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The Canadian Engineer

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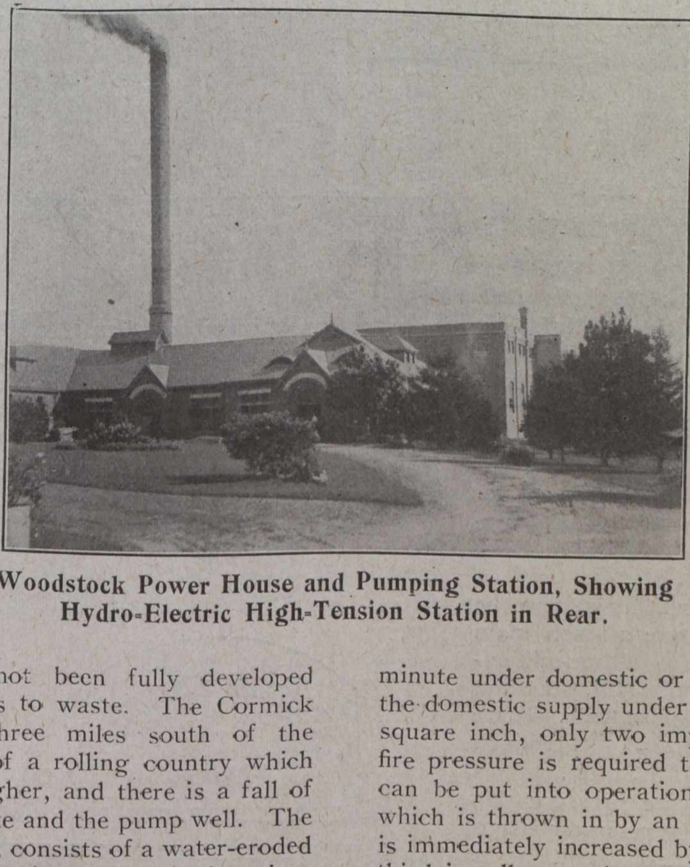
WOODSTOCK WATERWORKS

DESCRIPTION OF PLANT WITH SPECIAL REFERENCE TO WATER LEVEL ALARM AND VALVE FOR CONTROLLING MAIN DELIVERY.

By R. O. WYNNE-ROBERTS, M.Can.Soc.C.E.

THE waterworks of Woodstock, Ont., was originally constructed in 1880 by a private company for fire protection. It was purchased by the city in 1885 and in 1890 it was decided to elect water commissioners to administer the department. At that time the water was derived from the Cedar Creek, which passes through a portion of the city, and was seriously polluted, so the board set about to improve the quantity and quality. They appointed the late Thos. C. Keefer, C.M.G., to investigate and report in conjunction with the then city engineer, now Col. Wm. Mahlon Davis. The report was in favor of acquiring springs in the neighborhood and carrying out works in the city which will be referred to in the following notes.



Woodstock Power House and Pumping Station, Showing Hydro-Electric High-Tension Station in Rear.

The Hart Springs, located about three-quarters of a mile from the city, were purchased and the water utilized. In addition to these about 16 acres of land, since increased to 30 acres, were purchased on which there were a number of good springs, called the Cormick Springs, and the water taken into an 18-inch salt-glazed vitrified conduit and delivered into the city pump station well.

The Hart springs yield about 250,000 Imperial gallons per day and the Cormick springs over 1,250,000 gallons. The yielding capacity of the springs has not been fully developed and a considerable flow passes to waste. The Cormick springs are located about three miles south of the city in a hollow at the foot of a rolling country which rises about 200 or 300 feet higher, and there is a fall of about 40 feet between the intake and the pump well. The area, measuring about 30 acres, consists of a water-eroded formation covered with cedar and pine trees and a luxuriant growth of plants which are useful to reduce the evaporation and to conserve the water. These springs evidently tap a subsoil reservoir of some magnitude and the water is pellucid, cold and clear.

