

Contract for the reinforcing steel for the T. Eaton Co. building at Moncton, N.B., has been awarded to the Burlington Steel Co., Ltd., Hamilton, by the Geo. A. Fuller Co., who are the general contractors on the work.

In the estimates brought down in the Ontario Legislature by Hon. T. W. McGarry, provincial treasurer, is the sum of $90,000 voted for colonization roads, to be spent in the fiscal year ending October 31st. This is the same sum as was voted for this purpose last year.

The contract for the Hunter St. bridge, Peterboro, Ont., has not yet been let. Notice is being sent to all bidders, advising them of certain changes in the plans and enquiring what difference they will make in the prices bid. No award will be made until the contractors have had time to reply.

The annual meeting of the Toronto Section of the American Institute of Electrical Engineers will be held at 8 p.m., Friday, April 25th, in the lecture-room of the Engineers' Club, Toronto. The nominations for the season 1919-20 are as follows: Chairman, Ashton B. Cooper, Canadian General Electric Co.; secretary, Daniel M. Fraser, Canadian General Electric Co.; executive, L. B. Chubbuck, Canadian Westinghouse Co.; C. C. Clark, Swedish General Electric Co.; H. C. Don Carlos, Hydro-Electric Power Commission; F. R. Ewart, Ewart and Jacob; C. Sisson, Canadian General Electric Co.; and W. Volkman, Toronto Power Co.

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PRINCIPAL CONTENTS

BUILD INFLUENZA CAMPS NOW!

In the December issue of the "Journal" of the Boston Society of Civil Engineers, 26 pages are devoted to a discussion of the cause, prevention and treatment of influenza. While this is unquestionably a medical rather than an engineering subject, the vital importance of fuller public knowledge concerning this epidemic fully justifies its discussion by any body of professional men, along whatever lines their usual work may fall.

Naturally engineers do not usually read medical papers, and we do not know to what extent the subject of influenza may have been discussed in such papers, but the three articles which appear in the above-mentioned issue of the Boston society's journal, are certainly more instructive than any articles that have appeared in monthly or weekly magazines, daily newspapers or other engineering journals.

The most striking fact brought out in one of the three papers,—by Dr. Brooks, chief surgeon of the Massachusetts State Guard and founder of the Brooks Hospital at Brookline, Mass.,—is that by open air treatment a tremendous reduction in death rate was obtained. The death rate ranged from 30% to 50% for indoor treatment in most hospitals, says Dr. Brooks, while out of doors, in the camps throughout the state that were under his direction, the highest death rate was 16%, while at the Barre, Mass., tent hospital there were but four deaths out of 114 cases.

To the first tent hospital established in Massachusetts were sent 351 of the worst cases from among 1,200 army and navy patients, and out of the 351 cases only 35 died.

"Of one thing I am convinced,—that hospital wards are not the places for the treatment of influenza," concludes Dr. Brooks. "Up to the time that I went into the study of this big epidemic, I believed in the big hospitals. I believed that the wards were fine. To-day I am convinced that wards in hospitals are absolutely dangerous for diseases of the respiratory tract, and that they should be done away with. I am not sure that this is not true of other diseases besides influenza and pneumonia."

The experience gained in the ten tent hospitals established throughout Massachusetts proved that ordinary tents have their disadvantages for this work, as the space at the top becomes foul and there is no satisfactory way of introducing ventilation there; also the doctors and nurses are tremendously exposed in the inclement weather in passing from tent to tent.

Dr. Brooks suggests the construction of a series of cubicles, or shacks, 9 ft. by 9 ft., facing south or southwest, with a communicating passage, or hallway, on the north side. This passage could be heated and used in comfort by the attendants.

The fronts of the cubicles should be hinged on the floor so that they could be let down in all but the very worst weather, leaving the whole front side of the cubicle open to the air and also permitting the beds to be rolled out onto the ground or onto the lowered front, which could be used as a platform. The rear space would provide an eave, permitting of the circulation continually of a current of fresh air. As an alternative design, the front of the cubicle could consist of shutters that could be let down when storms come from the south or southwest.

Medical authorities agree that we will have another epidemic of influenza next fall, although not so severe as the last epidemic. They state that it is quite likely that the epidemic will recur every fall for some years, diminishing in severity and gradually passing away. If this is the prospect that this country has to face, and with the little accurate knowledge that there now is concerning the cause and prevention of this disease, it behooves the authorities of every province and municipality throughout Canada to adopt preparatory measures, so that when the epidemic comes again they will be fully prepared to combat it more scientifically and more successfully than was done last fall.

