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FREIGHT TERMINALS AND FREIGHT HANDLING AT TERMINALS.

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The problem of designing a freight terminal and of handling the freight in the terminal is one that is becoming more and more complex, and in making a study of any one particular situation a great many controlling factors have to be taken into consideration. Difficulties are introduced owing to the requirements in one town or city being different from any other town or city, so that the company which wishes to design a terminal for a certain city has no terminal situated and operated under exactly similar conditions which it can copy, but must make an independent study of the local conditions and requirements and then gather together as much information as possible in connection with the design and operation of as many other terminals as possible. It is beyond the scope of this article to deal with a great many of the modern freight terminals, but an attempt will be made to give a general description of the requirements and the methods employed at some of the up-to-date terminals handling large quantities of L.C.L. freight.

The handling of package—L.C.L—freight at the terminal is the most expensive item in the cost of its transportation from one point to another, so that a freight terminal must be so designed as to permit of the most economical and efficient handling of freight from the wagons and drays to the freight cars, and vice-versa.

Under the economic conditions prevailing, wages are continually increasing and at the same time, it is commonly asserted, human efficiency for performing physical work is diminishing, consequently all commercial interests are working to eliminate the human element by introducing all kinds of mechanical labor-saving devices for performing the work formerly done by man, and in recent years great strides have been made in the use of machinery for handling package freight, for it has been estimated that the cost of handling a ton of freight at its starting point and destination is over 10 times the cost of transporting it 100 miles on the railway.

Location.—In making a study of the conditions controlling the design of a freight station the first thing to be taken into consideration is the location of the terminal, as this is one of the most important items which will determine whether the railway company will obtain a large share of the city's business or not. In a great many cases there is no choice, but where there is, great care should be taken to have the terminal in the centre of the shipping district—using the word shipping to include consignors and consignees—because, other conditions being equal, the shipper will send his consignments to the nearest freight house. The placing of the terminal in the heart of a business district naturally means very high prices for the necessary land, but this can often be compensated by the use of a freight house of two or more stories, in fact, this type of house is coming more and more into use, not only on account of land values, but more particularly on account of the railway tracks having to be either elevated or depressed from the natural ground surface in order to eliminate grade crossings in the busy parts of the town or city. Details of this type of house will be dealt with later.

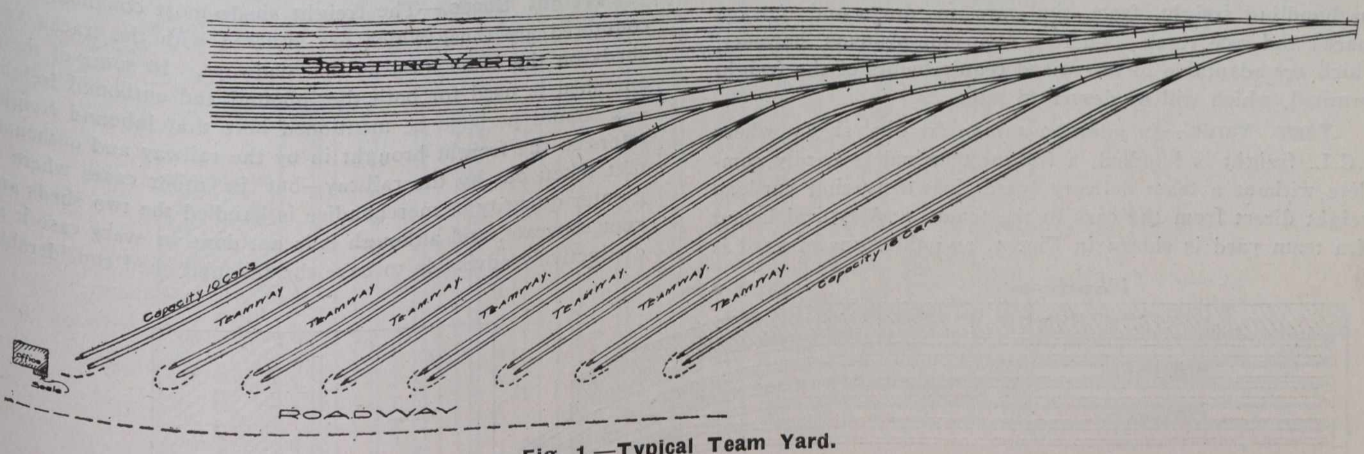


Fig. 1.—Typical Team Yard.

Layout.—Having selected the most suitable site for the freight house, and the necessary capacity decided upon, the next step is to look into the question of track layouts, storage and handling sheds and platforms, office, etc., and in doing this the capability of future extension must not be overlooked, as it is usually the best policy to acquire the necessary

* With the Montreal Tunnel and Terminal Company.

property at an early stage rather than wait until it has increased in value to prohibitive prices; and in this country of rapid growth future extensions of every kind of plant have to be properly provided for.

The general design of terminal sheds will be found to be different in almost every terminal examined, as they are always governed by such local conditions as the general topography of the surrounding neighborhood, the property limits, location of the streets in the immediate vicinity, direction of traffic, nature of the commodities to be handled, and numerous other factors.

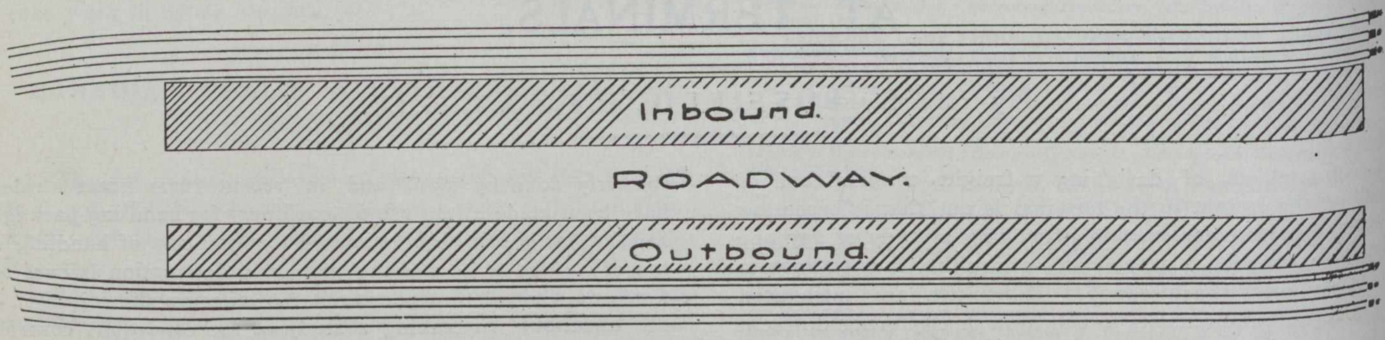


Fig. 2.—Typical Freight Shed Layout.

Mechanical Handling.—Mechanical handling of freight has not been adopted except in some of the most modern of large terminals, although various systems are being largely used at steamship piers where freight, both package and in bulk, has to be moved over longer distances and over more definite route than are obtainable in the average freight shed for handling freight from the cars to drays and storage spaces and vice versa. There are various systems, however, which are adaptable to the mixed requirements of the freight terminal, which will be described later.

Team Yards.—In addition to the freight sheds where L.C.L. freight is handled, a freight terminal is hardly complete without a team delivery yard for delivering car-load freight direct from the cars to the teams. A typical layout of a team yard is shown in Fig. 1, and this type of yard is

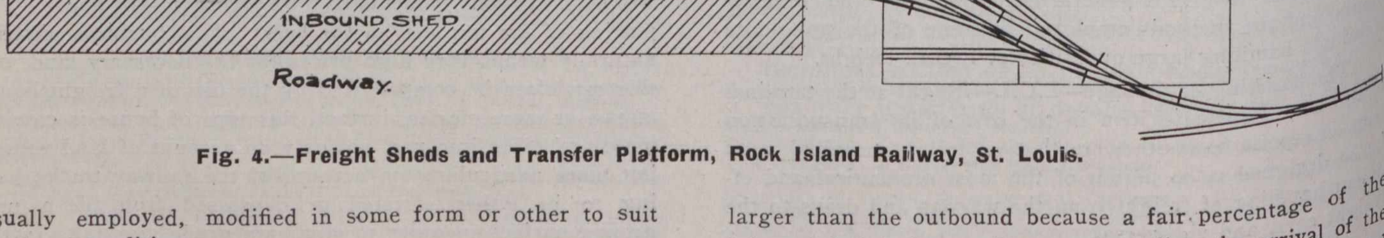


Fig. 4.—Freight Sheds and Transfer Platform, Rock Island Railway, St. Louis.

usually employed, modified in some form or other to suit the local conditions.

As will be seen in Fig. 1, the tracks are laid in pairs, with from 11 ft. 6 in. to 13 ft. centres between them. The width of the teamway is frequently made 40 ft. clear between the tracks, but in cases where a more economical layout is required and land is high priced, they can be narrowed down to 30 ft., but this latter is very apt to cause crowding and congestion, hence delays in the handling of the freight. The teamways should always be well made, either with a macadam surface or else with some standard paving block, care being taken to provide sufficient drainage facilities, as a muddy and heavy teamway is very detrimental to the business. Team tracks, as a general rule, should not be made excessively long, as this increases the cost of switching and making up the trains; the most convenient length has been found by experience to be about 400 to 600 feet in the clear, giving a car capacity of from 10 to 15 cars on each track.

For handling heavy machinery, boilers, lumber, etc., it is usual to provide one or more overhead travelling cranes. These are frequently made to span a teamway and the two adjacent tracks, or the teamway and each pair of adjacent tracks, or the teamway and one pair of tracks. In fact there are numerous different ways of locating the crane which, again, may be fixed or travel on its own track in the same direction as the team tracks.

Freight Sheds.—The freight sheds most commonly encountered are those which are situated with the tracks and sheds on the same level as the roadways. In some of these one shed is used for both the inbound and outbound freight —it should perhaps be mentioned here that inbound freight refers to the freight brought in by the railway and outbound that taken out by the railway—but in other cases where a greater quantity of merchandise is handled the two sheds are kept separate, and although it is not done in every case it is distinctively advisable to have the inbound shed considerably larger than the outbound because a fair percentage of the inbound freight has to be stored pending the arrival of the consignee's wagons to take it away, whereas in the outbound shed the merchandise deposited by the wagons can usually be taken direct to the cars. A certain quantity, however, has to be stored as frequently cars destined to certain points are only placed at the sheds on alternate days in order to insure a full load instead of shipping small loads, or having the goods transferred at some division point or transfer station.

There is a great deal of diversity of opinion with regard to the arrangement of tracks alongside the sheds, but the commonest method is to have two or three tracks on one side of the shed and have the cars spotted opposite the shed doors, with the doors of all three cars in line so that the outer one is loaded or unloaded through the other two. A general arrangement of this type of terminal is shown in Fig. 2.

This system has the great disadvantage of the costliness and danger of uncoupling, spotting and recoupling all the cars, and also of the congestion liable to happen on account of three cars all having to be worked through the one opening, but with this type of shed there is no immediate remedy, and it has its advantages which in many cases counteract the disadvantages.

Another type of freight house, differing somewhat from the general run, is that erected by the Pennsylvania Railroad at Indianapolis. (Illustrated in Fig. 3). The shed itself is L-shaped with the two portions 50 ft. x 335 ft. and 40 ft. x 180 ft. respectively. The tracks are spaced with 11 feet centres, and the intermediate platforms are 12 feet wide.

Figure 5 illustrates the freight terminal built by the Lake Shore Railway at Toledo, Ohio, and at first glance it does not look as though it could be operated very efficiently on account of the great amount of trucking required, but contrary to expectations the claim is made that the freight is handled at a cost of about 35 cents per ton.

From these few examples of terminals illustrated will be seen that in general terminals on the one level may be divided into two classes, namely, those in which the in and outbound freight can be handled to and from the cars without having to switch the cars from one track to another and, second, those in which the cars, after being unloaded at the

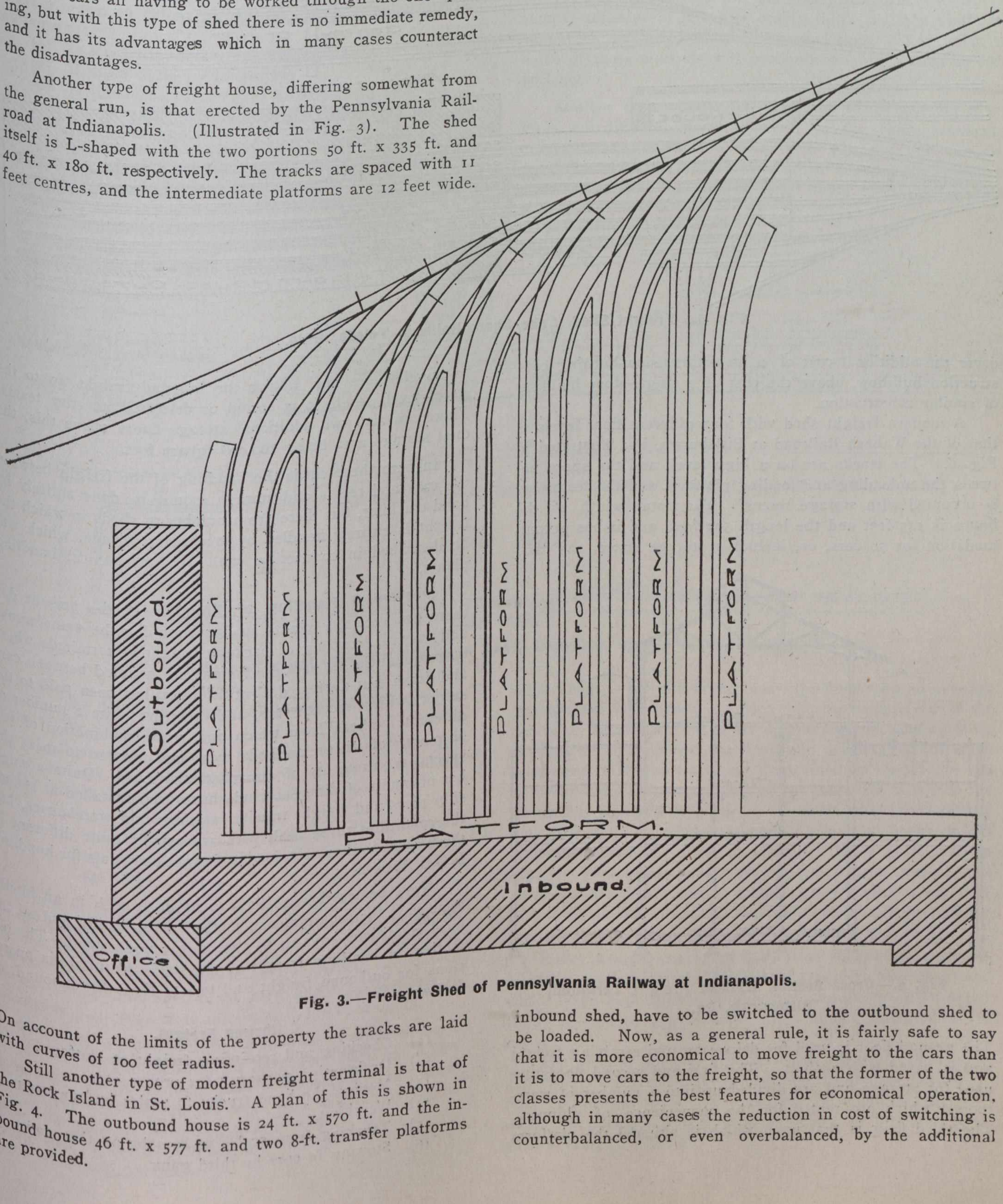


Fig. 3.—Freight Shed of Pennsylvania Railway at Indianapolis.

On account of the limits of the property the tracks are laid with curves of 100 feet radius.

Still another type of modern freight terminal is that of the Rock Island in St. Louis. A plan of this is shown in Fig. 4. The outbound house is 24 ft. x 570 ft. and the inbound house 46 ft. x 577 ft. and two 8-ft. transfer platforms are provided.

inbound shed, have to be switched to the outbound shed to be loaded. Now, as a general rule, it is fairly safe to say that it is more economical to move freight to the cars than it is to move cars to the freight, so that the former of the two classes presents the best features for economical operation, although in many cases the reduction in cost of switching is counterbalanced, or even overbalanced, by the additional cost of handling the freight in the terminal due to the longer haul necessitated by this arrangement.

Two-Story Freight Houses.—The best way of handling freight in and outbound without having to switch the cars from one shed to another, or having a very long trucking haul is to adopt a two story freight house. This type has other good features, such as economy of land, and is readily adaptable to modern conditions which require the tracks to be elevated or depressed in order to eliminate grade crossings. It is roughly estimated that $2 per square foot will

for loading and unloading the freight from the cars. Five large high-power elevators are provided for handling the freight between the different stories.

Still another type is that of the Wisconsin Central in Minneapolis. This house is 417 feet long and varies from 66 feet 1 inch to 79 feet 7 inches wide. The tracks are below the street level, and all freight is handled on a 24-foot platform and outbound freight is brought in on a low level roadway direct to this platform, ten 6-ton scales being provided, one for each of the doorways. There are four 5-ton and one

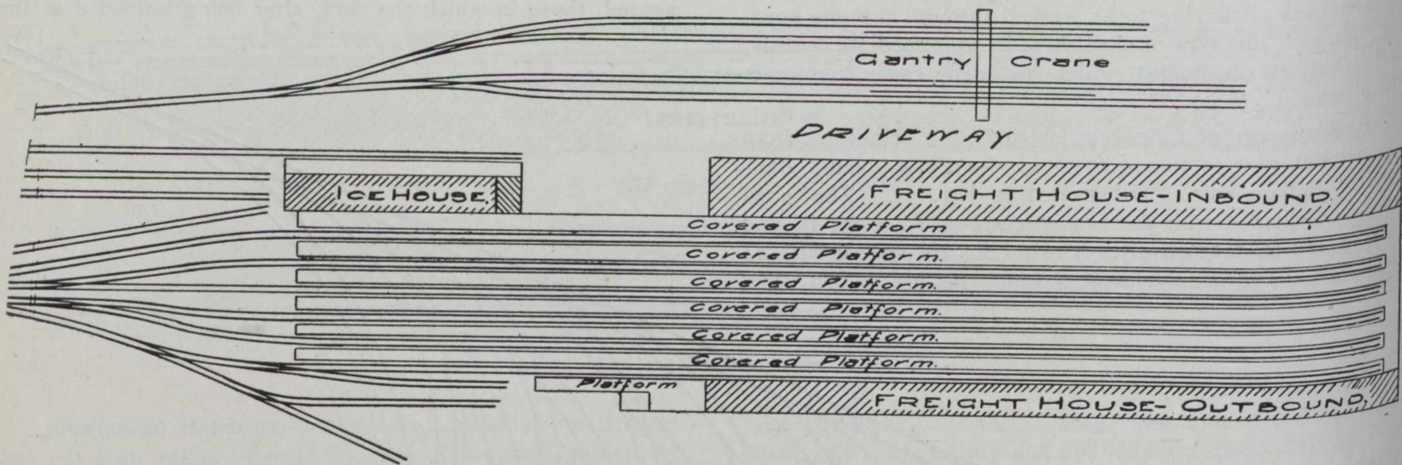


Fig. 5.—Freight Shed, Lake Shore Railway, Toledo, Ohio.

cover the additional cost of a two-story, slow-burning construction building, above the cost of a single-story building of similar construction.

A modern freight shed with four different floor levels is that of the Wabash Railroad at Pittsburgh, Pa, illustrated in Fig. 6. The tracks are on a high level, and the space between the unloading and loading platform and the teamways is occupied with storage rooms. The total width of the house is 145 feet and the length 572 feet, and it has accommodation for 50 cars, or, including storage space, 125 cars.

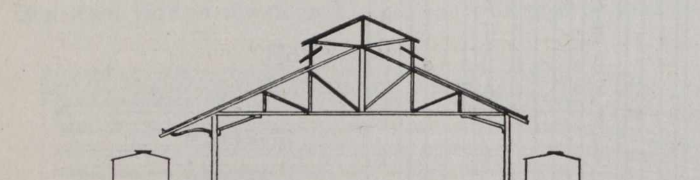


Fig. 6.—Cross Section Wabash Freight Terminal, Pittsburgh, Pa.

The ground floor is used for delivering and receiving freight and is paved with asphalt. The first and second floors are used for storage and are divided up into a number of warerooms, which are rented for the convenience of shippers. The third floor is that upon which is situated the platform

10-ton elevators for taking the inbound freight up to the street level, where it is stored or delivered to the teams. There are also two additional storage floors above this, the total storage area being 100,000 square feet.

In both these sheds the handling of the freight between the cars and teams and storage rooms is done entirely by hand trucking, but there are a number of sheds in which the freight is entirely handled by mechanical means, which will be described in connection with the mechanical handling plants.