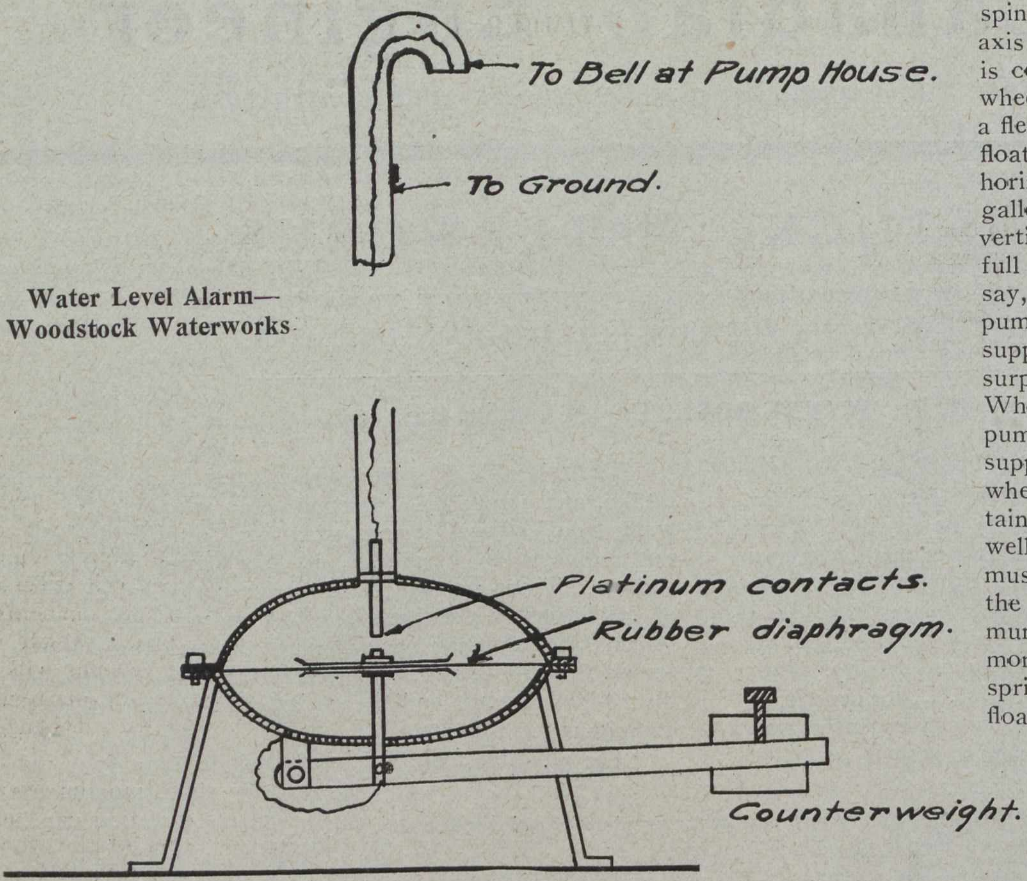
The city owns 120 acres of land at the springs, but only 30 acres are fenced in. A deep channel has been cut on the higher sides of the property to intercept freshets and pollution. This channel conveys the drainage below the intake.

There is a brick screen house 8 feet by 12 feet at the intake, and a concrete collecting basin adjoining it. The water from Cormick springs gravitates to the basin, where the sediment is deposited and the leaves removed by screens. There are sluice valves for periodical cleansing of the basins. The water has to pass vertically through screens, then along an open channel, through three vertical screens into the chamber where the water is admitted into the 18-inch conduit and thence into the pump well at the pumphouse in the city.

The pipe line from the headworks to the city is indicated by stone monuments, so that its direction can be located.