Large camps should be built this summer in every city and town throughout Canada. If any camp is not needed, so much the better, and the loss of the few hundred dollars that it costs will not be seriously missed. If the camps are needed, they will be needed quickly, and their existence, complete and ready to use, will be an enormous boon to the community and will help to solve the nursing, feeding and quarantine problems; and if results are obtained equal to those in Massachusetts last fall, thousands of lives will be saved.

We do not know whether any statistics have been prepared of the percentage of deaths last fall in Canadian hospitals, but it is quite likely that they would not be very much better than those shown by the American hospitals. At the Cooke Hospital in Chicago, said to be one of the finest in the country, there was a mortality of 31%, during the epidemic, while at the Massachusetts open-air camps there was a death rate of only 3% or 4% at some camps, the highest running to but 16%, and in the camp that had this high rate, some very advanced cases were treated, 39% of the cases that died having terminated fatally within the first 24 hours. At the Corey Hill open-air camp, which was one of the largest, the death rate was 10.25%.

The value of open-air treatment of influenza is also supported by the fact that 11.05% of the men of the United States navy who were quartered in the Commonwealth Pier buildings in Boston contracted influenza, while of those who were stationed in tents at Framingham camp, only 2.05% contracted the disease. The men at these two stations had arrived in the district only a short while previously, and all had been equally exposed to the infection.

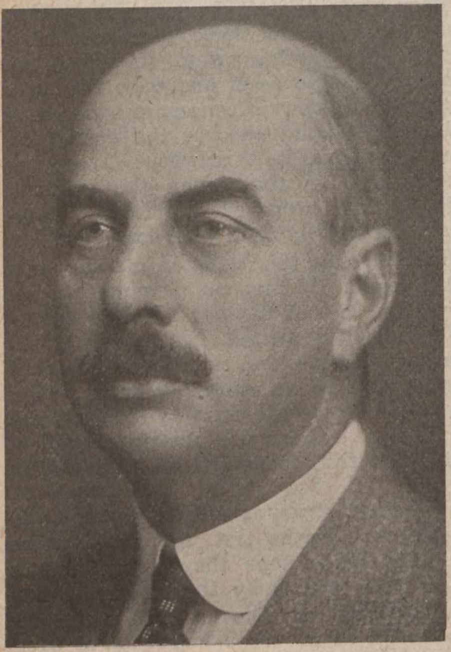
The three physicians who read papers before the Boston Society of Civil Engineers, all admitted that the origin of influenza is still a mystery. Dr. Brooks states his conviction that it is spread by droplet infection, but at the same time admits that it puzzles him to know why a farmer out in the country, who is not within a mile of a droplet and who has not been into town for months, should contract the disease; why at sea, after the ship has been out six or seven days, men should be taken ill with influenza; why it travels from east to west; why it goes to sleep for a whole year and then wakes up again in the fall; and why there is such a serious mixture of bacteria present in influenza cases.

Major Harrington, chief medical officer of the Massachusetts State Guard, stated that there is no unanimity of opinion to-day as to what type of bacteria causes influenza. Every case of influenza, he says, is a potential case of pneumonia. One peculiarity of the disease is the occurrence of hemorrhages of the nose, the back part of the throat and of the skin. In the lungs the blood vessels are plugged with clot after clot until frequently a large area of the lung is completely and quickly occluded from use. The blocked areas are frequently in the centre of the lung and not readily detected by physical examination.

Viewing the subject from every angle, influenza is the most serious problem facing Canada to-day. In districts where unemployment prevails, a few weeks of work for a certain number of men can be provided very profitably this summer by the construction of well-built, wooden, open-air camps for the treatment of influenza.