Mechanical Handling of Freight.—At the present day there are very few plants in operation for the transference and general handling of package freight at terminals where large quantities of package freight are handled between cars and drays, but a great deal of attention has been paid to the subject within recent years, and there are quite a number of different methods from which one, or a combination of two or more, of these methods may be selected to meet the special requirements of any particular case. Quite a number of plants of different kinds have been installed at steamship piers and freight transfer stations and warehouses, but the conditions to be dealt with are usually quite different in these cases to those obtained at freight terminals for handling L.C.L. freight.

Now, before the subject can be dealt with in an intelligent way, the requirements, method of operating and all the local conditions have to be thoroughly understood. The old method of handling freight at the sheds required six operations for outbound freight and two to three for inbound, as follows:—

Outbound Freight.

(1) Checking and receipting freight at platform.
(2) Designating packages for proper cars.
(3) Moving the hand trucks to scales by one gang.
(4) Weighing.
(5) Trucking from scales to cars by another gang.
(6) Stowing in cars by third gang.

Inbound Freight.

(a)

(1) Unloading from cars.
(2) Trucking to wagons.

(b)

(1) Unloading from cars.
(2) Trucking to storage space.
(3) Trucking from storage to wagons.

In order to increase the efficiency of the working of the terminal and hence reduce the cost per ton of merchandise handled in the terminal, a mechanical freight handling plant must conform as closely as possible to the following requirements:—

(1) It must eliminate rehandling as much as possible.
(2) It must cause no congestion.
(3) It should be so designed and operated as to give a large increased capacity to the terminal compared with the old hand trucking method.
(4) The operating expenses should be reduced.
(5) The switching of cars should be reduced as much as possible.

A type of moving platform has been devised for handling freight, and is capable of development for use in a number of cases. This platform can be used either to carry the package placed directly on the conveyer or else to move the trucks in which the freight is loaded. For use in a long freight shed two of these platforms could be placed on either side of the shed, moving in opposite directions. A great many suggestions have been made with regard to the use of these platforms, but they do not seem to have been used to any very great extent.

Some are in favor of a moving platform three to four inches above the level of the stationary platform, with short ramps, adjacent to it, while others think that the platform should be set in level with the shed floor. The relative value of these methods will probably only be settled by experience.

Another type, similar in operation to the moving platform, but different in construction, is the chain conveyer, different views of which are shown in Fig. 7. As will be seen, this is simply another means of moving the ordinary hand trucks at a fair rate of speed along fixed lines. The

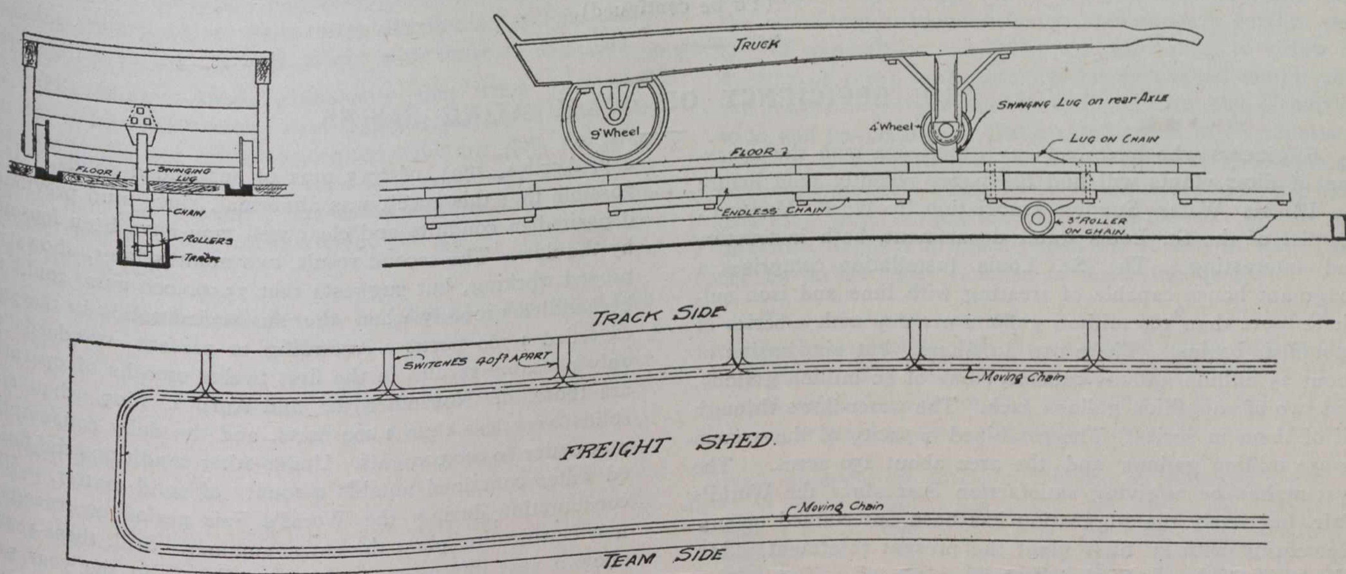


Fig. 7.—General Plan and Details of Chain Conveyer, with Truck in Position.

(6) The detention of cars in the terminal should be reduced to the minimum.
(7) It must be capable of being operated at high speed.

In general, the different kinds of plants for handling freight may be divided into four classes, viz.:—

(1) Conveyers.
(2) Overhead travelling cranes.
(3) Carrier systems.
(4) Motor trucks.

Whatever type is selected, it must be able to overcome the difficulties of coping with the great variety of shape, size and weight of commodities which it will be called upon to handle, also with the necessity of transferring the various packages from the teams to the cars, and from the cars to the storage platforms, or to the drays at the shed doors.

Conveyers.—There are quite a number of different types of conveyers in use for different purposes, such as roller, chain, belt, platforms, etc. These conveyers are very suitable for use where freight of one general class has to be handled on more or less fixed routes, such as are usual on steamship piers and transfer stations, but they are not adaptable to changing conditions.

roller chain is set in a space below the floor with an opening through the floor about one inch wide immediately over the centre of the chain. On either side of this opening running rails are set in flush with the floor, and in operation the truck is wheeled on to the track and when lined up the handle end is lowered and a swinging lug on the rear axle falls into the slot and is engaged by a lug on the chain which then pushes the car forward. Switches should be placed at about 40-foot intervals around the shed, as shown in the general plan in Fig. 7. This conveyer has been patented by a firm of conveyer manufacturers and is designed to travel at a speed of 60 feet per minute, carrying one truck every 12 feet, enabling the conveyer to handle about 100 to 150 tons per hour.

Roller gravity conveyers have been installed for special purposes, such as at the Minnesota transfer, near St. Paul, where large quantities of lumber and shingle are distributed from the cars by gravity over the lumber yard and warehouse.

The general opinion, however, with regard to these type of conveyers described above is that they are too limited in their capabilities to be really efficient in handling the great variety of package freight such as is usually met with at a general freight terminal.

Overhead Travelling Cranes.—Overhead cranes have not been installed to any very great extent for handling package freight, but they are serviceable for taking heavy and bulky loads over short distances and constant routes. They are very expensive to install, owing to the great weight of the moving parts and the heavy foundations and supports required. It has been suggested that a trucker could take his load to a crane which would then lift the truck with its load and carry it to its proper location in the house, the trucker returning to the car with the nearest empty truck, or it might be found convenient to have a narrow gauge track and car operated by hand from the track side door to the street side door. The crane could then handle this as easily as a truck.

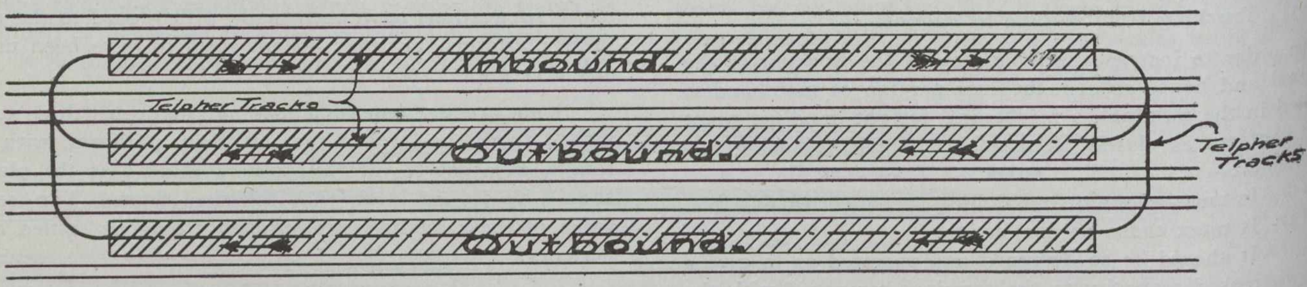


Fig. 8.—Plan Showing Telpher Tracks at Bergen, Sheds of Erie Railroad.

This scheme is as susceptible of development as that of the moving platform or chain, although the crane is liable to be more expensive both in installation and operation.

(To be continued).

THE EFFICIENCY OF COAGULATING BASINS.

Engineers who have had any experience with the operation of filter plants will find the paper recently read before the Illinois Water Supply Association by W. F. Monfort,, chemist of the St. Louis water department, both instructive and interesting. The St. Louis installation comprises a coagulant house capable of treating with lime and iron sulphate more than 160 million gallons per day with a series of unbaffled basins. There are no filters, but six basins of about 25 million gallons capacity; one of 40 million gallons, and two of 20 million gallons each. The water flows through all of them in series. The combined capacity of the system is 230 million gallons and the area about 250 acres. The system has been giving satisfaction ever since the World's Fair, but lately the suggestion has been entertained of supplementing with a filter plant the present treatment. Mr. Monfort's paper reads as follows:—

Capacity of the Plant.—It has been popularly assumed that the plant as now constituted is ample for the adequate treatment of an indefinitely large volume of water. One writer estimates the capacity of the plant at 250,000,000 gals. per day. Operating results warrant a much lower estimate based on the degree of success attained in treatment of varying quantities of different waters, ranging in suspended solids from 14 to more than 8,000 parts per million.

There is reason to believe that even in the first year of operation the clarifying system was overtaxed. The records of this laboratory afford but twelve determinations of suspended solids in river and clear well samples during the year 1904-1905, of which two must be discarded for obvious reasons. All are given in Table I. with consumption for their respective dates.

In the absence of any evidence to the contrary it is assumed that the scattered analyses are representative of the working of the plant. Treatment was begun on March 22, 1904; the first recorded result nine days later suggests the inadequacy of the plant, which then comprised but the six basins in series, to clarify 67,000,000 gals. per day when the suspended matter was 2,400 p.p.m. For 97.5 p.p.m. of suspended matter in the finished water indicates the introduction into the distribution system on the corresponding day, April 1, 1904, of 27.5 tons of suspended solids. It is possible that this result was abnormal, since mud previously deposited in conduits and clear well may have been loosened by the flow. The second result, two months later, shows improved working, but suggests that 75,000,000 gals. could not be handled properly when the suspended solids in the river exceeded 1,700 parts. According to present standards the only passable results in the first twelve months of operation are those of November 30, and April 1, 1905, when river solids were less than 1,000 parts, and the daily consumption was under 80,000,000 gals. Under other conditions the finished water contained notable amounts of solid matter. High consumption during the World's Fair period overtaxed the new clarification plant the entire summer. Still, these results show a vast improvement over conditions in the year prior to introduction of the lime-iron method, when the public was expected to make no complaint when 450 p.p.m. of suspended matter appeared in the tap water.

Table I.—Clarification Results for First Year of Operation, St. Louis Basins.

1904-1905.	Suspended solids. River.	Suspended solids. Clear well.	Daily consumption in million gallons.
April 1	2,442	97.5	67.5
May 30	1,717	25.0	74.5
June 30	3,753	32.5	87.9
July 30	1,694	43.6	95.6
August 30	800	15.0	89.8
September 30	1,268	22.0	91.1
October 31	578	12.0	81.7
November 30	376	2.0	77.3
December 31	208	10.0	71.2
January 31	181	—9.2	79.8
February 28	2,478	—4.4	73.7
April 1	990	0.0	70.4

In the second year of operation results are generally better. However, of 130 recorded determinations of suspended matter in clear well samples, 40 gave negative results. Figures given in Table II. are averages of 130 determinations for river and 90 for clear well. Average daily consumption for each month is from high service pumping.

Compared with the new standard set by the previous year, these results are good. Apparently lower consumption favored better operation; although the occurrence of so many impossible results (negative quantities) makes interpretation difficult. The records show that from June to January, inclusive, high caustic alkalinity was carried in the treated water. This is perhaps the explanation of the high suspended solids recorded, which seem to indicate somewhat less than 80,000,000 gals. per day as the maximum capacity of the plant when the river was carrying 1,800 p.p.m. suspended solids.

The writer specifically disclaims any responsibility for the foregoing results of operation and analytical data. Results for subsequent years were determined under his direction and are believed to represent with a fair degree of accuracy the working of the plant. Averages are used in lieu of reciting the full detail of determination made on all save holidays. Inasmuch as total displacement of water in the entire basin system requires from 7 to 15 days, the averages by months of operation better represent the blended waters issuing from the clear wells to the distribution system. They are platted in Fig. 1, in sequence with those of 1905-1906.

The diagram shows graphically that when suspended solids in the raw water were below 1,500 p.p.m. and consumption did not exceed 75,000,000 gals. per day, the average suspended solids in the clear well water were usually not more than 1 or 2 p.p.m., increasing slightly with a rise in either river solids or consumption, and greatly with concurrent rise in both.

Table II.—Clarification Results for Second Year, St. Louis Basins.

1905-1906.	Average suspended solids. Parts per million. River.	Clear well.	Average daily consumption million gallons.
April	.....	....	67.0
May	1,962	12.7	69.5
June	1,809	2.7	78.4
July	2,845	7.4	75.8
August	1,950	12.0	77.9
September	2,056	11.0	73.7
October	1,015	5.8	68.7
November	603	5.2	64.0
December	386	9.0	63.0
January	611	9.2	62.6
February	649	7.1	65.2
March	641	7.7	62.2
	1,320	8.2	69.0

It is noticeable that when pumpage was much above 75,000,000 gals. and river solids greatly exceeded 1,500 parts the quality of the treated water was seriously changed for the worse. In general, the curves of suspended matter in the treated water reflect the effect of high river solids and high consumption, following one or both in extreme cases, and illustrating the fact that these uncontrollable factors produce conditions which the present plant cannot meet. It appears that a raw water carrying not more than 1,500 parts of suspended matter can be made acceptable to the public of Saint Louis so long as consumption does not exceed 75 to 80 million gals. per day, but that the capacity of the plant varies inversely with the suspended matter.

The diagram further shows that from 1905 to 1910 consumption exceeded 75,000,000 gals. per day only in the summer and fall months, while in 1911 and 1912 the average daily consumption has rarely fallen below this figure at any time. The rise in river stage caused by rains of the late spring and summer brings high average suspended solids in the raw water; for suspended solids vary with the stage. Coincident with these times of high turbidity comes the heaviest draught upon the distribution system, when lawns are to be sprinkled and the greatest waste of water occurs It is, unfortunately, true that periods of highest turbidity are generally periods of greatest consumption.

Efficiency of Clarification.—There is abundant evidence that efficiency of clarification and bacterial reduction are conditioned by: Rate of flow through basins; amount of sludge already deposited; character and quantity of suspended solids in the raw water; temperature of water in river and basins; wind velocity and direction.

When a water properly treated is passed through the settling basins, 97 to 99 per cent. of the suspended matter is precipitated in the first basin, the percentage removal depending upon the character and quantity of solids contained, the temperature, wind velocity and direction, and the amount of sludge in the filling basin. In passing succeeding basins the remaining suspended matter undergoes a further reduction of one-half or one-sixth; corresponding to a few hundredths of 1 per cent. reckoned on suspended matter in the raw water, likewise dependent upon velocity, size of particles, wind and temperature. The major portion of clarification is, however, accomplished in the filling basin of 25,000,000 gals. working capacity. There is no provision for applying chemicals after water enters the basins. Efficiency of the plant, therefore, depends primarily upon the volume of water which can be satisfactorily clarified in the filling basin.

The weight of suspended matter in the effluent of successive basins varies with the weight of solids carried by the raw water. The percentage is approximately constant; the actual weight of solid matter remaining in the finished water is proportional to that originally present in the river water.

TABLE III.—SUSPENDED SOLIDS IN EFFLUENT OF SUCCESSIVE BASINS.

	Parts per million.	Per cent removal.	Parts per million.	Per cent removal.	Parts per millicn.	Per cent removal.	Parts per million	Per cent removal
River	1,444	....	3,000	...	4,500	...	1,000	..
Basin 1	14.0	99.01	47	98.5	95	98.0	25	99.75
Basin 2	12.1	99.16	21	99.3	50	98.8	20	99.80
Basin 3	8.4	99.4	14	99.5	35	99.2	10	99.9
Basin 4	7.1	99.5	12	99.6	20	99.5	10	99.9
Basin 5	5.8	99.6	10	99.7	15	99.7	5	99.95
Basin 6	5.6	99.6	10	99.7	15	99.7	5	99.95
Basin 7	..	...			..	...	5	99.95
Basin 8	..	...	..		.	.	5	99.95
Pumpage	70		80		80		120 million gal.	

The results in Table III. are from the records of periods when pumping was constant. Since the course of currents will vary with changing rates, and the velocity and consequent carrying powers of currents increases with increase in pumping, the weight of suspended matter carried over the first weir is subject to wide fluctuations. A change in pumping from a rate of 60 to 90 million gallons per day has increased the suspended matter in the treated water (clear well) by from 2 to 7 p.p.m., and a further sudden increase to 120,000,000 gals. per day has caused a further rise of 10 to 13 parts, which was carried through the entire series of basins and conduits to the clear well, where 25 to 30 parts of solids in suspension occurred.

Slight changes in temperature suffice to alter the course of currents through the basins. In the spring, when the temperature of water in the river and basins is rising, the sludge is less subject to disturbance than in the fall and early winter, when, with falling temperature, the influent water, more dense than the warmer water of the basins, passes downward over the sludge, causing it to carry over weirs.

In the fall, with lowering atmospheric temperatures, the sludge and water in the bottom of the basins are sometimes 1 degree Fahrenheit or more warmer than surface water of basins and river. Circulation is then effective in changing the course of influent water currents, making them deeper and increasing the scour.

The sludge is further subject to disturbance by wave action when high winds prevail, a frequent occurrence in March. In such case the amount of suspended matter carrying over the weir from the filling basin shows a marked increase. Our basins have a working depth of about 14 feet. Similar effects of wave action have been noted in other reservoirs 18 feet deep.

The basin at the Chain of Rocks (52 acres) are all uncovered, all used in series, and therefore, subject to disturbance by each of the agencies affecting their successful working.

Character of Sludge.—Suspended matter with the coagulum produced by chemical treatment subsides rapidly, undergoing a change in volume during its accumulation in the bottom of basins. When freshly formed it is loose, disseminated through the full volume of water in which it forms; under average conditions after 1½ hours it occupies about 3 per cent. and after 24 hours about 2 per cent. of the original volume. After this lapse of time only the newly precipitated portions are disturbed by gentle currents.

Opening mud gates at 8-hour intervals seems to reduce the sludge only near the gates, since it follows in a general way the contour of the bottom of the basin and is of such consistency that it does not flow readily over the compact material of earlier subsidence. The tendency is for each new deposit to collect more thickly upon the highest points of previous deposits.

Bacterial Removals.—Bacterial purification, as shown in Table IV., is proportional to the degree of clarification, falling a little below the percentage removal of suspended solids for the reasons which are cited below.

Table IV.—Removal of Bacteria With Suspended Solids.

	Suspended solids. Parts per million.	Suspended solids. Per cent. removal.	Bacteria per cu. cm.	Bacteria Per cent. removal.
River	1,444	.....	57,000	.....
Basin 1	14.0	99.01	933	96.1
Basin 2	12.1	99.16	.....	.....
Basin 3	8.4	99.4	500	99.1
Basin 4	7.1	99.5	.....	.....
Basin 5	5.8	99.6	100	99.8
Basin 6	5.6	99.6	.....	.....
Clear well	2.6	99.8	42	99.99

Bacteria entangled in the natural sediment of the water, and gathered into coherent masses with the coagulum, concentrate in the sludge to the extent of 1,000,000 or more per cu. cm.; they are subject to disturbance and dissemination through basin contents by varying currents, however produced, and are easily carried through latter basins to the clear well.

It has been observed that slight changes in temperature of the influent water, causing almost infinitesimal differences in the density from that of water at different levels in the basins, give rise to turbid, polluted effluents from each basin in series, as the less compact layers of sludge are moved; that overturning, which in large bodies of deeper water occurs but twice a year, may occur several times a week when warm and cold days alternate in spring and fall; and that with a slight rise in suspended matter carried from the older sludge in the filling basin may come an altogether disproportionate increase in bacteria, by reason of alterations in the rate of pumping, or the currents produced by high winds sweeping along the surface of a half mile of water. When it is considered that the combined surface of water exposed to winds and temperature changes is more than 52 acres it will not seem idle to refer to what might at first appear entirely negligible factors. See Table V.