The pump-house contains two Mather & Platt two-stage centrifugal pumps, fitted with a third stage to boost the water pressure for fire purposes. These pumps were supplied by the Canada Foundry Co. They are driven by induction motors. One is a squirrel-cage type with an ordinary starter switch. The other is fitted with a wound rotor and a control switch so that its speed can be regulated until the full load is carried. The motors are Canadian General Electric Co.'s make, 175-h.p., 2,200 volts, 25 cycles, 750 r.p.m. The pumps are rated to deliver about 1,700 gallons per minute under domestic or fire pressure. When pumping the domestic supply under a pressure of about 80 lbs. per square inch, only two impellors are operated. When a fire pressure is required the third impellor and chamber can be put into operation while the others by a clutch which is thrown in by an external slide and the pressure is immediately increased by 40 lbs. per square inch. The third impellor can be released and the pressure drops to about 80 lbs., without stopping the pump.

There is also a four-million-gallon-per-day, cross compound condensing steam engine and pump, built by John Inglis & Co., Toronto, working under 110 lbs. steam pressure, when required. This is provided with a Stilwell Bierce jet condenser supplied by Leonard, London, Ont. The steam cylinders are 18-inch and 36-inch with 30-inch stroke. The water cylinders are 12½ inches in diameter. There are four air chambers on this pump and



Water Level Alarm—Woodstock Waterworks.

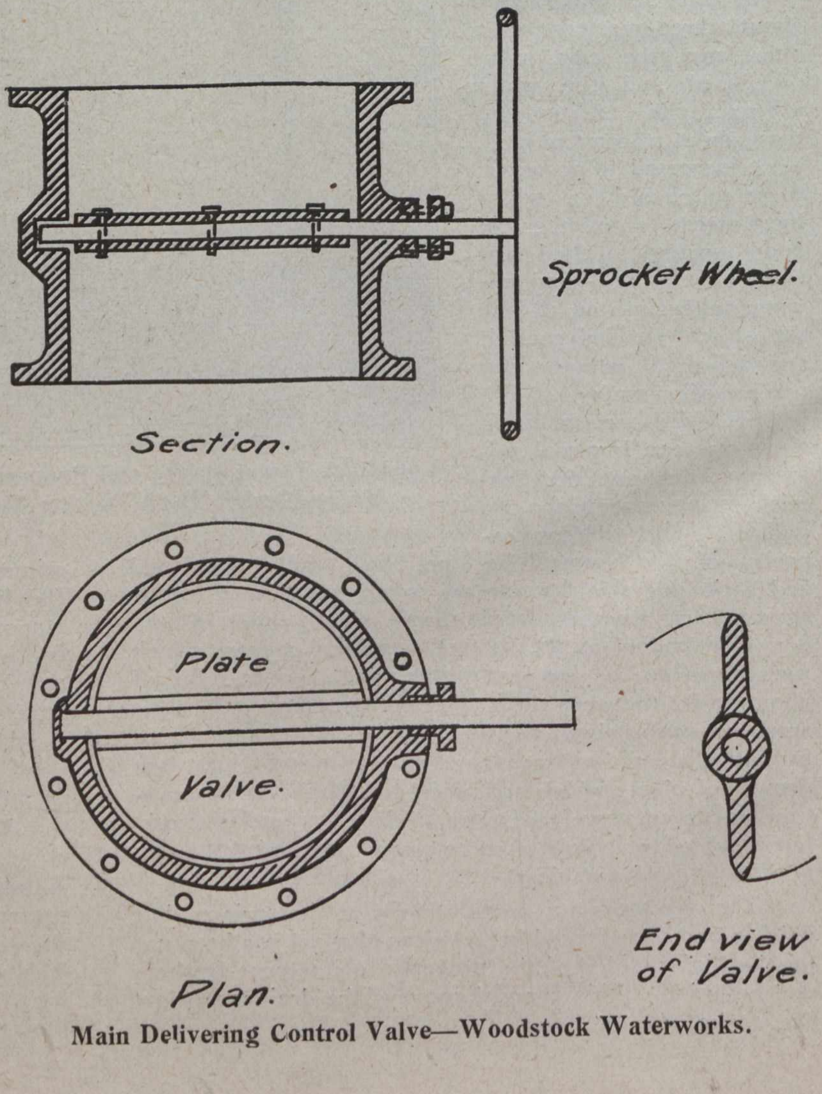
the supply of air is obtained from a small air compressor operated by a water motor mounted on the pump end. The air vessels are kept constantly charged with air so that a quick start can be made by the pump in case of fire.