PERSONALS

C. O. STILLMAN, formerly vice-president of Imperial Oil Limited, has been elected president of the company to succeed the late Hon. W. J. Hanna. Mr. Stillman is an outstanding figure in the oil world. He is best known as the creator and administrator of the Imperial Oil Co. at Sarnia, Ont. The Sarnia plant was the forerunner of the five great plants built for the company by Mr. Stillman during the past few years, all of which have come under his administration both during construction and operation. Mr. Stillman learned the rudiments of the oil business in the office of his father, the late Charles Stillman, and later obtained a practical technical education at several large refineries in the United States. When still a very young man he became superintendent of the Bushnell Co., Ltd., of Petrolea, Ont., one of the first Canadian refining enterprises, and then undertook the construction of the Sarnia refinery. It was in acquiring a site for this plant that Mr. Stillman and the late Mr. Hanna came into contact, with the result that they continued to be closely associated for twenty-two years. Mr. Stillman was elected a director and superintendent of the company in 1899, general superintendent in 1901, assistant general manager in 1910 and vice-president in 1911. His headquarters were moved from Sarnia to Toronto several years ago, and since he has become a resident of the Queen City he has been a leading figure in a number of municipal and philanthropic undertakings. He is an active member of the council of the Toronto Board of Trade. Mr. Stillman is also president of the Imperial Pipe Line Co. and of the Queen City Oil Co.



LIEUT. C. A. RICHARDSON, of East Cleveland, Ohio, a member of class '18, Faculty of Applied Science, University of Toronto, has returned to Toronto from overseas. He enlisted as a private in the C.O.T.C. and obtained a commission in the Royal Engineers upon his arrival in England.

C. S. OGILVIE has been appointed assistant engineer of the Ottawa division, Grand Trunk Railway. Mr. Ogilvie was formerly assistant engineer of the G.T.R. at Belleville, but he went overseas with the first contingent and was a prisoner in Germany for over three years, being released only after the signing of the armistice.

CAPT. C. A. JENNINGS has received his discharge from the Construction Division, Utilities Branch, United States Army, and has returned to the technical staff of Wallace & Tiernan Co. Inc., to resume charge of the Chicago office. Capt. Jennings' work in the army covered the supervision, operation and maintenance of water purification and sewage treatment plants in various camps.

LT.-COL. N. R. ROBERTSON, of Walkerton, Ont., recently arrived home. Col. Robertson went overseas with the first contingent as a captain in the 2nd Field Company, Canadian Engineers. Latterly he has acted as O.C. of the 9th Battalion. He won the D.S.O., and was mentioned in despatches upon three occasions. Col. Robertson graduated from the University of Toronto in Applied Science with the class of 1907.

A. M. MCQUEEN, who has been one of the senior officials of Imperial Oil Limited since 1916, has been elected vice-president of the company to fill the vacancy caused by the election of Mr. Stillman to the presidency. For the past three years Mr. McQueen has been in charge of the company's extensive prospecting and developing programme in the northwest, and has also had under his administration the drilling and producing operations of the International Petroleum Co. in Peru. Mr. McQueen was born in Petrolea, Ont., his father having been one of the earliest settlers in that district. His first employment was with the Petrolea Crude Oil and Tanking Co. Later he was associated with M. J. Woodward & Co., and the Premier Oil Co.'s refineries in the Petrolea district. Subsequently Mr. McQueen was manager of the business interests of J. H. Fairbank, Petrolea, one of the largest crude oil producers in Canada, and in this capacity obtained experience in the financial and executive side of the oil business as well as in refining and dealing in oil well supplies. Mr. McQueen left that position in 1916 to join the Imperial Oil organization. He is also vice-president of the International Petroleum Co.

OBITUARY

LIEUT. JOHN WORTHINGTON DORSEY, JR., formerly assistant professor of mechanical and electrical engineering, University of Manitoba, is reported to have lost his life while serving with the American army of occupation in Germany. Prof. Dorsey graduated in electrical engineering with the class of 1908, Lehigh University, and a few years later joined the staff of the University of Manitoba as a lecturer, subsequently becoming assistant professor. He joined the American army shortly after the United States entered the war. The first intimation of his death was the return to *The Canadian Engineer* of a letter that had been addressed to Lieut. Dorsey several months ago, and it was stamped "Deceased, verified Statistical Department A.E.F." The registrar of the University of Manitoba states that just a few days ago a member of the staff of the university met a returned soldier who reported having seen Lieut. Dorsey in Germany after the armistice. This would appear to indicate that Lieut. Dorsey's death, if it has actually taken place as stated by the statistical branch of the American army, was not due to the fortunes of war but to some accident or disease contracted since the cessation of hostilities. The University of Manitoba has telegraphed to the War Department at Washington, D.C., in an effort to secure further information.