An abrupt change in the rate of flow through basins may cause the sludge to carry its burden of bacteria through successive basins, e.g., on August 17, 1912, such a change occurred, followed on the 19th by the appearance in the clear well samples of contamination with organisms of the B. coli group.

Change in the direction of flow incident to cleaning and restoring a basin to service affects both suspended solids and bacteria per cubic centimeter in the finished water. Basin 1 was thus put in service June 6, 1912. The rise of bacteria in clear well samples was from 150 per cubic centimeter on the 6th, to 3,300 in the following week. In this case irregular pumping (at rates ranging from 70 to 120 million gallons per day) was a factor in producing bad results.

Table V.—Effect of High Winds on Bacterial Counts.

	February 17. Bacteria per c.cm.	February 17. Per cent. removal.	February 24, 1909. Bacteria per c.cm	February 24, 1909. Per cent. removal.
River	24,500*	.....	33,700*	....
Basin 1	1,550*	93.67	2,470*	92.68
Basin 3	1,000	95.92	890*	97.36
Basin 5	338	97.80	820	97.57
Drawing gate	720	97.06	2,960	91.22
Terminal chamber	1,325	94.59	3,475	89.70
Tap	6,563	73.21	13,750	56.26

It is apparent that bacterial reductions are subject to disturbance from too many factors to give constant results. We have no safeguard against turbid, contaminated water under these conditions. Table VI. shows the disproportionate increase of bacteria released by stirring previously deposited sludge.

River samples usually give evidence of the presence of bacteria of the B. coli group in 1,100 cu. cm. The finished water has given counts of more than 30,000 bacteria per cu. cm. on gelatine at 20 per cent. C., and members of the B. coli group have been found in 6 per cent. of tests on 1 cu. cm. samples in a single month.

Table VI.—Bacterial Increase in Clear Well After Basin Cleaning.

1912.	Suspended solids.	Bacteria per c.cm.	Per cent. removal.
June 6*	15	150	99.6
" 7	12	250	99.6
" 8	14	300	99.4
" 9	..	....	....
" 10	11	775	98.2
" 11	12	1,100	97.2
" 12	10	475	98.6
" 13	11	2,075	93.0
" 14	9	1,500	94.8
" 15	10	3,300	92.9

In reviewing bacteriological results for past years there is noticed a very wide divergence at any one sampling point, and extremely irregular counts for a given period at various points in the clarification system. The utmost we can hope for is a large percentage reduction of bacteria. We can have

*Note—Bacteria of the B. coli group present.

no assurance that the water which enters the distribution system will be free from pathogenic organisms regularly. While the improvement in the character of the effluent since the introduction of the clarification scheme seems to have reduced the typhoid death rate, the quality is still far from that of a good filter plant.

Residual Solids in Distribution System.—Water leaving the clear well contains small quantities of suspended and dissolved iron compounds, small particles of calcium and magnesium compounds, and larger quantities of silt and silicious matter too fine to be deposited during rapid flow through the sedimentation system. The amount of this material daily introduced into the distribution lines during the first year of operation, calculated from suspended matter and daily consumption, was as high as 27.5 tons, averaging 8.7 tons per day for the ten analyses referred to above. See Table VII.

This material is intermittently discharged from taps over the city in a very irregular way. At the laboratory of the city chemist samples are collected daily for analysis. Comparison of suspended solids in the clear well and at this tap illustrates the extent of this irregular deposition and displacement, as shown in Table VIII.

It is a matter of common observation that after unusual draught upon the mains in a portion of the system, very high turbidity appears, local, or affecting large sections of the city, according to the degree of the disturbance. Following a large fire complaints of turbid water are very numerous. So long as our practice continues sedimentation in the mains, the department cannot resent protests of consumers at turbid water when the accumulated solids are intermittently flushed out.

Table VII.—Average Weight of Suspended Matter in Daily Supply.

	Solids in tons.	Consumption in million gals.
1904-1905	8.7	79.0
1905-1906	2.35	69.0
1906-1907	1.05	70.1
1907-1908	0.31	68.9
1908-1909	0.5	70.7
1909-1910	0.34	75.4
1910-1911	0.92	76.1
1911-1912	1.74	83.5

Incrustation in Distribution System.—Because ours is a partially softened water there is always a certain variable amount of calcium carbonate present in the finished product. The softening process is completed slowly at summer temperatures and in winter is incomplete even when the water passes to the distribution system. There is, therefore, more or less deposit of calcium carbonate in mains and service pipes. Even with high bicarbonate alkalinity in the filling basin the water leaving the sixth or ninth basin is still supersaturated with calcium carbonate.

Connection with a 7-foot steel flow line was made in January, 1908, and the city supply drawn through it for 74 days. Examination at the end of the period disclosed a deposit, principally of calcium carbonate, 1/16 inch thick when moist, which shrank to 1/32 inch in drying. The water had an average total alkalinity of 59 p.pm., of which 25 were due to neutral carbonates and 34 to bicarbonates. Temperatures ranged from 32 degrees to 47 degrees Fahrenheit.

During the earlier years of operation there were notable deposits in meter gears, fish-traps and the like.

While the deposit in the distribution system does not now seem to be increasing rapidly, there is still some incrustation in progress, due to the blending of unequally softened waters. Trouble from this source can be lessened by longer storage, which will equalize the quality of the water before passing the high service pumps—a very costly expedient; or by so regulating the degree of softening that the finished water shall show a high degree of uniformity—a difficult matter when the raw water is changing quickly. Lower regular velocity through the settling basins would allow longer time for softening reactions; this entails the use of several filling basins, instead of but one with the rest in series. Finally, further reduction of this trouble could be effected by changing the order of chemical treatment, adding lime first and agitating the treated water before the charge of iron sulphate is applied.

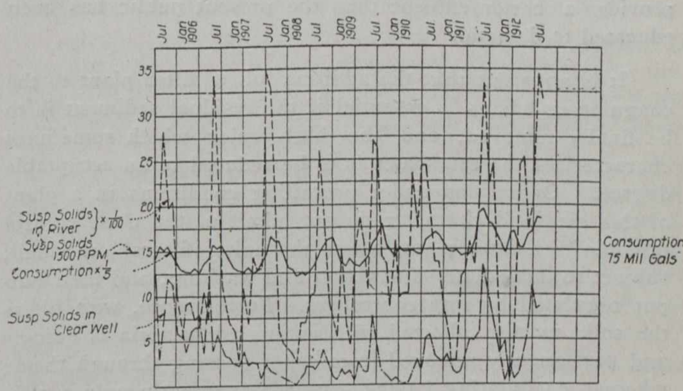


Fig. 1.—Diagram Showing Relation of Consumption to Classification, St. Louis Waterworks.

There are several methods of arriving at a standard of judgment for considering the efficiency of coagulating basins as full and final preparation of water for distribution to consumers; comparison of the quality of the effluent with respect to clarity and bacterial content (a) with that of the previous supply, (b) with untreated water from day to day, or (c) with the effluent of a well operated filter plant.

Table VIII.—Intermittent Sedimentation in Mains. Suspended Solids in Parts per Million.

	Clear well.		Tap—city chemist's laboratory.	
1905-1906.	Max.	Average.	Max.	Average.
April	..	..	8	6
May	40	13	22	21
June	6	3	25	15
July	21	7	162	81
August	34	12	20	16
September	26	10	20	17
October	19	6	12	8
November	7	6	13	11
December	30	9	12	12
January	15	9	4	2
February	14	7	0	0
March	12	8	12	6

During the first year of operation at Saint Louis the weight of solid matter carried into the distribution system averaged 25 p.pm.—ranging from none to 97 parts; the reduction was about 98 per cent. reckoned on the weight of solids in the raw water. While this was a decided improvement over conditions prior to treatment the introduction of an average of 8.7 tons of suspended matter per day into the mains left much to be desired if one compares this result with the standard set by a satisfactory filter plant, whose effluent contains no weighable quantity of solid matter in suspension, and shows no visible turbidity or opalescence in bright sunlight.

The local standard of purity has advanced from year to year since the clarification system has been in operation. Prior to 1904 sedimented water containing 60 to 450 p.p.m. of solids in suspension was accepted, if not approved. Compared with that standard, the quality of water furnished in 1904-1905 was excellent. The next year showed a marked improvement, and established in turn a standard for comparison of the succeeding year's supply. With each subsequent year the quality of water furnished has been progressively better, until 1910-1911, when consumption so far exceeded the plant's capacity that there was a falling off in the quality of the effluent, although it was still superior to that supplied before 1907-1908. The capacity of the present plant must be increased. The extensions and changes made must provide a better effluent than the present public has been educated to demand.

It is apparent that the addition of a filter plant to the coagulating basins is essential if the residual sediment is to be finally removed, and the high color which sometimes characterizes the raw water is to be reduced to an acceptable degree. Operations under prevailing conditions in a plant of this size and character do not admit of the close control possible in a filter plant, where the units (filters) are small, subject to immediate supervision and washing, and their output regulated by rate controllers. Furthermore, with filters the solid matter collected with entangled bacteria is quickly and permanently removed from water passing through them; whereas coagulating basins give too frequently only a temporary separation. It is manifestly impossible to interrupt the flow through any one basin at will, should the water in it prove unfit for use, without seriously affecting the contents of other adjacent units by altering the course of currents through them. Nor is it possible to wholly eliminate the previously accumulated sludge in filling and sedimentation basins, so that after cleaning the first water passing through them shall be faultless.

With seven filling basins and six additional new reservoirs for sedimentation, as considered in a report made by the writer, there would be effected at best only a percentage reduction of suspended solids and bacteria, with no assurance of a safe, clear, sparkling effluent. Irregularities incident to a plant of this character, where pumping and drawing and the consequent period of sedimentation are subject to wide variations directly affecting the finished water, can be avoided only by filtration.

The abridged form of treatment adopted prior to the World's Fair has beyond question served a very useful purpose. The question has arisen whether the present system of partial softening, coagulation and sedimentation shall be extended by adding further sedimentation basins to the already existing plant, or supplemented by a filter plant which shall afford a perfectly clear water at all times, with fairly constant bacterial removals and the possibility of immediate control of operating conditions. The cost of constructing two basins of 40,000,000 gals. capacity each was about $7,500 per 1,000,000 gals. capacity.

It is hardly possible to make the necessary changes in present basins and add the required reservoir capacity to provide for clarification of the volume of water which will certainly be consumed within the next ten years at a cost of less than $1,500,000. Whereas a filter plant added to the present basins with certain changes outlined comprising 40 filters of a normal rating of 44,000,000 gals. in 24 hours, can be constructed at a cost of about $1,250,000.

There are locations where basin construction is cheaper, where prolonged sedimentation in very large reservoirs may be advantageously used in producing an acceptable effluent for a time—until the public forgets its earlier satisfaction with an improved water supply, and clamors for further betterment. Before such installations are begun there is need of very careful study of the quality of the untreated water, to show its adaptation to coagulation methods and good judgment as to arrangement of the plant with a view to the ultimate addition of filters.

CONCRETE SWIMMING BATH AT SOUTHAMPTON.

By J. A. Crowther, A.M. Inst. C.E.*
(Borough Engineer and Surveyor, Southampton.)

The original bath, which was constructed some years before the writer of this paper came to the town, was presented to the Southampton Corporation by Mr. Tankerville Chamberlayne, Member of Parliament for the Borough.

The bath was originally 156 feet long by 30 feet wide, having a depth of 6 feet. The ground proved to be very treacherous, being on the bank of the River Itchen at Northam, and the bath was, and is, filled by the rising tide. Therefore, it will be seen that two forces must be provided for: (1) When the tide is out and the bath full of water; and (2) when the tide is high and the bath empty.

To meet the requirements of condition (2) it is evident that the bath must be securely anchored to the bed of the river to make sure that it shall remain in position when empty, and a high tide prevails, otherwise the bath might go sailing gaily down the river, possibly to the detriment of shipping.

Soon after the old bath was brought into use cracks in the walls and floor developed, and to such an extent that it was found to be impossible to keep the water in the bath when the tide was out.

Tests were made by closing the inlet valve, and allowing the tide to rise outside. The result was that as the tide rose a distinct tremor could be felt by any person standing on the edge of the bath. Further it was found that wooden wedges loosely inserted at low water and with the inlet valve closed, could not be withdrawn by hand when the tide had risen.

Under the above circumstances the author could not advise the Borough Council that it would be safe to use the bath, even when it contained a sufficient quantity of water.

In February, 1903, the author submitted two schemes to the Baths Committee for reconstructing the bath, and making adequate provision for withstanding the forces arising under the two conditions to which reference has been made.

Scheme 1 was for ordinary elm piles with a concrete superstructure.

Scheme 2 was for ferro-concrete on the Mouchel-Hennebique system throughout.

The estimate for Scheme 1 was $5,106.03, and that for Scheme 2, $4,623.90, and, being distinctly of opinion that ferro-concrete work will last as long or longer than ordinary timber piling, the author advised the Council to accept Scheme 2.

On account of expense, and in order to obtain better foundations, it was decided to construct the new bath of

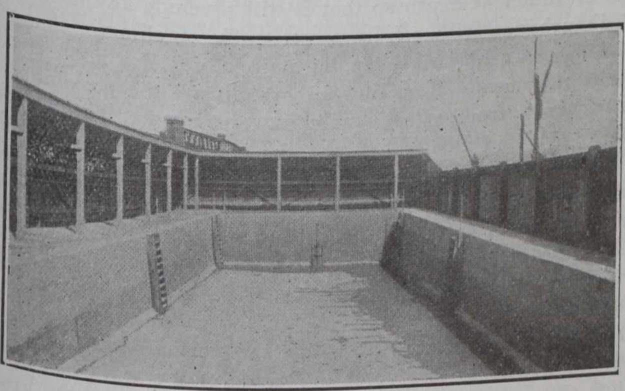
* From a paper read before the Institution of Municipal and County Engineers, England.

smaller dimensions than the first one, this being done by curtailing the projection of the bath into the river.

The dimensions of the new bath are 75 feet by 30 feet, by 7 feet deep at one end and 4 feet 6 inches deep at the other, having also a filter or straining chamber 30 feet long by 10 feet wide.

The greater part of the old bath was removed, but the side walls of the remainder were left so as to provide a promenade for the new part, care being taken to ensure the proper bonding of the old and new work.

Method of Construction of the New Bath.—The whole bath and filter are carried on twenty-two ferro-concrete piles, 14 inches square by 32 feet long, longitudinal ferro-concrete beams, 5 inches wide by 10 inches deep, spaced 4 feet 10 inches apart, centre to centre, and ferro-concrete cross-beams, 7 inches wide by 10 inches deep, laid 9 feet 4 inches apart, centre to centre. The specification provides that in the driving of the piles the set should not exceed half an inch for the last ten blows of a 30-cwt. monkey falling 30 inches.



Open Air Swimming Tank.

The formula used for calculating the resistance of the piles was the usual one of L = WH/8D.

Where L = Safe load on pile in tons, W = Weight of monkey in hundreweights, H = Fall of monkey in inches, D = Set of pile in inches.

The set of every pile was carefully observed, and hereunder will be found a few examples:—

Pile No.	Length of pile, ft.	in.	Length driven, ft.	in.	Set, in.
11	32	0	28	9	⅜
12	32	0	28	0	½
13	32	0	27	6	½
14	32	0	26	9	½

It will be noted from the above table that, although the piles were made 32 feet long, the distance driven was from 26 feet 9 inches to 38 feet 9 inches, at which depth the required resistance was obtained.

The concrete was then stripped off the projecting portion of the piles, and the steel bars bent over and thoroughly interlaced with those of the horizontal and cross-beams.

The floor and walls are 4½ inches thick. The concrete walls of the old bath (before referred to as being left as a promenade), are carried on the cross-beams, which were continued through the pile heads, and about 15 inches under the old walls. A chase was then cut vertically in the old concrete wall and the cross-beam continued upward on this chase as a counterfort. The steel work of the whole structure, including the piles, beams, floor and sides, was all tied together and interlaced by means of straps and the main bars, so that the whole was securely bound together.

The piles were made in wooden moulds laid horizontally, and the reinforcement of each pile was made up of four 1¼ inches diameter bars running the entire length of the pile, these bars being braced together with links or stirrups of 3-16-inch diameter. The steel work was first placed in position so as to leave a space of about 1½ inches (not less than 1 inch) between the steel and the wood framing, in order that the concrete might entirely surround the metal and preserve it from the action of sea water. The mould was then filled up and carefully punned so as to make a solid mass.

The piles were turned in about fourteen days, and then left for further seasoning. When considered to be sufficiently hardened, the piles were placed in an upright position for driving, and in this position the atmosphere could play on all four sides of the pile, and so quicken the process of seasoning. While in the vertical position each pile was watered every day before being driven.

As it was necessary to complete the work as soon as possible, some piles were made up with concrete in the proportions of 1 part of Portland cement to 3 parts of sand and aggregate, and driven three weeks after having been made.

The specification provided that the concrete for the piles should be in the proportion of 1:5, and that for the sides, floor and beams in the proportion of 1:4. The specification for the concrete was very stringent. All the cement was carefully examined and tested for specific gravity, fineness of grinding, tensible strength and soundness. Care was also taken to secure clean aggregate.

Well knowing the difficulty of securing good concrete work in tidal waters, and especially in Southampton, where we have four tides to be contended with each day, the author attached much importance to securing a good contractor, and to a stringent specification governing both workmanship and materials.

The first condition was secured by adopting the Mouchel-Hennebique system of construction, as this firm insist upon their work being carried out by licensed contractors, which, of course, means that none but good and experienced men are employed.

The specification provided that upon the completion of the work the bath was to be charged with water to high water of the highest spring tide, and to remain so for at least forty-eight consecutive hours; then to be left completely empty for the same period, and to remain perfectly watertight and sound in every detail under these conditions before the engineer would give his certificate as to final completion, and that the contractor should maintain the bath in such watertight condition for a period of twelve calendar months. Although the contractor experienced great difficulty in doing this, he succeeded and left the bath as specified.

The view reproduced in the accompanying illustration shows the new bath when empty.

REINFORCED CONCRETE COALING STATION.

A locomotive coaling station of reinforced concrete of 2,000 tons capacity, has recently been built for the Philadelphia and Reading Railway at Philadelphia. The building, which spans seven railway tracks, is supported on seven rows of five columns each, and one end row transversely, the rows of columns being parallel to outer lines of tracks. The floor of the bunkers is of sufficient height above rail level to permit the largest engines to take on coal and discharge ashes.

GAS DISTRIBUTION IN TORONTO.*

By D. L. Hill.

[NOTE.—Municipal engineers are frequently confronted with real problems caused by gas mains crossing the underground work of other corporations, such as telephone, conduits, water mains, etc., and it is felt that the paper printed herewith will prove of considerable interest to many of our readers who are coming in contact more or less frequently with this difficulty.—Ed.].

In taking up the subject of gas distribution, the question is so broad and the time at my disposal so brief, that nothing more than a mere synopsis can be given of the various operations connected with this branch of the industry. For this reason I have divided the subject into sections, so as to be more easily understood and followed.

The view of the lantern slide shows the trunk main system of Toronto, and is confined to cast iron pipe only.

Street Mains; Their Functions.—Street mains bear the same relationship to the gas company as the delivery wagon bears to the merchant; they both deliver to the point of consumption the commodity sold. It is a noticeable fact that a mercantile house doing a large volume of business covering a wide area, has delivery wagons made of various sizes. For local delivery, small one-horse wagons are used, but for suburban and interurban delivery, large trucks and vans are employed with a capacity several times greater than for local duty.

The analogy is apparent when applied to gas mains, hence the diversity of sizes. The large, or trunk mains, as they are usually called, carry the gas away from the holder to the distant points of consumption, the intervening territory being interlaced with what might be termed intermediate trunk mains, which are fed by the larger ones. These intermediate trunk mains divide the city into sections, comprising many streets and blocks, and it is from these intermediate mains that the service mains derive their supply.

Sizes of Mains.—The sizes of the various feeder mains are determined by Pole's formula for the flow of gas in pipes when the quantity, or volume, of gas to be delivered is known, but, unfortunately for the gas engineer, this is not always obtainable, for oftentimes large building operations are launched in isolated sections of the city which develop quickly into an area of large consumption, a condition which in no way could be pre-determined. Therefore, unless the feeder mains have been laid of ample capacity, the company would be put to considerable trouble and expense to meet the increased demand, so that the decision as to size of these mains rests largely upon a question of judgment born of experience and knowledge of local conditions.

The size of service mains is determined more from the standpoint of durability and economy than of capacity, for in the majority of cases where 4-inch mains are laid a 2-inch or 3-inch would amply supply the maximum demand, but owing to the structural weakness of the smaller sizes, causing the supply to be frequently interrupted by breaks, stoppages by "trapping," etc., attended by the necessity of immediate and expensive repairs, it is more economical to adopt a liberal policy regarding the sizes of service mains; the company's rule being to lay nothing smaller than 4-inch.