The two steam boilers are Babcock & Wilcox double-drum type, each 220 h.p. with Moffat feed water heater and purifier supplied by Goldie & McCulloch, of Galt. The chimney is 120 feet high, 5 feet flue diameter, built of reinforced concrete by Webers, of Chicago. As the hydro-electric current is paid for on the basis of a 20-minute peak load, it is necessary to have the steam plant ready for operation within that time.

The Venturi meter is 10 inches diameter, 5-inch throat fixed as a part of the vertical delivery from the pump.

There are two 12-inch mains leading from the pump-house to the city and one 16-inch main leading from the pump-house to a one-million-gallon open reservoir on Wilson's Hill, standing about 190 feet above the pump-house floor. There is also an 8-inch connection from the 16-inch rising main to the city along Mill Street, with a non-return valve to prevent fire pressure discharging into the reservair. The reservoir is 150 feet long 80 feet wide and 12 feet deep, and is about 6,500 feet west of the pump-house. The electrically operated pumps have 12-inch suction connected to a joint 16-inch suction from the well, and the delivery connections are 10-inch. The well is 16 feet in diameter and 15 feet deep, built of brick and located by the building.

There are two devices installed which are interesting. First, the control valve in the delivery main and connected by a flexible line to a float in the well. There is a plate attached to a central spindle fixed at right angles to the axis of the vertical delivery pipe and is connected to an external sprocket wheel which in turn is connected by a flexible wire attached to a weighted float in the well. When the plate is horizontal it will allow about 400 gallons per minute to pass and when vertical, then the main is practically full open and the pump can deliver, say, 1,700 gallons per minute. The pumps are operated at full load to supply water direct to the city and the surplus is delivered into the reservoir. When the reservoir is about full the pumps are shut down and the city is supplied by gravity. It is necessary when operating the pumps to maintain a fairly uniform water level in the well; that is, the quantity pumped must be about equal to the flow from the springs so as to secure the maximum efficiency. If the pump raises more water than is coming from the springs the water level falls and the float causes the plate valve to check the quantity delivered. In this way the record on the Venturi meter chart is maintained at a relatively even line. In case of fire, water is returned from the



Main Delivering Control Valve—Woodstock Waterworks.

reservoir by the rising main to supplement the flow from the springs and in this case the plate valve is operated by hand to maintain a pressure of 120 lbs.

The other device is the water level alarm. It is necessary to know when the reservoir is full and to prevent overflowing and unnecessary waste of energy.

There is an indicator consisting of a rubber diaphragm enclosed in an iron case 10 inches in diameter. The upper side has a 1¼-inch pipe standing vertically about 12 feet, through which is placed a wire connection to the upper and fixed contact. The lower side of the case and diaphragm is open and as the water level rises the pressure acts on the under side of the diaphragm and tends to cause it to give way, but this is retarded by a counterweighted lever. This counterweight is designed to be balanced by the pressure equal to a head of 12 feet. When this depth of water occurs the diaphragm rises and with it the lower contact, until the electric line is closed and the bell in the pumphouse is rung. The electrical current is got from a low voltage transformer. These two devices were designed by Mr. E. Hubner, the chief engineer.

During 1915, 472,750,000 gallons of water were pumped. The average per day was about 1,300,000 gallons. The pumps were operated on an average of 17¼ hours daily. The population is about 10,300 and therefore the daily average consumption per capita is 126 gallons. The fuel and energy cost $3,734.30, which is equal to about $7.90 per million gallons pumped and 4.15 cents per million gallons raised one foot.

The water is good in quality. It has about 14 parts per million temporary hardness and about 4 parts per million permanent hardness. Mr. I. G. Archibald is the superintendent.