Peak Load, or Maximum Demand.—The question of maximum demand might be of sufficient interest to mention in passing. If it were possible for the daily consumption to be uniform for each hour of the twenty-four, it would mean a great economy to the company in street mains, but the mains must be of sufficient capacity to meet the demand at "peak load." By referring to a Bristol recording gauge chart it will be noticed that the time of this increased demand is variable, but in general it occurs between the hours of 5 and 7 p.m. daily, during the fall and winter months, due to the overlapping of lighting, industrial, and domestic loads. The extreme "peak load" will cover a period of perhaps 15 minutes, in which time the consumption is increased many times over any other similar period out of the 24 hours, necessitating a severe tax on the main system, while some other periods of the day have practically no consumption. To increase the consumption of gas during these "off periods" is a desideratum which is vigorously encouraged by the company through the sale of industrial appliances, thus bringing a return from a heavy investment in a main system at a time when it would otherwise be earning little or nothing.

Main Laying.—Mains should be laid in a straight line and of sufficient depth so that it will preclude any possibility of disturbance, either from street traffic or climatic changes. The first consideration can be omitted, for if a main is laid below the normal frost line in this climate the possibility of disturbance from street traffic is very remote, besides, our mains are laid chiefly between the curb and the street line, so that heavy traffic could only affect the mains at street crossings. The custom is to lay mains four feet below the surface and of the same grade as the street, but in many cases the mains are laid in advance of street grading, in which event the main is laid to a grade of 2 inches, approximately, for every 100 feet. When the grade reaches a level of one foot, more or less, below the normal depth, a "drip pot" is set, from this point the grade of the main is upward until the summit is reached at normal depth, when the grade again is turned downward. The necessity of this gradient is due to the fact that the aqueous vapors held in suspension in the gas while in the holder are thrown down, or condensed, when subjected to the varying temperatures of the street main. This condensation then flows to the "drip pot" by gravity, to be pumped out at intervals.

The trench should be no wider than is necessary to lay the main, which should rest on good firm earth, for if it sags or settles, the condensation finds lodgment there, thus restricting the flow of gas, or completely obstructing it if the sag is deep enough. After the trench is ready to receive the pipe, the spigot end is brought home into the bell of the preceding length, care being taken to see that the bell and spigot end are perfectly clean before entering. This jointing space is then filled to within 1½ inches to 2½ inches of the face of the bell (the depth varying with the size of the pipe) with jute yarn twisted into a rope of sufficient size to completely fill the joint space, after which it is driven up hard with hammer and yarning iron so that it is gas tight. The remaining space is now filled with molten lead. This operation is performed by placing a lead rummer, or dam, made of asbestos rope, around the pipe immediately in front of the bell, the ends being turned out and held by a clamp, leaving a triangular space for the "gate" through which the lead is poured. When cool, the lead runner is removed, the lead forming a fillet, outside the bell, which is then upset with a hammer and cold chisel, followed with caulking tools of varying thickness until the last or finishing tool completely fills the jointing space. When the joint is finished the lead is flush with the face of the bell.

In general, mains should be laid with as few bends as possible. In turning sharp curves the pipes should not be "broken" or swung over at each joint until the desired curve is reached, but circle bends should be used, for it is

* Paper read before the Consumers' Gas Company Educational Association meeting, April 8, 1913.

impossible to make a good joint when the pipe is not in line. At the junction of intersecting streets special pipe castings are placed so that at any future time it might be necessary to make a connection with this main, an outlet is ready, thus obviating the necessity of cutting out and inserting a branch.

Leak Work.—No matter how carefully the main laying is done, leaks are sure to develop, for it must be borne in mind that the gas company has only the same rights as any other corporation enjoying the privilege of using the streets for their underground operations. In a densely populated city, like Toronto, the underground work of other corporations frequently comes in contact with our mains, thereby disturbing the earth surrounding them. In the course of time through the settlement of the newly filled trench, our main is carried down with it, attended by leaky joints and frequently causing a break.

As soon as the report of a leak in the street is received, a survey of the surrounding territory is made immediately to locate its source. It might come from a dozen causes, such as broken stand-pipes, defective house piping or fittings, leaking meter, etc., any of which is comparatively easy to find and repair, but a leaking main or service requires different treatment, and is frequently attended with no small amount of danger, particularly if the main is in close proximity to some other foreign structure such as an electric conduit, or telephone duct. As these structures are not tight enough to prevent the gas from entering, it is liable to be carried long distances from the source of the leakage and its presence is manifested at the nearest manhole. The accumulation of gas in this confined space only requires a spark to create an explosion, at times resulting in serious injury to life and property. When the leak is in a street where no such foreign structures exist, it is usually found by "barring" over the main. This operation consists in driving a steel shod bar through the earth over the main, the leak being detected by the odor coming from the opening after the bar is withdrawn. If the leak is found to be at a joint, the lead is merely recaulked, but if the main is broken a temporary repair is made by wrapping the fracture with a bandage of soaped muslin until a split sleeve can be procured and put into place, i.e., if the break is of such a nature that it can be repaired in this way. A "split sleeve" is what its name implies—a sleeve, split or divided through the centre, and held together by bolts through flanges cast on either side.

To place a split sleeve in position, the main is scraped thoroughly clean, and millboard, after being softened in warm water, is placed between the flanges, the bolts are inserted and the nuts brought up tight, so that the millboard is compressed into any unevenness in the iron, which, when dry, gives a permanently tight joint. The jointing space between the sleeve and main is made up by first driving in jute yarn, which is then followed by molten lead, similar to an ordinary bell and spigot joint. If the break is longitudinal, the affected section of pipe must be removed and a new piece inserted. This operation necessitates the interruption of the gas supply, if the main is fed from one way only, in which event the consumers affected must be notified that the gas will be shut off while repairs are being made.

The gas is shut off when repairs or the connection of two mains are being made, by drilling a hole in the main of sufficient size as will admit a rubber bag. This bag is made of thin sheet rubber, from one to two inches larger than the diameter of the main, to which a hose is attached for inflating. For the smaller mains the bag can be easily inflated by placing the end of the hose to the mouth and blowing, but for larger mains a "stopper" is usually employed in conjunction with the bag, the bag being inflated with a hand air pump.

The "stopper" consists of two flexible strips of whalebone to which is fastened oiled canvas of the diameter of the pipe. When pressure is exerted on the ends the centre portions spring outward in the form of a hoop, bringing the oiled canvas taut, thus relieving the gas pressure from the rubber bag.

Services.—It is through the service that the consumer receives his supply from the street mains. The company install all services gratis when the building is on the street line, but if the building sets back from the street line a small charge is made to run the service from street line to building, being merely sufficient to cover the cost. It is the policy of the company to maintain these services and ensure the consumer an adequate supply permanently, even if subsequent appliance installations would render it necessary to lay an entirely new service in addition to the one already in place.

The considerations affecting the size of pipe to be used for services are, generally speaking, maximum demand, distance from main, and economy of maintenance. By taking into account the number of outlets or gas-consuming appliances, and assuming them to be all in use, the maximum demand is easily computed. The length of service to be run is known, and its size is readily determined by the use of Cox's gas flow computer, which is a circular slide rule, as it were, which graphically solves Pole's formula for the flow of gas in pipes. But in this relation it will be found in the great majority of cases a one-inch or even a three-quarter pipe would meet all requirements regarding size for ordinary dwellings, while the question of economy would dictate a larger size. The prevailing practice is to lay no services smaller than inch and a quarter. The small extra cost of this size pipe over the smaller sizes is not a very large percentage of the total cost of the service, while it will provide for a possible increase in the amount of gas required. Its greater weight also adds considerably to the life of the service and is not so susceptable to become "trapped" by condensation due to settlement. The pipe is coated with a coal tar preparation before being laid.

The service is connected to the main by means of what is termed a "street tee" and "ell," which, when connected, forms a swing joint, thereby relieving the strain on the street main in case of any movement. The service is connected by drilling and tapping a hole in the upper side of the main in which is inserted the street tee. A wood or rubber plug is placed in the open end of the tee, thus shutting off the gas from the service until the work is completed, when it is removed and replaced with a screw plug. In making the hole in the main the old method was to chip a hole in the pipe with a cape or diamond pointed chisel, as close as the eye could judge for size, after which it was reamed and tapped. This method is not unknown to-day, but the practice must be discouraged, for in case the hole is chipped too large, it will not permit a full thread to be made when tapped, in which event the hole is made a size larger, subjecting the workman to the danger of being overcome by escaping gas, not to mention the weakening of the main thereby. A very ingenuous device which is in general use to-day drills and taps the hole in one operation with little or no escape of gas.

The service is laid on solid earth with an incline towards the main so that any condensation from the gas will not be carried into the building. Anyone who has ever encountered the odor of this condensation in the house will appreciate this precaution.

House Piping.—This is a branch of the business over which the company has little or no control, except in an advisory capacity. The house piping is usually installed by a steam-fitter or plumber while the building is in course of erection, and is too often left to his discretion as to size, etc. In the interests of economy, without regard for the duty they are to perform, the pipes installed are usually too small, in which event the gas company is condemned for not furnishing an adequate supply when the whole trouble rests with the house piping.

Various tables or rules are in use setting forth the minimum sizes of house piping which should be used, based upon the knowledge of the quantity of gas to be supplied, through a given length of pipe, with an allowable drop in pressure of 1/10 inch for every 50 feet. The necessity of some regulations relative to the size of house piping has been brought home very forcibly through complaints of insufficient supply that the company is now co-operating with architects and builders in this respect, in order that the consumer shall have an ample supply for any additional requirements.

As the question of meters was discussed at a previous meeting, I will not touch upon that branch of the business here.

AN INTERESTING EXCAVATOR.

We present herewith two illustrations of a rather interesting machine which is now engaged at the works of the Tofield Coal Company, at Tofield, Alta. This machine is capable of excavating at a high or low depth from six to nine meters, and giving an output of 1,100 cubic yards in light dry soil.

It is worked on the continuous bucket system, and has a bucket at every sixth link. These buckets work in a guided ladder which is pivoted at the inner end to the body of the machine, and suspended by wire ropes from steel jibs, and can be raised or lowered as required.

Fig. 1.

The chain of buckets is worked by a hexagon tumbler at the top of the machine, and the buckets empty into a hopper as they pass over the tumbler on which is fitted a cleaning knife to ensure the emptying of the buckets.

The hopper guides the excavated material on to a belt conveyer 26 meters long, which works at an inclination of 15 degrees.

The whole excavator is supported by springs on twelve wheels running on a track consisting of three 90-lb. rails.

The power is derived from a horizontal tubular boiler and twin cylinder engine, and all the motions of the machine are derived from this engine, and they consist of the following movements: Travelling of the machine backwards or forwards; lifting or lowering the bucket ladder; stopping or starting of the buckets (all controlled by three levers worked by one man).

All these movements are got by an arrangement of toothed wheels and pinions, and fitted with friction clutches to ensure no breaking of the teeth should the machine be overloaded or the buckets meet any obstruction.

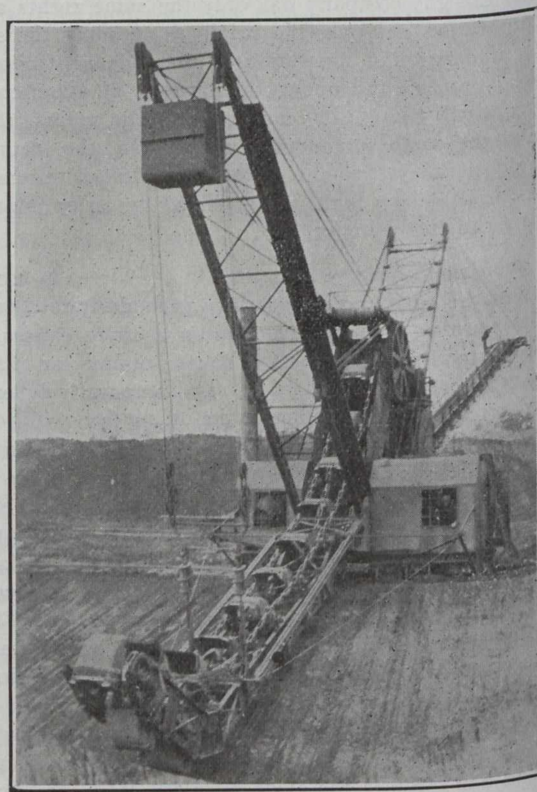


Fig. 2.

The method of working the machine is to level the earth in front by the machine travelling backwards and forwards over the higher parts until these are level with the lower, then to set a cut by the machine of from five to six inches depth, and travel the machine along the full length of rail and on completion of each cut to lower the bucket ladder another five or six inches for the return cut, keeping the buckets working continuously.

The machine is at present excavating below its base. On a sufficient opening being made to allow the machine to work in the excavation, the machine will be moved on top of the coal. A strip of coal will be removed parallel to the cutting, broad enough to allow the railroad to be laid alongside the cutting, and also sufficient space to deposit the excavated material from the end of the conveyer beyond the railroad. The machine will then excavate the earth above the coal, and deposit beyond the railroad in the space the coal has been cleared from.

As the track of the machine is moved in closer to the bank (which will be about 12 feet at each move, this being the length of the horizontal piece at the bottom of the ladder) it will leave a strip of coal 12 feet broad to be taken away at the back of the machine, with a railroad alongside the coal, and as this strip of coal is removed, the rail-track will be moved up to the coal face again, and by this method the coal can be loaded direct into the cars.

This machine is manufactured by the Lubecker Machine and Manufacturing Company, and was supplied by F. S. Dudgeon, Limited, of London, England, and is the usual A type machine supplied with the conveyer.

COST COMPARISONS OF ELECTRIC AND HORSE-DRAWN TRUCKS.

Interesting figures are published in the April issue of the Journal of the American Society of Mechanical Engineers with regard to the findings of an investigation into the comparative cost data of electrically equipped trucks and horse drawn vehicles made by W. R. Metz, superintendent of the government office, Washington, D.C., for purposes of ascertaining the desirability of replacing the horse-drawn wagons with electric motor trucks. An abstract of the report is published below:—

In the preliminary investigation figures were obtained on a 2,500-lb. electric truck that had been in service at the Washington naval gun factory for four years. The cost of operation and the saving accomplished were as given in Table 1. A 5-ton electric truck was in use there during the same period. Its cost of operation was about the same as for the 2,500-lb. truck, except that it cost $1.10 for charging per 40-mile radius as compared with 75 cents for the smaller truck. Its total cost of operation, including depreciation and interest, was figured at $2,843.84. It displaced two two-horse wagons, affecting a net saving annually of $2,460.92.

Table 2 gives cost figures for the single-horse vehicles of a large company using horse-drawn wagons and electric and gasoline machines. By adding the items for extra horser and harness, similar totals for two, three and four-horse wagons are found to be $740.52, $1,016.23 and $1,291.94.

In Table 3 are given the operating costs for the same company's electric trucks.

During the fiscal year 1910 the expenses of the stable section of the government printing office were $31,113.58, and those for the delivery section were $17,093.93, making a total of $48,207.51. The figures were slightly higher in 1911. Table 4 itemizes these 1910 costs, and from this table Table 5 is derived, showing the operating cost of one two-horse wagon of 5,000-lb. capacity.

Beginning in November, 1911, electric trucks and carriages of various capacities have been installed, and most of the horses and their equipment have been sold. Table 6 gives costs with the present equipment. The remaining horses are to be replaced, after which the four remaining stablemen will probably be supplanted by two helpers and a laborer, effecting a further reduction of $1,377.20 annually.

From the monthly cost records the operating cost of one 5,000-lb. electric truck is derived and shown in Table 7. One such truck replaces two two-horse wagons, the cost of which, as shown in Table 5, was $6,737.72. The annual saving due to the electric truck is therefore $4,204.39.

Based upon the assumption, in the absence of mileage figures for the horse-drawn wagons, that they averaged 12 miles per day—it being known that the electric trucks average 24 and make twice as many trips as the teams did—Table 8 is derived to show the comparative costs per month and per mile for operating the horse-drawn vehicles and the three sizes of electric trucks.

Table 1.—2,500-Pound Electric Truck.

Cost of truck	$2,230.00		
Labor for charging batteries		$ 46.44	
Charging		16.50	
Acid		18.00	
Rubber jars		15.00	
Batteries (partly renewed)		64.98	
Carbon brushes		1.80	
Repairs		99.96	
1 operator at $2.48 per day		776.24	
2 laborers at $1.92 per day each		1,201.92	
Totals	$2,230.00	$2,240.84	
Depreciation 10 per cent.		223.00	
Interest on investment at 2 per cent.		44.60	
Total cost			$2,508.44
Total mileage per year....3,366			
Cost per mile $0.745			
This truck displaced 5 horses and carts costing as follows:			
5 carts by contract at $1.92 per day		$3,004.80	
5 laborers at $1.92 per day each		$3,004.80	
Total			$6,009.60
Net saving of truck over horses per year			$3,501.16

Table 2.—Horse-Drawn Vehicles.

Investment—		
1 horse	$250.00	
1 vehicle	125.00	
Harness	30.00	
Total	$405.00	
Maintenance and upkeep—		
Depreciation—		
Horse at 20 per cent.	$ 50.00	
Vehicle at 15 per cent.	18.75	
Harness at 15 per cent	4.50	
Interest on $405 at 6 per cent.	24.30	
Total		$ 97.55
Horse upkeep—		
Feed at 47.4 cents × 365 days	$173.01	
Shoeing at 7.5 cents × 365 days	27.38	
Veterinary at 1.1 cents × 365 days	4.02	
Total		204.41
Vehicle expense at 43.4 cents per day	$158.35	
Harness expense	4.50	
Total		162.85
Total expense exclusive of labor and stable		$464.81

Table 3.—Expense of Operating Electric Commercial Vehicles.

Capacity, Lb.	850-1,000	1,500-2,000	2,500-3,000	4,000	7,000
Interest and depreciation (machine less batteries and tires)	$244.50	$306.30	$391.40	$422.94	$470.84
Mechanical and electrical upkeep	67.54	84.15	101.70	110.96	121.42
Tire repairs and renewals	79.28	97.30	155.05	267.60	535.25
Battery repairs, cleaning and renewals	130.50	175.36	219.34	271.54	312.84
Current at 1 cent per kw. hr.	20.00	30.20	40.00	60.00	51.50
Totals	$541.82	$693.31	$907.49	$1,133.04	$1,491.85

Table 4.—Cost Data for Horse-Drawn Vehicles for Year Ending June 30, 1910.

Equipment—	
23 Horses (average per year)	$ 6,900.00
Harness, blankets, etc.	1,350.00
1 Five-ton truck (2-horse)	425.00
7 Large delivery wagons (2-horse at $475 average)	3,325.00
6 Single delivery wagons (1-horse at $275 average)	1,650.00
3 Light mail wagons at $200	600.00
4 Depot wagons (carriages) at $300	1,200.00
2 Coupes, with pole and shafts, at $540	1,080.00
Total	$16,530.00
Cost of operation of stable section—	
Wages of foremen and stablemen	$10,113.59
Wages of drivers	12,666.21
Rent	2,400.00
Feed	3,172.20
Supplies	959.62
Repairs to harness, wagons, etc.	626.86
Shoeing	906.60
Gas and electricity	268.50
Total cost of operation, maintenance and repair	$31,113.58
Depreciation, horses 20 per cent., harness 15 per cent., wagons 10 per cent.	2,410.50
Interest on investment at 2 per cent.	330.60
Total cost, including depreciation and interest on investment	$33,854.68
Cost of operation of delivery section—	
Salaries and wages	$17,085.93
Material and supplies	8.00
Total cost	$17,093.93

Table 5.—Cost per Year of One 2-Horse 5,000-Lb. Wagon.

Wagon expense—			
Cost of truck	$ 425.00		
Cost of maintenance and repair		$ 31.75	
Cleaning and washing		66.76	
Lubricants		1.00	
Depreciation, estimated at 10 per cent.		42.50	
Total			$ 142.01
Horse expense—			
Cost of two horses	$ 615.00		
Cost of feed		$264.33	
Cost of care (hostler)		702.60	
Cost of veterinary and office labor		250.10	
Cost of medicine		2.17	
Cost of shoeing		78.84	
Cost of blankets, nets, etc.	12.22		
Rental value of space (2 horses) (based on $2,400 for 22 horses)		218.00	
Depreciation, estimated at 20 per cent.		125.44	
Total			$1,641.48
Harness expense—			
Cost of harness	$ 123.00		
Cost of maintenance		$ 7.68	
Depreciation, estimated at 15 per cent.		18.45	
Total			$ 26.13
Miscellaneous supplies		$ 10.00	
Drivers' wages		751.20	
Helpers' wages		751.20	
Gas and electricity		23.34	
Interest on investment at 2 per cent.		23.50	
Total			$1,559.24
Total original cost	$1,175.22		
Total expense for one year			$3,368.86

Table 6.—Equipment and Number and Class of Men Now Employed.

Equipment—		
Two 1,000-lb. trucks	$ 4,639.00	
Two 2,000-lb. trucks	5,498.78	
Three 5,000-lb. trucks (two in use during full year)	10,625.22	
One 8,000-lb. truck (installed in January, 1913)	5,509.00	
One electrically driven carriage (installed in November)	3,671.00	
Total cost		$29,943.00
Wages		$28,276.96

Table 7.—Cost of Operating One 5,000-Lb. Electric Truck.

Cost of truck and equipment (including spare battery and parts)	$3,745.00	
Maintenance and repair		$ 581.53
Depreciation at 10 per cent.		374.50
Interest on investment at 2 per cent.		74.90
Chauffeur's wages at $2.40 per day		751.20
Messenger's wages at $2.40 per day		751.20
Total original cost	$3,745.00	
Total expense for one year		$2,533.33

Table 8.—Costs of Electric Trucks and Two-Horse Wagon.

	2-horse wagon 5,000-lb. capacity.	5,000-lb. electric truck.	2,000-lb. electric truck.	1,000-lb. electric truck.
Average trips per day.	4	8	8	9
Mileage per day, average	12	24	20	20
Mileage per month (loaded halfway).	312	624	520	520
Average load per trip, lb.	4,000	5,500	2,500	900
Total load per month, tons	16,000	44,000	20,000	8,100
Total cost per month..	$280.74	$211.11	$187.81	$180.98
Cost per mile	0.899	0.338	0.361	0.347
Cost per mile (omitting driver's and helper's wages)	0.499	0.138	0.121	0.107

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MONTREAL AND ITS LOST OPPORTUNITIES.

Those of our readers who are at all acquainted with Montreal will appreciate and realize how much to the point is a criticism that Mr. T. H. Mawson, of the University of Liverpool, and who is an acknowledged international authority on the subject of Town Planning, makes regarding the city's lack of appreciation and making the most of their opportunities for a beautiful city. In his recent lecture in Montreal before the Greater Montreal Planning and Housing Association, his remarks as regards any attempts that have been made to make the most of its natural advantages were not by any means very flattering. It is hardly to be expected, in fact, that an observing man could fail to criticize.

Montreal's streets for a city of its size are probably the worst on the continent. While severe winter weather no doubt makes it hard to maintain good roads, nevertheless neither the weather nor the engineers are to blame for their absence, but the Civic Administration itself. It has always seemed impossible to persuade the majority of the aldermen of Montreal to take any kind of a broad-minded view of affairs, or to have pride in the construction and building up of a clean, well-built, beautiful city. Instance of civic lack of appreciation of opportunities and future needs are numerous. One occurred a few years ago in connection with the sale of some property belonging to the Redpath estate. This estate occupied part of the southern flank of the Montreal Mountain and abutted on Mount Royal Park. The purchase of it would have given the city, in addition to acreage, a beautiful driveway and entrance to the park from Sherbrooke Street, which had been long needed and was considered extremely desirable. The land was offered to the city at what those qualified to judge considered a most reasonable figure, and had behind it, we believe, a public-spirited consideration of the city's good. After a great deal of unnecessary delay and hesitancy and opposition on the city's part, the owners became disgusted, withdrew their offer, and it was quickly sold at a higher figure to real estate people, who have since used it for building purposes. A more utter lack of appreciation for the city park system and future good of the absent than that exhibited in the above case could hardly be found.

In his criticism of Montreal, Mr. Mawson stated that he had been in the city many times, and had always been struck with the magnificent opportunities which have been lost. The city has been laid out on the most unimaginative lines, and no cognizance whatever has been taken of its natural contours. This great natural amphitheatre overlooking the river offered opportunities for one of the most magnificent cities in the world. There were few sites which could compare with it.

On the subject of the streets and the steep grades of same, a suggestion which Mr. Mawson made which will appeal to all acquainted with the city's layout was that for the construction of a new and direct highway between Victoria and Dominion Squares. Such a road would do away with the steep traffic conditions encountered on such streets as Windsor, Bleury and Beaver Hall Hill. It is a subject which, now that the Canadian Northern is busy on the planning and construction of terminals and stations across the immediate path of the proposed road, should have been considered and provided for in the general layout beforehand by the Civic Government.

It is sincerely to be hoped that Montreal will shake itself of the lethargy it has shown in the past as regards the beautification of one of our finest cities.

THE LIVINGSTONE CHANNEL.

The opening of navigation of the Great Lakes continues to bring into public prominence the Livingstone Channel in the Detroit River. In last week's issue we spoke of it in connection with the work of the International Joint Commission, and their decision, re a proposed new dyke for maintaining the depth of water upstream from it.

At the present time of writing word has just come to hand of the grounding of a steamer in the channel which seriously threatens any navigation through it. When we consider the enormous traffic through the Detroit River, any threatened interruption naturally affects shipping interests to a very marked extent and the business public as well.

The Livingstone Channel was only formally opened on October 19th of last fall, and apparently the conditions are not yet ideal for traffic through it. Its construction was authorized by the United States Congress in 1907, and four and a half years were occupied in its completion at a total cost of ten million dollars. The channel was cut through practically solid rock for more than six of its thirteen miles of length, and runs in a direct line from above the head of Bois Blanc Island to deep water in Lake Erie.

The preparatory work was begun in the spring of 1908, when the contractors began erecting the cofferdam, which enclosed what is known as the dry-work section, about a mile of the river bed near the upper end of the rock cut. Actual channel digging was begun in the fall of the same year.

Originally constructed with a width of 300 feet, the dry section was completed in November, 1910, but was later widened to 450 feet, and addition being completed in December last, before the river was permitted to fill the enclosed space. Below the dykes for about five miles the channel has a width of 300 feet, while below that point, where the material to be removed was earth, the width is 800 feet. In the dry section the channel has a depth of 23 feet. Throughout the remainder of its length the least depth is 22 feet.

PROPOSED FEDERAL LAW IN REGARD TO THE POLLUTION OF NAVIGABLE STREAMS.

There has recently been appointed at Ottawa a Commission comprised of eighteen members of Parliament for the purpose of enquiring into the pollution of Canadian sources of water supply. The appointments are the result of the introduction for a second reading of Mr. Bradbury's Bill to prevent pollution of streams as above.

That the Government should take means to be advised on the subject, and to frame legislation in connection with same, is admittedly a most desirable step. It has been brought out in the past on several occasions that even the water of our Great Lakes, which ordinarily one would not consider on account of their bulk to be in any probable danger of general pollution for years to come, contain considerable amounts of chlorine at far distant points from sources of contamination. Analyses show, for instance, that the amount of chlorine in the west end of Lake Ontario has increased two and a half times in thirty years, while in the easterly end the amount of chlorine has doubled in twenty years. This increase in chlorine indicates sewage pollution, which, if not stopped or minimized, will in time render even our Great Lakes unsafe for use as a public water supply.

Consider the official figures, which show that the toll of death from typhoid in Canada is 35.5 per 100,000 of the population. In Germany it is only 7.6 and in England 11.2. Ottawa and Winnipeg are cities whose populations have suffered severely from epidemics of typhoid, due to the pollution of the Ottawa and Red Rivers, respectively. What they have gone through, other towns will have to combat with, unless steps are taken immediately to fortify with federal aid the sometimes inadequate and careless attempts of local municipalities to protect their water supply from dangerous contamination.

The ultimate aim of the Government in appointing the Commission is most admirable, but we cannot see that there is anything to be commended in their way of going about the work before them. The work in connection with this Commission could have been much more efficiently and rapidly carried through by the appointment of a much smaller commission composed of competent engineers and medical health officers rather than by an unwieldy body of non-engineering parliamentarians, whose appointment leaves a very probable opening for misunderstandings and mis-translations of engineering opinions and data given them. We cannot see any possible excuse, if efficiency is desired for such appointments. While this parliamentarian committee may wade through investigation to some beneficial and corrective legislation, they are, nevertheless, both on account of bulk of numbers and lack of training on the subject, unwieldy, slow and unfitted for the work.

It is time the Government was made to wake up to the fact that when reports and investigations are wanted on subjects relating to science, any ignoring of the professions concerned is dangerous to them, politically. The public should be made to understand the foolishness and unbusiness-like method of eighteen unscientific and wholly unqualified Parliamentarians enquiring into a matter which could be much better done by those acquainted with the engineering and scientific sides of the problems involved.

MONTREAL TRANSPORTATION PROBLEM

It begins to look as though Montreal would shortly find an exit from the tramways problem which has been worrying it so long. Two announcements have recently been made, either of which contains the elements of relief.

Recently the president of the Tramways Company approached the city with a tentative proposal. Later a conference was held at which something in the nature of a definite plan was placed before the representatives of the city. In this was outlined a scheme for the relief of congestion both immediate and future. Certain streets were asked for, for the extension of the company's lines. The programme was not unlike that proposed by Mr. Duncan McDonald. The Tramways president does not appear to have asked anything unreasonable. His proposal called for practically only one new line of any considerable extent, which line ran through a section of the city not now adequately served and upon streets to which there could be no particular objection. Other proposals were such as have been approved by the city council, such as making the stops less frequent. In the down town section it was proposed to use Victoria Square as a stopping point for certain cars instead of continuing these through the congested district. Altogether the proposals seemed of a reasonable nature, and unless there is more behind them which has not yet been made public, there would not seem to be any good reason why the city should not meet the company in the matter. President Robert promised to put on a very much larger number of cars and to construct a roadbed of a superior character. Up to the present the city authorities do not appear to have given any very definite indications of how they regard the proposals.

Shortly after President Robert made his proposals to the city, fuller details concerning the Canadian Auto Bus Company appeared. It may be recalled that this company was organized some time ago to carry on an auto bus service in the city of Montreal. The company made certain proposals to the city, in which the city was to be a holder of a very considerable number of the shares of the company, this being the company's reward to the city, so it was thought at the time, for granting an exclusive franchise for ten years on certain streets. Objection to the arrangement between the city and the company was offered by a number of citizens and it it quite likely that the question is still before the courts.

At first, the names connected with the company were not those of well-known financiers, and a certain amount of doubt concerning the seriousness of the project was entertained. Within the past week, however, an announcement has been made to the effect that Mr. H. S. Holt, president of the Montreal Light, Heat and Power Company; D. Lorne McGibbon, president of the Canadian Consolidated Rubber Company; F. L. Wanklyn, general executive assistant of the Canadian Pacific Railway; are all mentioned in connection with the concern.

The capital of the company is $10,000,000, and the Canadian group, together with the English group, which has become interested in the concern, have already subscribed $1,500,000. The concern has a Federal charter which permits it to operate in any city in Canada.

The interesting features in connection with the above directorate is the mention of a number of names which have been spoken of as greatly opposed to projects of the president of the Montreal Tramways Company. It is generally considered on the Street that the Auto Bus Company will be strongly opposed to the Tramways Company. The franchise from the city of Montreal dates from last August, and according to the terms the company is obliged to give a five-minute service. It has been stated, however, that instead of a five-minute service the concern will give one which will be twice as frequent. The cars will be of the single deck variety on all steep grades, but it is not impossible that the double-deck variety will be employed on the leveller grades. The capacity will be from 28 to 38 people and the franchise insists that there shall be no strap hangers but that all passengers shall be provided with seats. The fares will be five cents, straight, and transfers to all lines of the company.

The city of Montreal has now spread clean across the island and extends a long distance east and west so that the auto busses will not be confined to a limited territory because of lack of ability on the part of the city to extend permission. The franchise, of course, only covers certain streets. Altogether it is expected that fifty auto busses will be running here by mid-summer, or shortly thereafter. There seems to be some disposition on the part of the city officials to delay action in the matter of the Tramways Company until the effect of the establishment of the auto bus service is felt. In the winter time the heating of the cars will be sufficiently accomplished through the exhaust.

AN INTERESTING HYDRAULIC INVESTIGATION.

In the fall of 1912 an investigation of the power possibilities for the town of Picton, Ontario, was made on the Mountain Lake power site by Mr. H. G. Acres, hydraulic engineer to the Hydro Electric Power Commission of Ontario. The report of the investigation appears in the last report of the Commission and is given herewith:

The Mountain Lake power site is owned by F. S. Wilson, Esq., of the J. C. Wilson Co., of Glenora, and hydraulic power is produced for the purpose of operating a machine shop, foundry and grist mill. The machine shop runs practically continuously six days a week, eleven hours a day, and uses about 28 h.p., while the grist mill and a storehouse, which use the greater amount of power, operate intermittently, being frequently closed for a week or more at a time.

The gross operating head is between 165 and 170 feet, the mean effective head being probably not less than 160 feet.

Mountain Lake, Approach Channel to Weir.

Although there is sufficient turbine capacity installed to generate about 130 h.p. it is probable that 75 h.p. would amply cover the average annual demand. On a basis of 66 hours a week operation the annual expenditure of energy would therefore, be about 257,400 h.p. hours. If this amount of energy were expended uniformly and continuously over the whole year of 365 days, it would be equivalent to about 30 h.p. continuous 24 hour power. With the turbine installation at present existing, this amount of power would be produced by a continuous uniform outflow from the lake of about 3 cu. ft. per second. Allowing 2 cu. ft. per second for leakage, the total discharge required would, therefore, be 5 second feet.

Five second feet flowing for one year would deliver a total volume of 157,680,000 cu. ft. of water. The area of the lake with its tributary water-shed could be reasonably taken at 600 acres, and assuming 12 inches of precipitation available for power purposes, the total surface inflow into Mountain Lake would amount to 26,136,000 cu. ft. per annum. Subtracting this amount from the total quantity above specified as being delivered to the wheels, leaves a remainder of 131,544,000 cu. ft., which is, therefore, the annual volume of delivery from underground sources. This volume of underground supply is equivalent to continuous uniform flow of 4.2 cu. ft. per second, which, on the basis of the above assumptions, would be the average volume of discharge from the underground supply.

The above figures constitute practically all the information that could be derived from the data in existence when the investigation of the power site first came up for consideration.

Owing to the existence of a market for power in the town of Picton, about 4 miles from the power site, it was considered necessary to investigate conditions in greater detail in order to ascertain definitely whether or not there existed in this power site a sufficient capacity to supply the requirements of the town, and in this connection the first step was to devise some means of accurately measuring the discharge out of the lake.

The lake is located at the top of a precipitous hill on the south shore of Picton Bay, the difference in level between the bay and the lake being ordinarily about 175 feet, the shores of the two bodies of water being not more than 600 feet apart. The water is carried from the lake through a small head gate and several hundred feet of riveted steel pipe to which the various wheels are connected at the foot of the hill. Owing to the leakage in the pipe and the absence of data relating to the volume of discharge through the wheels, it was necessary to use some other means of measuring the discharge from the lake. It was found upon examination that the only practical means of doing this was to excavate a channel about 150 feet long from the lake into the bed of a small brook, which was evidently at one time the lake's natural outlet. This channel was excavated 12 ft. wide and to an average depth of 2 ft., and at the head of it was placed a sharp crested weir having a clear width of 12.01 feet. With the weir so placed it was possible to get the maximum head of 11½ inches on the crest, which was equivalent to a total discharge of about 37.6 cu. ft. per second. Discharge readings were taken on this weir at intervals of 15 minutes between 3.15 p.m. on Sept. 7th and 3.15 a.m. on Sept. 8, the work having been done on Sunday in order that the mills could be closed down and the head gate tightly closed. The readings taken over this 12 hour interval showed a total volume of 1,450,202 cu. ft. and it was also observed that during this 12 hour period the surface of the lake had dropped 1.56 inches. This drop in water level indicated that the measured outflow was composed of the underground discharge plus a volume of water corresponding to a drop in lake level of 1.56 inches.

During the course of the investigation an accurate stadia survey was made of the lake, and the area was found to be 9,352,000 sq. ft., or about 215 acres, so that 1.56 inches drawn off this area would mean a total volume of 1,215,760 cu. ft. which was discharged over the weir. As above mentioned, the discharge over the weir amounted to 1,450,202 cu. ft., so that the difference between these two totals, which amounts to 234,442 cu. ft., is a measure of the volume of supply from underground sources. This volume of flow delivered for a period of 12 hours is equivalent to a continuous discharge of about 5 cu. ft. per second, which is one of the results which the experiment was designed to supply.

At the conclusion of the above mentioned 12 hour period, the discharge was entirely shut off and it was found that for a subsequent 12 hour period the lake showed no tendency to fill up, the gauge readings being practically the same at the end of the second 12 hour period as at the beginning. In this connection, it is to be noted that the supply from which the lake was to be refilled had been ascertained to be 5 cu. ft. per second. With this volume of inflow it would require about 80.5 hours for the lake to fill to the original level, which would be at the rate of slightly less than ¼-in. every 12 hours. The slow rate of refilling, therefore, accounts to a certain extent for the absence of appreciable variation in level during the second 12 hour period, but sufficient evidence was obtained in any event to prove that the recuperative capacity of the lake is very small.

From the above, therefore, it seems evident that while the lake appears to be supplied by springs having a very large volume of discharge, the dependable power capacity would not be more than 75 h.p., and that while the site is eminently suited to the purpose for which it is now utilized, it cannot be considered an adequate source of power for general industrial purposes.

It is, of course, possible that if the lake level could be materially lowered a corresponding increase of flow from the springs could be anticipated. The lowering of the lake level would tend to reduce the power capacity through the reduction in head, and this would, to a certain extent, effect the tendency to augment the power capacity through the result of the increase in flow, so that there would be what might be termed a critical head at which the maximum power capacity would be realized. This critical head could, of course, only be ascertained by very expensive experimental procedure. As an example of what the result might be, it might be assumed that by lowering the lake 20 feet the discharge from the springs might be tripled, so that there would be a discharge of 15 sec. ft. operating under a head of 145 feet. This would produce about 198 mechanical horse power. It would seem, therefore, that under no conditions would the site have sufficient power capacity to make it an attractive commercial proposition.

While the work preparatory to the experiment was being done the records were kept of variations of lake level. During the first week of operations, when the machine shop only was running, the water level remained practically constant, while during the second week when the machine shop and grist mill were both running, the water level dropped about two inches, notwithstanding the fact that heavy rains occurred during that interval. During the second week of the observations, therefore, the power required to run the mills absorbed about 1,500,000 cu. ft. from storage in addition to the normal inflow from the springs, plus the precipitation during that interval. This affords additional evidence of the small capacity of the source of underground supply.

TENSILE TESTS OF CONCRETE.

A series of tests on concrete specimens measuring 18in. long by 6in. square has recently been made in the engineering laboratory at Cornell University.

The specimens were of three different mixtures, the first a 1:2:4 mixture containing limestone crushed to pass a 1½-in. ring, the second a 1:2:4 mixture containing sandstone, crushed to pass a 2½-in. ring, and the third a 1:2½:5 mixture containing crushed sandstone similar to that of the second mixture.

In six tests the 1:2:4 limestone concrete showed an average tensile strength of 278lb. per square inch, the highest being 308lb. per square inch, and the lowest 253lb. per square inch.

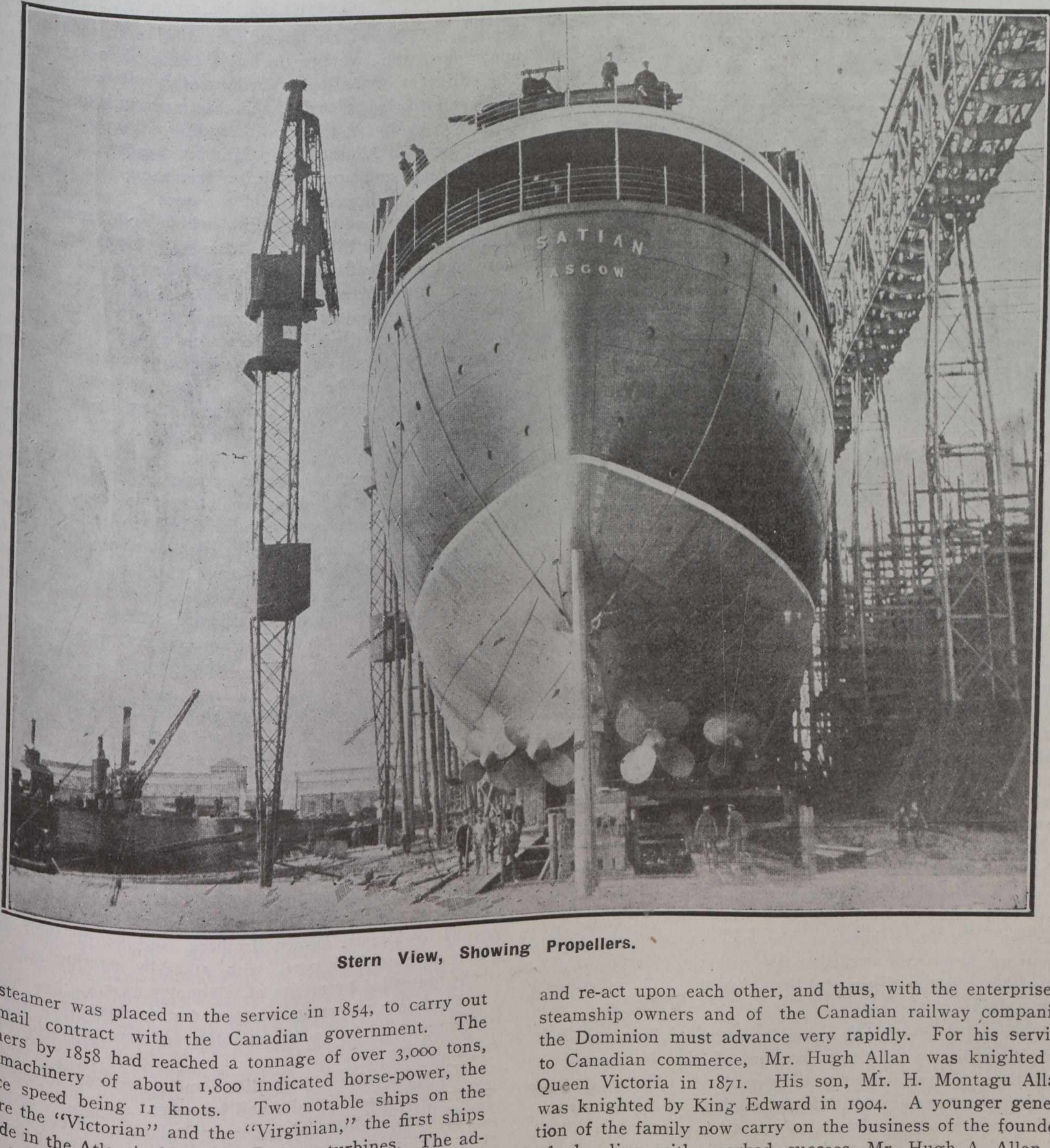
In nine tests, the 1:2:4 sandstone concrete showed an average tensile strength of 150lb. per square inch, the highest being 178lb. per square inch, and the lowest 128lb. per square inch.

In nine tests, the 1:2½:5 sandstone concrete showed an average tensile strength of 129lb. per square inch, the highest being 179lb. per square inch, and the lowest being 97lb. per square inch.

It is worthy of note that in many instances particles of sandstone were split in two in the plane of the fracture instead of breaking the bond with the mortar; this was particularly so in the case of the red sandstone, and illustrates the importance attaching to the selection of aggregates for employment in concrete work.

QUADRUPLE-SCREW TURBINE ALLAN LINER "ALSATIAN."

The Allans have been identified with the Canadian mail, passenger, and emigrant service for over ninety years. The line was originated by Captain Alexander Allan, a ship-owner-mariner of Glasgow, with a brigantine, named the "Hero," of 175 tons, her first duty being to carry stores to Wellington's army in the Peninsula. The service to Quebec was inaugurated by the "Jean" of corresponding size to the "Hero," in 1819, and was continued with a fleet of sailing ships of from 300 to 400 tons. Later, iron was adopted, and by 1845 the tonnage of the ships had risen to 710 tons. The first steamer was placed in the service in 1854, to carry out the mail contract with the Canadian government. The steamers by 1858 had reached a tonnage of over 3,000 tons, with machinery of about 1,800 indicated horse-power, the service speed being 11 knots. Two notable ships on the list are the "Victorian" and the "Virginian," the first ships to trade in the Atlantic fitted with Parsons turbines. The advance in size and speed is the more remarkable as the condition of the channel between Quebec and Montreal greatly limited the dimensions of steamers sailing up the St. Lawrence. But improvements have been made within the last few years, with the result that steamers of 16,000 and 18,000 tons now find no difficulty in reaching Montreal. The total fleet of the Allan Line is now represented by a quarter of a million tons gross, and there can be no doubt that the Allans, not only in connection with their steamship service, but in other respects, have done much to develop Canada to that state of prosperity which in recent years has enabled the extension of railway lines to be profitably undertaken, and to stimulate the utilization of the natural resources of the enormous tract of rich grain-growing soil. Internal development and attractive emigrant services across the ocean act and re-act upon each other, and thus, with the enterprise of steamship owners and of the Canadian railway companies, the Dominion must advance very rapidly. For his services to Canadian commerce, Mr. Hugh Allan was knighted by Queen Victoria in 1871. His son, Mr. H. Montagu Allan, was knighted by King Edward in 1904. A younger generation of the family now carry on the business of the founders of the line with marked success, Mr. Hugh A. Allan, in London, being the chairman of the company.



Stern View, Showing Propellers.

The first of the two new ships to be launched is named the "Alsatian," and has been constructed by Messrs. William Beardmore and Company, Limited. A sister ship, the "Cal-

* Abstract of portion of a description of "Alsatian" in Engineering.

garian," is being constructed by the Fairfield Shipbuilding and Engineering Company, Limited. The launch of the "Alsatian" recently was an unqualified success, and the occasion is of interest, as the vessel is the first to be launched by Mr. A. J. Campbell, who has taken up the management of the works, after having completed the organization of the Spanish naval establishments at Ferrol and Cartagena, as shipyard manager of the Sociedad Espanola de Construccion Naval.

The following are the principal particulars of the "Alsatian," which was designed, and was built from specifications, by Mr. A. M. Gordon, the naval architect of the Allan Line:

Length on L.W.L.	600 ft.
Length between perpendiculars	570 ft.
Breadth, moulded	72 ft.
Depth, moulded, to "D" deck	54 ft.
Gross tonnage (about)	18,000
Draught fully loaded	28 ft. 6 in.
Speed on trial, fully loaded	19 knots
S.H.P. on trial (about)	20,000
Speed on service	18 knots
Number of decks	8
Number of water-tight bulkheads	11
Number of first-class passengers, about	200
Number of second-class passengers, about	500
Number of third-class passengers, about	1,000
Number of officers and crew, etc.	500

A notable feature of the ship is the adoption of the cruiser stern. This arrangement confers several advantages. In the first place it is possible to get a greater displacement on a given length over-all, with corresponding increase in dead-weight, or, if the displacement be not increased, the lines may be fined down, so that the ship is more easily driven, with corresponding reduction in engine power. In the second place, the fuller water lines aft which are permissible with this type of stern ensure greater stability, especially at the deeper draughts. In the third place, it is probable that this form of stern tends to reduce the vibration due to propellers. This reduction in vibration is further ensured by the placing of the steering gear low down in the ship, immediately over the rudder-head, so that the weights in the after part are more directly water-borne than where the steering gear is placed on the poop-deck or immediately under it, with an overhanging counter. It is further claimed that the cruiser form of stern will make the ship more comfortable with a following sea, as there will be less tendency for her to "slam" on the waves. This form of stern also increases the deck space aft for the accommodation of passengers. The balanced rudder fitted with this type of stern considerably improves the manœuvring powers of the vessel, and being entirely immersed and protected by the long overhang aft, it is less liable to damage from ice, floating wreckage, or other obstructions, especially when the vessel is going astern. To some, however, the appearance of the ship aft may not appear so attractive as with the older form of stern with a counter of graceful lines, but this is largely due to the training of the eye.

The vessel is fitted with a double bottom all fore and aft, which is carried to the upper portion of the bilge—much higher than in some recent passenger ships. Bilge-keels of the Admiralty type are fitted for about half of the vessel's length amidships, to minimize rolling in heavy weather. The shell for about 80 feet from the stern has been doubled for a considerable extent both above and below the water-line, with a view to protecting the hull from ice, and the framing has also been specially strengthened for this purpose. The frame-spacing for the major portion of the length is 3 feet, being reduced gradually at the ends to 2 feet in the forward and after peaks. Hydraulic riveting was adopted for a considerable portion of the length amidships on the upper portion of the shell and stringers, where tensile and compressive stresses are likely to become greatest. Another feature in connection with this vessel is that no expansion joints are fitted in the boat or promenade decks forming the upper structure; these have been specially strengthened with a view to taking their portion of the stresses.

The vessel is designed so that she will have a positive G.M. of not less than 3 inches when fully equipped, in light condition; thus she may be moved in dock without the excessive use of water ballast. The vessel has been subdivided by eleven water-tight bulkheads, built up generally of plating 17/40 inch at their lowest part and 10/40 inch at their upper part, the average thickness being about 15/40 inch. The stiffeners of the lower portion consist of bulb angles 10 in. by 3½ in. by 22/40 in., and the upper portion of angles 4 in. by 3 in. by 12/40 in., with additional webs where required locally. All the water-tight bulkheads are carried up to "E" deck, and are therefore 9 feet above the maximum load line at the lowest point of the deck. Several of them, however, are carried to "D" deck, which is 8 feet higher. In addition to this, "F" deck is made water-tight at the forward and after ends of the vessel, beyond the machinery spaces. It is therefore calculated that the vessel will float with any four adjoining compartments open to the sea. Hitherto the Board of Trade have only required a vessel to be capable of remaining afloat with any two adjacent compartments open to the sea, so as to enable her to claim a reduction on the number of boats and other life-saving appliances to be carried; but in this vessel the aim has been to ensure her remaining afloat with four adjacent compartments open to the sea, which is far in excess of Board of Trade requirements, whilst the boats and life-saving appliances are also sufficient for every person on board, in accordance with the latest regulations. A further element of safety in this vessel is that all the vertical and horizontal sliding watertight doors which it was found necessary to fit in the watertight bulkheads below "E" deck are actuated hydraulically from the bridge on the Stone-Lloyd system, and provision is also made for working them independently at the doors or from "E" deck.

The vessel has eight decks, so constructed that they ensure the passengers of the three classes comfortable and pleasant quarters.

The gear for working the anchors consists of two separate and independent engines, each driving one cable-holder and one warping capstan, by Messrs. Napier Brothers, Glasgow. In addition there are four independent steam warping capstans, two on each side of the vessel. The engine for each capstan is placed in a separate house, and connected by shafting to the capstan, which is outside of it. The steering gear is by Messrs. Brown Brothers, and is of their latest steam steering-tiller type, with stand-by steering gear, the whole controlled by means of tele-motor gear.

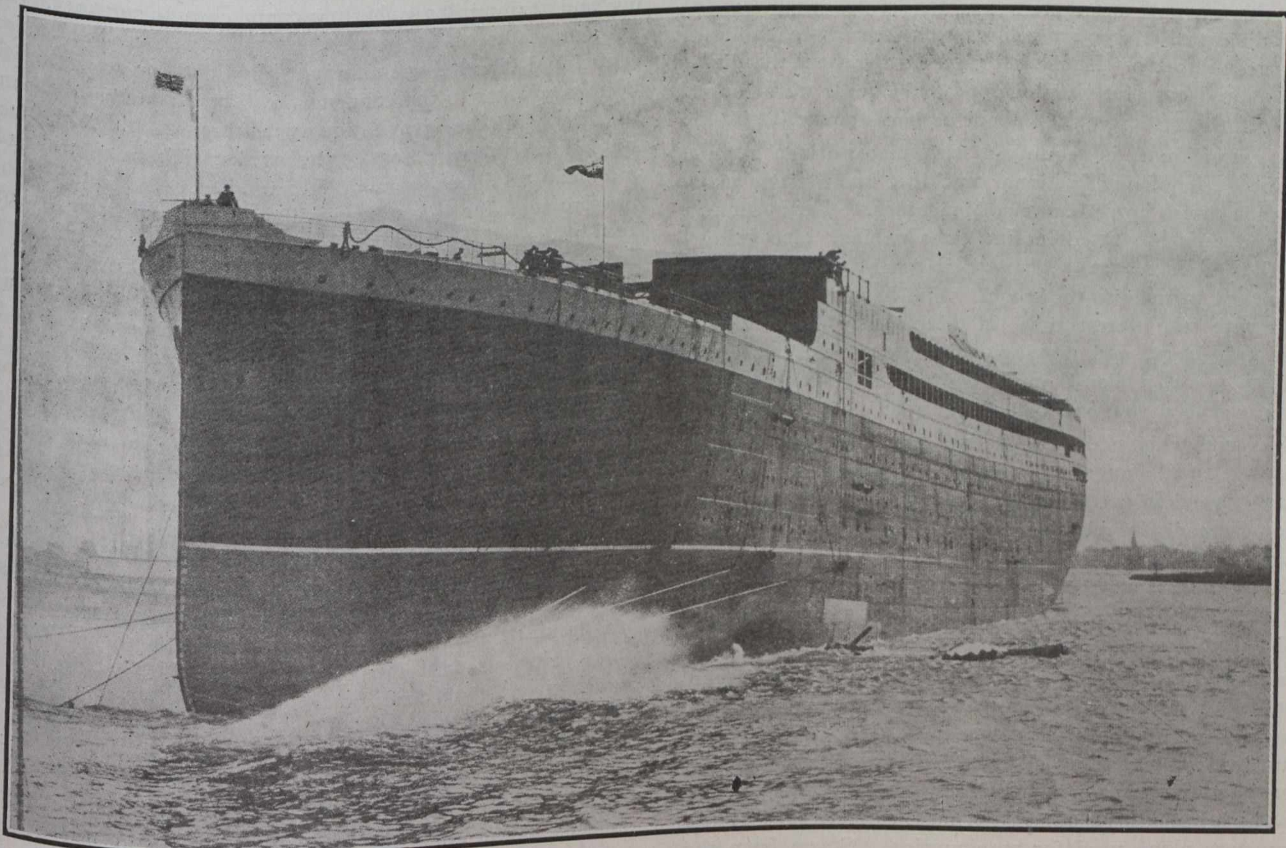
There are ten steam-winches for working cargo, six of which are 8 in. by 12 in. (double), and four are 8 in. by 12 in. (single).

There are five electric lifts, one passenger lift, two for stores, and two for mails and baggage.

The main electrical generating plant consists of three steam-turbine-driven sets constructed by the British Westinghouse Electrical Company, each capable of giving a continuous output of 250 kw. at a pressure of 2 × 110 volts when running at 3,000 revolutions per minute. The turbines of the main generating sets are of the Westinghouse impulse type, the normal steam pressure being 150 lb. per sq. in., exhausting against a back pressure of 12 lb. gauge. The dynamos are of special construction, and are fitted with slip-rings on the shaft, to which tappings are taken from the armature windings, thence through brushes to the auto-transformers or balance-coils, the middle or neutral point of the balance-point constituting the mid-point of the direct-current circuit. A small emergency turbo-generator is also provided and placed in a separate compartment on the lower promenade "C" deck well above the load water-line of the vessel. This emergency set is also being manufactured by the British Westinghouse Company, and is of 20 kw. capacity at 110 volts. The main generators are placed on an elevated platform on the port side of the engine-room aft, and the main switchboard abaft of the machines on the bulkhead. The switchboard contains the three dynamo panels fitted with automatic circuits of massive design; voltmeters and ammeters of the moving coil type and shunt-regulators for each

from the main switchboard to the emergency dynamo-room for supplying a separate emergency circuit, a change-over switch being provided so that in case of accident a sufficient number of lamps can be kept lighted in the engine-rooms, boiler-rooms, and passenger accommodation, also on the boat-deck should the main dynamos be shut down. Power is also available from this emergency dynamo for working the wireless installation and navigation lights.

The fittings in the public rooms and state-rooms are in keeping with the scheme of decoration, which is Jacobean. The domes of the lounge, smoke-room, and first-class entrances are arranged with concealed lamps above the colored glass, giving a pleasing effect. Electric clocks of the "Magneta" type are placed in the public rooms, entrances and chart-room, and all are controlled by a master clock. Pearson's automatic fire alarms are fitted throughout the vessel, with an indicator in the navigating-room. Thermostats, or



Ship After Launching.

dynamo, there being in all thirty circuit-breakers and fourteen switches and fuses.

A special feature of the installation is the three-wire system, which, we believe, is now fitted for the first time on a large passenger ship. All heavy-power circuits are fed direct from the main switchboard at 220 volts pressure, the lighter and smaller motors being supplied from each side of the three-wire supply at 110 volts. From the switchboard heavy lead-covered cables are run on the port and starboard side to auxiliary switchboards placed in different compartments, and interconnected by heavy cables through circuit-breakers, forming complete ring mains round the ship, these being so arranged that in the event of a failure on any cable, a full supply is still obtained through the opposite feeders. Special precaution against heating has been made by carrying all feeders clear of the engine and boiler-room on the deck above these compartments. The total number of lamps installed throughout the ship is about 3,000, all of these being of the metal-filament type. Cables are also run

heat detectors, are fixed in the different compartments. These can be set so as to give an alarm at a rise of 15 deg. Fahr., and can be limited for compensation to any predetermined temperature; means are also provided to allow each circuit to be tested for continuity by pressing a button at the indicator. In addition to the above there is a very complete system of fire alarm pushes or bells in corridors, etc., these being connected to indicators in the engine-room and navigating-bridge. Telephone instruments are fitted throughout the suite and special state-rooms are connected through a central exchange situated on the main deck. There is also a system of intercommunication telephones between the officers' cabins, and a similar system in the stewards' department, all of the Sterling Company's make.

For the ventilation of the ship an elaborate system of Ashwell and Nesbit's hot and cold air apparatus is fitted, the whole of the fans for this installation being electrically driven. Forty-six motors are used, which require over 150 horse-power.

For the navigation of the ship Graham's loud-speaking telephones are adopted on the navigating-bridge, communicating between forecastle, crow's-nest, docking bridge aft and chief engineer, Marconi room and engine-room and bow. A complete system of submarine signalling apparatus is arranged in the ship, and also a semaphore with Morse flashing-lamp and keys on a platform above the bridge. There is a navigation-light indicator of McGeoch's new pattern for masthead lights, bow lights, anchor and stern lamps.

As regards the electric appliances in the machinery department of the ship, there are four large forced-draught Howden-Laurence Scott combination fans for boiler-rooms, and twelve ventilating fans for stokeholds and engine-rooms, the total horse-power for these being 250. The three turbine lifting and turning motors have a total capacity of 15 horse-power.

In galleys, electrical power is used for the bakery machine, cooking-ovens, and there are motor-driven spits, knive-cleaners, dish-washers, potato-peelers, and freezing-machines, and a large number of electric hot plates throughout the dining-saloons and bars for keeping food and liquids warm during service; this gear requires about 60 horse-power.

The gymnasium is equipped with motor-driven appliances, consisting of one frictional machine, one Seiste's machine, and three horse exercise machines. Curling-tong heaters and fans are fitted in first-class cabins, also wing fans in the public rooms. A motor-driven printing-machine is also placed in the printing-room. The barbers' shops are provided with the latest type of electrically driven hair-brushes, hair-dyers, and massage apparatus; each machine is fed from a socket placed in a convenient position to the chair, no overhead shafting being required.

The steam whistle is the Willett Bruce pattern, and is worked by a small motor and solenoid enclosed in a water-tight case placed in a convenient position near the whistle. Provision is made for blowing by hand-cord in the ordinary way, and the whistle can be operated by the three switches placed port, starboard, and amidships on the captain's bridge, these are so arranged that either "time control" or "signal control" can be made.

The propelling machinery consists of Parsons' compound steam-turbines arranged in series on four shafts, and including one high-pressure, one intermediate, and two low-pressure turbines. Two astern turbines, each with impulse and reaction blading, are incorporated with the low-pressure turbines, which latter drive the inner lines of shafting. These, therefore, are alone used for manœuvring. Steam from the boilers may pass direct to each turbine, and by a suitable arrangement of pipes and valves, any shaft may be operated independently of the others; but normally the steam will pass in sequence through high, intermediate, and both low-pressure turbines. With this arrangement of machinery, better economy is expected than with the usual four-shaft parallel arrangement.

The turbine casings are of cast iron, and the drums, dummies, spindle, wheels, and shafting are of forged steel made at the Parkhead Works of the builders. Forced lubrication is fitted throughout for the main bearings, adjusting-blocks, and plummer blocks, and the arrangements include four Weir's lubricating oil-pumps, two Carruthers' water service pumps, with the necessary oil-coolers, drain, and reserve-tanks.

The condensing plant is fitted in a separate water-tight compartment immediately aft of the engine-room, and consists of two main condensers of the "Uniflux" type, in conjunction with two dual air-pumps, together capable of carrying and maintaining a high vacuum even in summer, when the temperature of sea-water approaches 75 deg. Fahr. Four centrifugal circulating-pumps are provided for supplying the necessary water to the condensers. The air-pumps discharge to filters of the gravitation type, through which the feed-water flows to large float-control tanks. These control-tanks are arranged about the middle line of the vessel, and suctions are provided for the main auxiliary feed pumps. A large feed-heater of the surface type takes all the exhaust steam from the auxiliary machinery, including the turbine-driven electric generators, and is drained to the float-tanks through the filter. Any surplus exhaust steam may be passed to the turbines. With this utilization of the exhaust steam for heating the feed-water for the boilers great economy in working is expected. Other auxiliaries include pumps for bilge, sanitary, ballast, hot and cold fresh water, hot and cold salt water, and ash-ejector purposes. It should be noted that the sanitary pumps are of the rotary type, driven by electric motors, thus eliminating noise and shocks.

Steam at a working pressure of 200 lb. per sq. in. is supplied by six double-ended and four single-ended boilers of the cylindrical type, working under Howden's system of forced draught, and arranged in two compartments. There are four forced-draught fans, placed on deck above the boilers, and driven by electric motors. Ash-ejectors and ash-hoists are fitted in each compartment, and special arrangements have been made for ventilation of boiler-rooms by electric fans of the pressure type.

The vessel, boilers, and machinery have been built under special survey to British Corporation Rules to enable her to class B.S. with that society, and she will also comply with latest Board of Trade requirements and Canadian immigration laws.

TEST TO DESTRUCTION OF BRICK PIERS FOUR FEET SQUARE AND TWELVE FEET HIGH.

The testing of two brick piers of unusual size is described by Maj. J. E. Howard, Engineer Physicist, Bureau of Standards, in a paper before the National Brick Manufacturers' Association. We have redrawn the diagram showing the test results and with it publish here the portion of the paper relating specifically to the tests. The piers were about 4 ft. square by 12 ft. high, weighing a little over 13 tons each. They were built of common, hard burnt, wire cut building brick from one of the yards of Messrs. Booth & Flinn, Pittsburg. One pier was laid in 1:1 cement mortar, the other in 1:3 lime mortar.

The brick were selected with a view of laying a pier which would display a crushing strength of about 3,000 lbs. per square inch when laid in cement mortar, provided this

Table I.

Pier laid in	Dimensions. Height.	Cross-section.		Sectional area, sq. ins.	Average thickness of joints.	First crack. Total lbs.	Total lbs.	Ultimate strength. Lbs. per sq. in.
cement mortar	12 ft.	47.5 ins.	47.5 ins.	2,256	5-16 ins.	4,737,000	6,580,000	2,917
lime mortar	12 ft.	47.5 ins.	47.5 ins.	2,256	5-16 ins.	676,800	1,710,000	757

pier of nearly 190 cu. ft. volume had a strength per square inch of cross sectional area proportional to one of 8 cu. ft. volume. The pier actually displayed an ultimate strength of 2,917 lbs. per square inch, indicating substantially the same strength in each size. Similarly the pier which was laid in lime mortar was expected to have an ultimate strength somewhat less than 900 lbs. per square inch. It failed at 757 lbs. per square inch.

Owing to their great size the piers were built in the testing machine, where they seasoned until the time of testing. The test of the cement mortar pier was completed when four weeks and three days old. Ten gauged lengths in all of 20 ins. length each were established on the four sides, the extremities of which were defined by small metal plugs cemented in the bricks. As loads were applied and advanced the compression of the pier was measured on these 20-in. lengths by means of a strain gauge, in practically the same manner as thermal effects on cement filled brick pavements are being observed by means of that instrument. The compression of the lime mortar pier was measured when it was 25 days old.

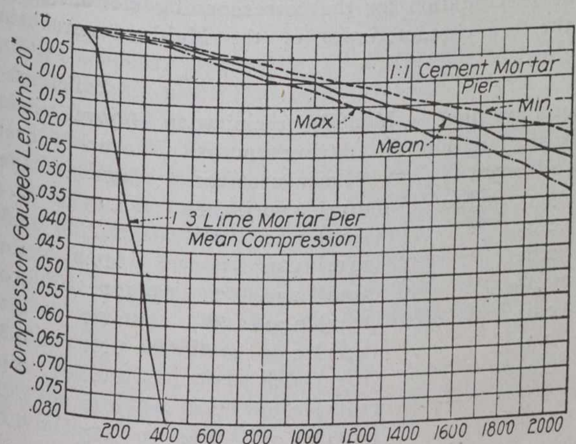


Fig. 1.—Curves Showing Relative Compressibility of Brick Laid in Cement and Brick.

The results of the tests were as shown by Table I.

In failing, along the middle of their heights, the sides opened laterally. Frictional resistance at the ends, between the brickwork and the platforms of the testing machine, strengthened the piers against lateral deformation and probably influenced the pyramidal shapes assumed after rupture. The manner of failure of these large piers was the same as that witnessed in piers of smaller dimensions.

Diagrams are presented to illustrate the behavior of these piers during test and at their ultimate strength. Figure 1 shows the compression curves of the two piers as loads were successively applied. The pronounced difference is in their rate of compressibility is well indicated. This difference is, of course, due to the difference in the mortars used. These curves represent the total compression of the brickwork, which in the case of the lime mortar pier was chiefly permanent set. But that of the cement mortar pier at 1,000 lbs. load was about one-third permanent set and two-thirds elastic compression, or, stated differently, the cement mortar pier would recover about two-thirds of the observed compression upon release of load.

Three curves are given for the cement mortar pier, one representing the mean compression, one representing the minimum compression of the several gauged lengths and one gauged length which displayed the maximum compression. Since the ends of the pier were in contact with and were moved by the rigid platforms of the testing machine this difference in the amount of compression on the several gauged lengths, which were established along the middle of the height of the pier, represents unequal compression locally, and would occasion bending stresses in the bricks and lead to the formation of transverse fractures.

HYDRO-ELECTRIC POSSIBILITIES OF THE MAITLAND RIVER, ONTARIO.

In June of 1912, a report on the power possibilities of the Maitland River was made to the Hydro-Electric Commission of Ontario by Mr. H. G. Acres, hydraulic engineer to the commission. This report, which is incorporated in the last annual report of the commission, just published, gives a considerable amount of data regarding the hydrology of the stream, together with an analysis of the possibilities of commercial development. The report is given herewith in full:

The natural source of power for the county of Huron is the Maitland River, which rises on the height of land between Lake Erie and Georgian Bay, and flows into Lake Huron through the town of Goderich. The watershed of this river is about 950 square miles in extent, and is largely drained and deforested. As a result, the natural flow characteristics have been destroyed, and the watershed of the Maitland River, in common with the watersheds of other rivers in the southwestern peninsula, has an uncontrolled run-off which produces heavy spring freshets, and a consequent low discharge during the late summer and early autumn periods.

The abnormal flow characteristics of the Maitland River to a large extent discount its value as a source of power, the more so by reason of the fact that its watershed is almost entirely lacking in natural storage basins. The country throughout the whole area is cleared and for the most part cultivated, so that the land damages and construction costs in connection with the establishment of remedial works of sufficient magnitude to adequately offset the effects of drainage, cultivation and deforestration would be prohibitive. In view of this fact, the power possibilities of the Maitland River, considered as an independent source of continuous power, can only be discussed on the basis of minimum flow, in conjunction with such advantages as can be derived from local pondage.

The total drop of the Maitland River from headwaters to mouth is approximately 900 feet, but the topography of the watershed is such that no natural heads of any consequence exist, the gradient of the river-bed being fairly uniform and the average velocity high. As a result, power can only be developed by diversion or by the creation of an artificial head, or by a combination of both methods. This condition, in conjunction with the poor run-off regulation, will tend to make power development expensive, and to increase the annual cost of power.

The above general facts and the general conclusions deduced therefrom, comprised practically the sum total of all hydraulic data in connection with the Maitland River which could be safely used when the Huron County scheme first became a definite issue. The proper consideration of the scheme, therefore, necessitated at the outset a systematic investigation of the flow characteristics of the Maitland River. Owing to the desire of the county authorities to have a report at the earliest possible date, it was decided to carry on the hydraulic investigations for one year only, the understanding being that any conclusions arrived at by the end of that period should not be considered as final, but merely as indicating reasonable possibilities. The extent to which this end was attained will now be considered.

Early in May, 1911, a gauging station was established at Ben Millar, and since that date monthly measurements of flow have been made, and in connection with these measurements daily records of level were also obtained.

The records obtained up to the present time are tabulated hereunder:—

Date of measurement.	Discharge. Cu. ft. per sec.	Water level.	Electric h.p. per foot of head. Horse-power.
May 19, 1911	979	14.27	82
June 14, 1911	549	13.80	46
July 20, 1911	305	13.60	25
August 11, 1911	170	13.37	14
September 18, 1911	172	13.39	14
October 16, 1911	257	13.55	21
November 20, 1911	4,068	15.34	340
December 22, 1911	1,280	14.30	107
January 27, 1912	752	Ice	63
February 29, 1912	506	Ice	42
March 28, 1912	2,116	Ice	176
April 6, 1912	41,000	20.26	3,420
April 7, 1912	65,000	21.60	5,420
April 26, 1912	1,437	14.40	120
May 30, 1912	5,815	16.13	485
Estimated extreme minimum on Aug. 30, 1911	120	13.18	10

The last item in the above table is inserted by reason of the fact that there was no actual measurement of flow taken when the water-level reached its lowest stage of 13.18 at Ben Millar, as evidenced by the daily records. The estimated discharge of 120 cubic feet per second is considered to be a generous one and is to be considered the minimum volume of flow so far recorded.

The flow characteristics of the river during the term covered by these records may be summarized as follows:—

(1) The minimum run-off of the watershed was about .125 cubic feet per second per square mile.

(2) The maximum run-off of the watershed was about 68 cubic feet per second per square mile.

(3) The ratio of minimum to maximum flow was at 1 to 543.

(4) The low stages of flow occurred during the months of July, August, September and October.

(5) The intermediate stages of flow occurred during the months of November, December, January, February, March and June.

(6) The high stages of flow occurred during the months of April and May.

These records also indicate:—

(1) That the river is extremely sensitive to the effects of rain-fall.

(2) That the river is seriously deficient in ground storage capacity.

(3) That deforestation, cultivation and drainage have so accelerated the run-off that the ground storage of the watershed can never be filled to its natural capacity. The falling off in discharge from 65,000 sec. ft. on April 7th to 1,437 sec. ft. on April 27th plainly indicated the existence of this condition.

The records so far obtained seem to indicate, therefore, that the discharge of the Maitland is mainly dependent upon surface run-off, and the power capacity of the river from month to month will vary almost in proportion to the monthly precipitation on the tributary watershed. This contention is borne out by the evidence of the May discharge. On May 19, 1911, there was 82 h.p. per foot of head at Ben Millar, with the May precipitation slightly below normal. On May 30, 1912, there was 485 h.p. per foot of head at Ben Millar, with the May precipitation 300 per cent. above normal.

This intimate relation between rain-fall and power capacity indicated the necessity of determining what relation the monthly precipitation during the year covered by the records bore to that of previous years, and precipitation records from all meteorological stations located in or adjacent to the Maitland River watershed were obtained with this object in view. These records proved to be so disconnected and otherwise unsatisfactory that an exhaustive analysis of the same would have been useless. The figures relating to precipitation have, therefore, a low degree of accuracy, and are submitted only because of the impossibility of procuring more reliable data.

The figures in the table below were compiled from precipitation records taken at Goderich for 36 years, at Clinton for 8 years, at Mount Forest for 7 years, at Stratford for 16 years, at Lucknow for 27 years, and at Listowel for 10 years. The first column contains the average of all records of monthly precipitation to date, and the second column contains the precipitation for the corresponding months during which the flow characteristics of the Maitland were being investigated.

	General average monthly precipitation for all years.	Monthly precipitation during months of measurement.	Difference Above average.	Difference Below average.
Jan.	3.55 inches	(1912) 4.70 inches	1.15	....
Feb.	2.95 "	(1912) 2.12 "	....	0.83
March	2.62 "	(1912) 1.59 "	....	1.03
April	2.15 "	(1912) 2.10 "	....	0.05
May	2.93 "	(1911) 2.71 "	....	0.22
June	2.91 "	(1911) 2.02 "	....	0.89
July	2.91 "	(1911) 1.90 "	....	1.01
Aug.	2.47 "	(1911) 2.59 "	0.12	....
Sept.	2.86 "	(1911) 3.71 "	.85	....
Oct.	3.39 "	(1911) 4.45 "	1.06	....
Nov.	3.49 "	(1911) 4.33 "	.84	....
Dec.	3.48 "	(1911) 2.13 "	....	1.35

It will seem from the above that the monthly precipitation during the year of investigation fell below the general average during the months of February, March, April, May, June, July and December, and was above the general average during the months of August, September, October, November and January.

While, as previously stated, the reliability of the precipitation data is questionable, several deductions can be drawn from the above figures which have a certain value.

These deductions may be itemized as follows:

1. The average precipitation for the three winter months of December, January and February from the above table is 9.98 inches. The precipitation for this period in 1910-11 was 9.46 inches, or 0.52 inches below the average. The precipitation for the corresponding period in 1911-12 was 8.95 inches or 1.03 inches below the average. It is to be inferred from this that there was a greater volume of spring run-off during the spring of 1911 than there was in the spring of 1912. This condition should reasonably be expected to produce a greater summer flow in 1911 than in 1912, on account of the fuller replenishment of ground storage.

2. The average precipitation for the three months of March, April and May is 7.70 inches. The precipitation for this period during 1911 was 8.21 inches, and for the same period in 1912 was 10.54 inches, being therefore 0.51 inches above the average for 1911, and 2.84 inches above the average for 1912. Under these conditions the tendency would be to produce a spring discharge in the Maitland slightly above

the average in 1911, and considerably above the average in 1912. This should also have a tendency to make the summer flow for 1911 less than the summer flow for 1912, but slightly more than the average.

3. The average precipitation for the three summer months of June, July and August is 8.29 inches. The precipitation for the summer months of 1911 was 6.51 inches, or 1.78 inches below the average. The tendency would, therefore, be for the production of a summer discharge below the average during 1911.

4. The average precipitation for the three autumn months of September, October and November is 9.74 inches. The precipitation during the autumn months of 1911 was 12.49 inches or 2.75 inches above the average. The tendency of this condition would be to produce an autumn discharge greater than the average in 1911, and also to produce a discharge greater than the normal during the winter months of 1911, and 1912.

Applying these deductions to the flow characteristics found by measurement during the years 1911 and 1912, the following conclusions are derived:—

1. The winter precipitation for 1910-11 was slightly less than the average but greater than the winter precipitation for 1912, the tendency being therefore to produce a summer flow in 1911 slightly above the average, and greater than the summer flow for 1912.

2. The spring precipitation for 1911 was slightly greater than the average but much less than the spring precipitation for 1912, the tendency being, therefore, to produce a spring run-off and consequently a summer flow, slightly above the average in 1911, but less than would obtain in 1912.

3. The summer precipitation for 1911 was considerably below the average, the tendency therefore being to produce a summer flow less than the average.

4. The autumn precipitation for 1911 was considerably above the average, the tendency being to produce an autumn and winter flow greater than the average.

As regards summer flow in 1911, we have therefore two factors, the winter and spring precipitation and the spring run-off tending to make it a maximum through the effect of ground storage, and one factor, the summer precipitation, tending to make it a minimum by reason of a summer run-off which was below the average. Inasmuch as surface flow is assumed to be the governing factor as regards the discharge of the Maitland River, it may be reasonably stated that the summer discharge for 1911 was really below the average, and also that the summer discharge for 1912 may be expected to be greater than that of 1911 and possible above the average.

In the matter of autumn and winter flow, that shown by measurement during 1911 and 1912 is probably much greater than can ordinarily be expected, as the autumn precipitation was so much in excess of the average. Smaller values for discharge are to be anticipated during the coming autumn and winter if, as seems probable, the precipitation more closely approaches the average.

To conclude this portion of the argument it may be said that, as regards the flow characteristics of the Maitland River, the outstanding features are, first, its sensitiveness to the effects of rain-fall, and, secondly, its dependence upon surface run-off as against ground storage. Therefore, while the conclusions above set forth may cover the general behavior of the river over a cycle of years, the occurrence of abnormal or unusual precipitation phenomena during some particular season may give rise to temporary conditions of flow, the nature of which it is not now possible to anticipate.

The initial decision that the Black Hole power-site was the best suited to the requirements of the commission and the county of Huron is amply justified by the results of the subsequent investigation. The minimum capacity of 10 h.p. per foot of head proves the necessity for developing under the highest possible head that topographical conditions will permit and that capital cost will justify, and also for choosing a site providing the best facilities for pondage in order to make peak load and daily storage capacity a maximum. The Black Hole site, with an operating head of 80 feet, and something over 700 acres of pondage obtainable, fulfils the required conditions more satisfactorily than any other possible location on the lower river and has been considered to the exclusion of all others.

Referring back to the table of discharge measurements, the power capacity of the Black Hole site, under an 80-foot head, upon the various dates of flow measurement, would be as follows:

Date of measurement.	Continuous 24-hour power capacity.	Probable combined 10-hour and 24-hour capacity.
May 19, 1911	6,560 E.H.P.	10,000 E.H.P.
June 14, 1911	3,680 "	5,800 "
July 20, 1911	2,000 "	3,200 "
Aug. 11, 1911	1,120 "	1,800 "
Aug. 30, 1911 (min.)	800 "	1,200 "
Sept. 18, 1911	1,120 "	1,680 "
Oct. 16, 1911	1,680 "	2,400 "
Nov. 20, 1911	27,200 "	38,000 "
Dec. 22, 1911	8,560 "	12,000 "
Jan. 27, 1912	5,040 "	7,100 "
Feb. 29, 1912	3,360 "	4,700 "
Mar. 28, 1912	14,080 "	21,000 "
April 26, 1912	9,600 "	15,400 "
May 30, 1912	38,800 "	62,000 "

Considering the above figures in connection with the conclusions derived from the study of precipitation, the following general statements with regard to power capacity would seem justifiable:

1. The spring flow will, under all circumstances, produce power in excess of economic installed capacity.

2. The summer flow was probably close to the minimum during 1911 and a larger summer power capacity may be anticipated under average conditions.

3. The autumn precipitation and late autumn flow was considerably in excess of the average, so that the power capacities established by measurement during the autumn and winter of 1911-12 cannot be considered normal, and conditions much less favorable should frequently obtain.

Considering the power capacities in connection with the market demand, it is evident that even under average conditions, the summer power capacity of the Black Hole site will not be sufficient to carry the Huron county load, so that some portion of it will always have to be carried by Niagara during the summer season, and probably at times in the early autumn. Also while the autumn and winter capacity may at all times be sufficient to carry the Huron county load, it is by no means certain that sufficient surplus capacity will be available to supply auxiliary power to the Niagara system. As the Maitland River will be obliged to furnish power to the Niagara system during the autumn and winter months to compensate for power obtained from Niagara during the summer, the serious nature of this condition is evident; for unless the Maitland River can furnish auxiliary power during the peak load period when it is required, the summer power supplied by the Niagara system will have to be paid for by the county of Huron.

The projected scheme of development at the Black Hole involves the creation of an artificial head and also a diversion. It is proposed to build a dam of sufficient height to back the water up to Ben Millar bridge and to further increase the head by diverting the flow across the neck of a sharp bend in the river. The additional head obtained by this diversion will be at 5 to 15 feet, depending upon the relative locations of the dam and power-house, and the total average head available would be about 80 feet.

The largest item of capital cost in connection with this development is the dam construction, and before the flow characteristics of the river had been investigated it was thought that earth fill construction could be used for the main dam, but the abnormal flood flow conditions evidenced by this spring's measurements demonstrated the practical impossibility of utilizing this type of construction at the Black Hole. It was therefore necessary to largely increase such preliminary estimates as had been made to provide for a masonry dam, and the hollow reinforced type of construction was adopted as being the cheapest and most economical after giving proper consideration to safe and efficient handling of ice and flood-water.

In a general way it may be said that the conditions relative to development at the Black Hole could not well be more unfavorable, as the low water power conditions are such as to make the revenue-producing power capacities very small, while the flood conditions are such as to call for an abnormally heavy capital expenditure for dam construction and permanent works. The annual cost of generated power is therefore affected by reason of the fact that the revenue from power generated at low stages of flow must be sufficient to cover the heavy capital charges and maintenance costs arising out of the necessity for handling an abnormal flood discharge.

Two estimates of the cost of development at the Black Hole have been made, one for 2,000 h.p., and one for 6,000 h.p. installed capacity. The 2,000 h.p. estimate represents the cost of developing the Black Hole site, as an independent source of power, to the limit of dependable 10-hour capacity. The 6,000 h.p. estimate provides surplus installed capacity for the purpose of using the higher stages of flow to supply auxiliary power to the Niagara system.

The 2,000 h.p. estimate shows a capital cost of $587,000, and a total annual charge of $45,500. The 6,000 h.p. estimate shows a capital cost of $637,000 and a total annual charge of $51,500. Considering these figures in connection with the statements made above as to the effect of a low power capacity, combined with a heavy flood discharge, upon cost, it is interesting to note:—

1. In the 2,000 h.p. estimate, the dam construction amounts to 63 per cent. of the total capital cost, and the annual charges against dam construction alone amount to 51 per cent. of the total annual charges.

2. In the 2,000 h.p. estimate, the interest and sinking fund charges amount to 75 per cent. of the total annual charges.

3. In the 6,000 h.p. estimate, the dam construction amounts to 58 per cent. of the total capital cost, and the annual charges against dam construction alone amount to 45 per cent. of the total annual charges.

4. In the 6,000 h.p. estimate, the interest and sinking fund charges amount to 71 per cent. of the total annual charges.

It is evident from the above figures that the annual cost of generated power at the Black Hole will be high as long as the interest and sink fund continues to be an annual liability, the more so because the revenue from such continuous power as can be generated under conditions of minimum flow will always have to carry the bulk of the annual charge against the development.

FREIGHT RATES BY WATER

The plans of the department of railways and canals for ascertaining the average rate per ton per mile on the inland waters of Canada involved the recording of the freight rates on each ship's report filed at the various canal offices. As an alternative those operators who wished to do so were permitted to send a monthly statement to Ottawa of tonnage, mileage and gross freight earnings. Ship owners were also required to send in at the close of the season a report showing:—Total tons carried, total ton mileage of loaded vessels, gross receipts from freight. On the whole, and having regard to the difficulties which are inseparable from the inauguration of new undertakings of that character, the results obtained during the past year the first of the operations of the plans were satisfactory. For example, out of a net Canadian tonnage of 6,942,278, definite information was received with regard to the mileage and freight earnings on 6,292,661 tons. St. Peters and St. Andrews canals were left out of the scheme for the year 1912, and they accounted for 170,358 tons; so that the actual net Canadian tonnage affected was 6,771,920. Returns were thus received in relation to 93 per cent. of Canadian business. These returns covered all classes of traffic, and it might reasonably be assumed that had every ton been accounted for, the result would not have been altered.

The Canadian returns applied to 6,292,661 tons of freight, to 3,286,187,160 ton miles, and to gross freight earnings amounting to $6,378,893.43.

From United States shipping companies reports were received covering 26,030,661 tons, out of a total net tonnage of 36,840,812. These reports had reference to all classes of commodities, and were thoroughly typical of the whole business on inland waters of Canada. It may be confidently asserted that absolutely complete returns would not have materially affected the final calculation of the average rate per ton per mile. The number of ton miles accounted for amounted to 21,799,392,809, and the gross earnings on United States freight to $14,617,368.60.

Using the factors which have been indicated—the ton mileage and the gross earnings from freight—the results are as follows:—

Canadian traffic:—
Average rate per ton ....91. 04 cents.
" " per mile .... 0.194 "
United States traffic:—
Average rate per ton ....50. 62 cents.
" " per mile .... 0.067 "

Without an explanation, the difference between the Canadian and United States rate per ton per mile will not be understood. Of the 36,840,812 tons of United States traffic through the canals of Canada in 1912, no less than 31,134,251 tons, or nearly 85 per cent., consisted of iron ore. Upbound coal accounted for a further 2,945,441 tons, or 8 per cent. In fact, if iron and coal were eliminated from the total account, the volume of Canadian traffic would exceed that of the United States.

The transportation of iron ore and coal is a special feature of the trade of the Great Lakes. Most of the ore is carried by the vessels of the Pittsburg Steamship Company, and the rate in 1912 was 55 cents per ton from the head of Lake Superior to ports on Lake Erie. These vessels are owned and operated by the iron interests of Pittsburg, and do not carry other commodities than ore and coal—ore down and coal up. For this upbound coal, without regard to ownership of the vessels, the rate last year was 30 cents per ton. Thus, while wheat was being carried to Buffalo at as high a rate as 2.616 cents per ton per mile, iron ore was passing over the same route at .063. Coal was being moved upward at the still lower rate of .046 per ton per mile. In a word, any analysis of freight rates on the inland waters of Canada would be misleading which failed to recognize, and to separate for special treatment, this overwhelming movement of ore and coal under the conditions indicated.

Special care was taken during the year to ascertain with accuracy the rates which were charged on waterborne wheat. The facts in that regard were carefully tabulated. They yielded the following results:—

Fort William to Buffalo, per ton per mile, .103 cent; per bushel, 2.863 cent.

Fort William to Georgian Bay, per ton per mile, .163 cent; per bushel, 2.629 cent.

Fort William to other Canadian ports, per ton per mile, .115 cent; per bushel, 2.384 cent.

Fort William to Montreal, per ton mile, .160 cent; per bushel, 5.774 cent.

The lowest rate prevailed in May, and the highest in December.

There was not any wheat actually brought down from Fort William to Montreal in December; and the rates are for November. The largest volume of wheat moved between Fort William and Montreal occurred in October, when the average rates were .184 per ton mile and 6.149 cents per bushel. For the same month the rates from Fort William to Buffalo were .084 per ton per mile, and 2.259 cents per bushel. The maximum rate of the season between Fort William and Montreal was in effect in November, and was 8 cents per bushel.

To measure the conditions which influenced the movement of Canadian wheat to Montreal or Buffalo, it is necessary to know the freight rate on wheat from Buffalo to the Atlantic seaboard during 1912. It was officially ascertained from the Buffalo chamber of commerce, under date of 14th February, 1913, that these rates per bushel were: May to end of September, on lake wheat for export, 4½ cents; in October 5½ cents; after fifteenth November, six cents.

Thus, the all water rate from Fort William to Montreal in May was 5.444 cents per bushel, and the combined water and rail rate from Fort William to the American seaboard (say New York) was 7.219 cents. In November, the water rate from Fort William to Montreal was 7.129 cents per bushel, and the combined water and rail rate from Fort William to the United States seaboard, via Buffalo, was 8.616 cents. The apparent difference in favor of Montreal was 1.765 cents per bushel in May, and 1.487 cents in November, so far as the rates of freight were concerned.

There remains to be presented the facts with respect to traffic by way of Fort William and Georgian Bay ports. The average rate for the season was 2.629 cents per bushel. It was officially ascertained that the rail rates from Georgian Bay to Montreal were as follows:—

	Per Bushel.
Canadian Pacific Railway	6 cents.
Grand Trunk Railway, January 1st to June 30th	5 cents.
Grand Trunk Railway, July 1st to September 30th	4 cents.
Grand Trunk Railway, October 1st to December 31st	5 cents.

Speaking broadly, it might be assumed that the combined water and rail rate is adjusted to practically equal the all-water rate.

Among the causes which operate to divert a large percentage of Canadian wheat from Canadian to United States channels despite the lower transportation cost are:—The availability of ocean tonnage at New York, the consideration of time in making delivery at foreign ports, and the rates of marine insurance. It is obvious that these causes must have continued to operate effectively in 1912.

The question is frequently, and quite naturally, asked: How do freight rates by water compare with freight rates by rail? This question will never be fully and satisfactorily answered until carriers by water are required to report in precisely the way railways are asked to do.

This year, for the first time, accurate information has been obtained with regard to the average rate per ton per mile on the waterborne traffic of the Great Lakes. That rate, so far as Canadian business was concerned, was found to be .194 cent. It is pointed out, however, that this rate does not take cognizance of the special conditions under which traffic on the inland waters of Canada is conducted, and that the contribution of government should be taken into the reckoning. There is pertinency in such a contention. It would seem, at all events, to be proper to include the interest charge on the capital cost of the canals and the annual outlay by government for up-keep. The facts in that regard are definitely known. This plan omits all expenditures for harbors, lighthouses, dredging, buoying, etc., which might be included; but, whether they should be included or not, the matter is ruled out for the time being by reason of the fact that the sum of such expenditures is not definitely known.

HARDENING ARMOR PLATE BY WELDING.

Sheffield steel experts are awaiting with considerable interest further information concerning tests, which, it is stated, have been applied with some success to armor plates manufactured by a new process which, the inventor claims, renders them capable of resisting projectiles of the highest power.

The inventor is William Henry Worrall, of Sheffield. He states that the new armor plate does not at all rely upon any new ingredient for its increased resisting power, but that this is obtained as the result of a different process of hardening, largely secured by the welding or bonding of four or six sheets of metal into one plate, instead of molding the plate as a whole in one ingot. The main object is to effect a thorough homogeneous hardness. This, it is said, will permit of ironclads being as efficiently protected with much thinner and lighter plates than is at present the case.

Several experts express some doubt as to whether the welding of a number of plates contributes to greater homogeneity. They all agree that experiments conducted on somewhat similar lines have not hitherto been attended with success. Dr. J. O. Arnold, F.R.S., professor of metallurgy at Sheffield University, said:

"Practical experience in armor plate manufacture is that you must have the face sufficiently hard and with sufficient depth of hardness to smash up a shell. No reliable estimate can be formed of the value of a plate until it has been drastically tested by the admiralty, under standard conditions. So far as I know there is only one plate of this so-called bonded process of manufacture which has been so tested, and that was a failure. There is a new system of manufacturing armor plates, at present in the experimental stage, which consists of welding a face of high-speed steel on to the relative soft backing of the plate. This has been done with some measure of success, but the ultimate value of the plate can only be determined by an admiralty test. I see it is claimed that Mr. Worrall's plate has withstood a fourteen-inch shell. If that is so, it must have been an admiralty test, because I do not think any private firms are equipped with such a gun.

COAST TO COAST.

Montreal, Que.—The Great North Western Telegraph Company will install in June next between this city and Toronto the Wheatstone high-speed automatic apparatus, which will transmit 400 words a minute, or 24,000 an hour, as compared with 5,000, the record for Morse operators under quadruple operation. The system has been used extensively by the British post-office and the Western Union Telegraph Company, of the United States. Mr L. S. Hume, local manager, recently stated that no reduction of operators would be made on account of the Wheatstone installation. At present, he stated, the growing demands of patrons of the company, both in Montreal and in Canada generally, required increased facilities for handling telegrams. The new arrangement will enable the Great North Western to better cope with their largely increased business. It is learned that one circuit of the new installation will require a staff of twenty-six persons to properly operate one wire only. Three operators will look after a perforating electrical machine run from a typewriter keyboard. A punched tape, which is fed by a "transmitter" working at high speed, where the signals are transferred to a tape by a "receiver." The tape is then handed to typewriter operators, who copy them.

Ottawa, Ont.—Mr. W. A. Legge, the British engineer sent here by Sir Alexander Binnie, has started work in connection with the proposed water supply from the Gatineau lakes. He is first getting the information which may be gleaned from plans and reports in the city engineer's office and from information given Dr. King by the Government parties of surveyors. About the end of this week he will go to the lake district and take charge. There are two Government parties out. One is working around Little Whitefish, Thirty One Mile and Pemichangaw Lakes, and the other is taking levels between Gracefield and Ottawa. After looking over the ground, Mr. Legge will direct what particular work he wants done first and the areas covered. He is not a member of Sir Alexander Binnie's firm, though sent here by him. He is prepared to stay all summer, if necessary, but says no time will be lost. He hopes to get the required information so that Sir Alexander Binnie may make his final report before the winter.

Selkirk, Man.—George H. Bradbury, member for Selkirk, introduced for a second reading to the Dominion Government his bill to prevent the pollution of navigable streams. Mr. Bradbury, in opening, pointed out that Canada had spent millions in the material development of the country, in building railways, canals and public works, while little had been done for the health of the people of the Dominion. Providence had been lavish in providing waterways for Canada, but we had neglected to protect these waterways, and they were now proving a menace. Twenty-five years ago the Ottawa River was pure, and to-day one glass of its water contained misery and death to those who had the temerity to drink it. The records of death from typhoid was an awful record for a city like Ottawa. Mr. Bradbury quoted figures prepared by Dr. Charles Hodgetts, of the Conservation Commission, to show the toll of death from typhoid in Ottawa, Winnipeg and other Canadian cities. In Canada the death rate from typhoid was 35.5 per hundred thousand of the population. In Germany it was only 7.6; England, 11.2; Belgium, 16.8; Austria, 19.9; Hungary, 28.3, and Italy, 35.2. In the face of these figures surely it was time that Canada did something, and put an end to the abominable practice of dumping sewage and offal into streams. Typhoid, Mr. Bradbury said, was a preventive disease, and he quoted several sanitary experts on the subject. It was time, in view of the epidemics which had taken place in Ottawa and other Canadian points, for drastic action. During the past ten years there had been no less than 5,796 deaths from typhoid in Ontario alone. He did not believe loss of life could be estimated by money. But, placing each life at $3,000, this meant a total of over $17,000,000. There had been in that time 50,000 cases in Ontario. Each patient lost on an average ninety days, which, at $1.50 a day, meant $6,500,000 in wages. Nursing is placed at five million more, making a total loss in Ontario of $28,000,000. This amount would have been sufficient to give a proper system of sewerage to all the important cities of Canada. On this basis of reckoning the city of Winnipeg had lost five million dollars. Mr. Bradbury explained the situation at Winnipeg. There were two rivers which united at Winnipeg. The Assiniboine flowing from the west carried down the sewage of Brandon and Portage la Prairie. It emptied into the Red River in the heart of the city, and the Red River flowed north with the sewage of Winnipeg, with all its manufacturing plants, and the sewage of Brandon and Portage. Four or five years ago the Government built a dam at St. Andrew's Rapids. Previously the current of the Red was fairly swift, and, while the river was contaminated, it carried the nuisance away. Now the Red consisted of a large basin twelve miles long and one hundred yards wide. The Red, with all this sewage, flowed through Selkirk, and at that point the water was unfit even for cattle to drink. Men could not water their horses in it. Lake Winnipeg had been contaminated for eight or nine miles, and nearly every year there was an outbreak of typhoid among the men who work on the dredges.

Sydney, N.S.—One million four hundred thousand gallons of creosote could have been produced in Western Canada in 1910 if the coal that was converted into coke had been coked in by-product ovens. This is the somewhat startling statement made by the Dominion Commission of Conservation. With the exception of the creosote produced from the by-product ovens at Sydney, N.S., and at Sault Ste. Marie, Ont., no creosote is produced in Canada. This valuable wood preservative is imported from Britain and the United States, but the high cost of the imported article has restricted its use very materially. In view of the steady and even rapid rise in the price of almost all classes of wood products, the importance of creosote is readily seen. For example, there is the problem confronting Canadian railways in obtaining timber from cross-ties. There were 13,683,770 ties purchased in Canada in 1911, an increase of 48.5 per cent. over the figure for 1910. When it is considered that the annual replacement of ties on existing lines amounted to about 10,000,000, it is evident what enormous quantities of tie material are required in order to supply the demand. This demand will not remain stationary, but, on account of the increased mileage of railways being constructed in Canada, will increase each year. Owing to the other demands for lumber and wood products, the price of cross-ties has been steadily increasing. The cost of tie maintenance is now a large item of expense, and the higher prices of the better grades of wood have forced the railway companies to use inferior woods. In 1908 cedar ties constituted 40 per cent. and jack pine (an inferior wood) 10 per cent. of the total used on Canadian railways. In 1911, the proportions were, cedar, 5.3 per cent. and jack pine, 39.9 per cent. In order that the lower grades of wood may be economically used for ties it will be necessary to creosote those species that fail through decay. In order, also, to utilize ties of the softer woods, it is necessary to use tie-plates. When it is remembered that the average life of an untreated tie is seven years, while the life of a treated tie is seventeen years, the importance and value of creosote is readily seen.

Montreal, Que.—Should the plans for the enlarged Montreal waterworks have been submitted to the International Waterways Commission? That is a question which several eminent engineers are asking, and which has resulted in an enquiry into the matter. When the enlarged aqueduct is completed there will be a flow of 6,500 cubic feet per second from the St. Lawrence above the rapids into the waterworks canal, or about one-eighteenth of all the water of the St. Lawrence. This, it is claimed, will have a direct effect in lowering the level of the water above and along the rapids. Therefore, the plans should have been, or should now be, submitted to the Waterways Commission. It has been decided that plans for power plants in the Cedar Rapids and other points must be submitted to the Waterways Commission, and that the enlarged Montreal Waterworks, drawing such a supply of water from above the rapids, should necessarily fall under the same category. In discussing the matter, Mr. T. W. Lesage, superintendent of the Waterworks, stated that: "The plans were never submitted to the Waterways Commission, and there was no reason why they should be. We are drawing the water out of the river near the rapids, and it is going back into the river near Victoria Bridge. I cannot see that the enlarged works will have any effect upon navigation." "Our enlarged waterworks," says Controller Godfrey, who has special charge over the waterworks, "cannot have any effect upon navigation, except as regards the small river steamers. It will not affect the water in the canal. The water flows into our canal above the rapids, and flows right out again lower down, so that it will not affect the level of the river in the harbor. In any event, the plans for the enlarged plant were completed before the present Waterworks Commission was in existence." Against all this, it is claimed that the plans should be submitted to the Commission, even if it were only as a matter for formality, just the same as power projects in relation to the St. Lawrence are submitted as having international importance. City hall officials assert that when the plans for the waterworks were passed some years ago, they were recommended by three expert engineers, who pronounced that they would not interfere with navigation.

PERSONAL.

MR. GEO. B. WILSON, secretary to the mayor of Toronto, has been appointed the head of the street cleaning department, which is to be reorganized.

MR. W. R. SWEANEY, recently acting general manager of the Toronto Hydro-Electric system, has been appointed sales manager of the Toronto Electric Light Company, taking the place of Mr. Parker Kimble, who received an important appointment at Cincinnati.

E. BRYDONE-JACK, Professor of Civil Engineering, University of Manitoba, has opened an office as consulting engineer at 305 Boyd Building, Winnipeg. He will conduct a general consulting practice covering the fields of bridge, structural and concrete work, power development, tests and inspection, etc.

CUMMINS & AGNEW, consulting engineers, Vernon, B.C., have been appointed as city engineers of Vernon, B.C. This consulting firm was recently organized, and consists of a partnership of several established practising engineers. They have several irrigation projects on hand, and are engineers to several towns in the Okanagan Valley. They are undertaking all classes of civil engineering work, both consulting and constructing. Associated in the firm are A. P. Cummins, C.E., B.C.L.S., J. C. Agnew, B.C.L.S., F.R.G.S., D. M. Mathieson, B.Sc., C.E, and J. C. Dufresne, M. C. Soc. C.E.

PROF. VAN, graduate of McGill University, Montreal, at present head of the College of Mines of the University of Minnesota, of which university he has been associated with for the last fourteen years, has been appointed director of the department of mines and metallurgy of the Panama-Pacific Exposition, to be held in San Francisco in 1915. He is a native of Holland, and he has had an extensive experience in practical mining work in the United States, Mexico and Canada.

Plans for the Palace of Mines and Metallurgy show that it will be one of the handsomest of the fourteen exhibit palaces now being erected at Harbor View, the exposition site. The extent to which the subject is to be featured at the Panama-Pacific international exposition is indicated by the classification of exhibits in this department, just announced by Capt. Asher Carter Baker, director of exhibits. There will be five groups, subdivided into fifty-eight classes, which will include displays relative to equipment and methods of geological surveys, mining bureaux and other societies for the promotion of mining.

Prof. Van, Graduate of McGill and Director of the Panama-Pacific Mines Metallurgy Exhibit.

The exhibit in its entirety will not only afford exceptional educational opportunities to the public in general, but will be of particular value to mining men in the special fields of their activity.

H. B. PULLAR, Assoc. Am. Soc. C.E., and C. H. ENZENROTH, B.S., announce the opening of their consulting laboratory at 378 Woodward Avenue, Detroit, Mich. Mr. Pullar was formerly assistant manager and chief chemist of the American Asphaltum and Rubber Company, Chicago, and has had long experience in the testing of asphalts and bitumens, and the practical handling of these materials in the construction of roads and pavements, having made and supervised the mixes on approximately 10,000,000 square yards of bituminous roads and pavements of various types.

Mr. Enzenroth is a graduate chemical engineer of the University of Michigan, and has for the past few years been associated with Mr. Pullar. The firm will make a specialty of road and pavement inspection and the testing of bituminous materials. They have a plan for the inspection of pavements which they claim is new, practical and thorough. They intend to give special attention to municipal plant work.

In our issue of April 24th, under the heading of "Personals," a slight inaccuracy occurred when reference was made to the organization of the firm of McPhie, Kelly & Darling, of Hamilton. We find that Mr. McPhie has had an established architectural business there for eighteen years, and Mr. B. F. Kelly, O.A.A., has been associated with him for five years. It was Mr. Darling, not Mr. McPhie, who was connected with the Hamilton Bridge Works Company for fourteen years. We are glad to place this matter correctly before our readers and regret the mistake made. It is the firm's intention to conduct a combined architectural and engineering practice.

COMING MEETINGS.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, T. S. Young, 220 King Street W., Toronto.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, Phelps Johnson; Secretary. Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to Aprii.

OTTAWA BRANCH—177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings,

QUEBEC BRANCH—Chairman, A. R. Decary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

CALGARY BRANCH—Chairman, H. B. Mucklestone; Secretary-Treasurer, P. M. Sauder.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, F. Pardo Wilson, Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290. Meets 2nd Thursday in each month at Club Rooms, 584 Broughton Street.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson. Sask.

THE ALBERTA L. I. D. ASSIOCATION.—President, Wm Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer. J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer. Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ALBERTA ASSOCIATION OF LAND SURVEYORS.—President, L. C. Charlesworth, Edmonton; Secretary and Registrar, R. W. Cautley, Edmonton.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, A. C. Garner, Regina; Secretary-Treasurer, H. G. Phillips, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, The Thor Iron Works, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary. James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary. H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, James Coleman; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, F. C. Mechin; Corresponding Secretary, A. W. Sime.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, J. L. Doupe; Secretary-Treasurer, W. B. Young, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary. H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, N. Vermilyea, Belleville; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. S. Dobie, Thessalon; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

QUEEN'S UNIVERSITY ENGINEERING SOCIETY.—Kingston, Ont. President, W. Dalziel; Secretary. J. C. Cameron.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5. Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman. Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.