CANADA'S IRON AND STEEL INDUSTRY.

Reflected in Canada's larger production of iron and steel, are the output of the munitions industry and the larger domestic requirements of last year, together with exports of billets and wire. Mr. J. McLeish, B.A., chief of the department of mines, division of statistics and mineral resources, has compiled the following table. The summary of iron and steel statistics, 1914-1915, are as below:—

	1914. Short tons.	1915. Short tons.
Iron ore shipped	244,854	398,112
Canadian iron ore charged to blast furnaces	182,964	293,305
Imported iron ore charged to blast furnaces	1,324,326	1,314,957
Iron ore charged to steel furnaces	37,686	74,872
Pig-iron made	783,164	913,775
Pig-iron and ferro-alloys exported	19,063	26,545
Pig-iron imported	78,680	47,842
Ferro-alloys made	7,524	10,794
Ferro-alloys imported	22,147	13,758
Pig-iron and ferro-alloy consumption	872,452	959,254
Pig-iron used in steel furnaces	619,030	747,834
Steel ingots and castings made	828,641	1,020,336
Steel rails made	428,225	232,411
Canadian coke used in iron blast furnaces	330,269	578,743
Imported coke used in iron blast furnaces	590,902	486,022
Iron and steel imported	878,179	771,007

Considerably over 100,000 tons of iron are produced annually in electric furnaces in Sweden.

The new bridge across the Tiber at Rome, having a span of 328 feet, is said to be the longest reinforced concrete arch in the world.

TIMBER DECAY AND ITS GROWING IMPORTANCE.*

By C. J. Humphrey,
Forest Products Laboratory, Madison, Wis.

DECAY is due almost entirely to the growth of wood-destroying fungi within the tissues of the wood. There are many hundreds of different species of these which disintegrate wood in the forest, but the greater part of the economic losses in structural timber is referable to a comparatively small number. These fungi are plants just as much as are trees and herbs. They differ merely in their form, lack of green coloring matter and methods of nutrition. While green plants absorb their food supplies from the soil through their roots, fungi derive their nutriment from the substance of the wood.

In the life-cycle of a wood-destroying fungus there are two distinct stages: 1, the vegetative stage, consisting of thread-like, usually much branched, filaments, termed "mycelium"; 2, the fruiting stage, which is nothing more than a compact mass of mycelium which takes on a definite form on the surface of the decaying timber and serves for the production of spores and, hence, the propagation of the species.

The mycelium is usually confined within the wood substance, the fine cotton-like filaments ramifying throughout the tissues and filling the pores of the wood and the cells of the pith rays, as well as boring through the walls of the wood elements. Sapwood is in most cases more susceptible to decay than heartwood because it contains a greater amount of the more easily digested compounds and, unlike the heartwood in many kinds of timber, is not infiltrated with compounds which in themselves retard the growth of the organisms.

Conditions Essential for Growth.—In addition to available food supplies fungi require certain essential conditions for their development. These are sufficient moisture, at least a small amount of air within the wood and a suitable temperature. A suitable amount of moisture is, without doubt, the most important factor in decay. Certain ones classified as "dry rot" organisms seem to get along on a comparatively small amount, while others thrive only in highly humid surroundings. In the case of "dry rot" fungi it appears to be more a question of the ability of the organisms to tolerate dry conditions, or to produce their own moisture from the wood, than any essential need for such conditions, for observations and laboratory tests demonstrate that an increase in the moisture under such circumstances leads to more rapid decay.

The need for at least a certain minimum of water is well shown under practical conditions. The points of failure in ordinary dry buildings are the points at which a little extra water is brought to, or held within, the timbers; for example, the ends of joists or girders set in brick or concrete walls, outer window casings, wood surrounding water pipes which may sweat or occasionally burst, porch floors and ceilings and other exposed trimmings where atmospheric moisture may collect at the joints, and last and often most important, basement timbers, either in contact with, or close to moist soil.

Most people are familiar with the way in which posts and telephone poles rot at or near the ground line. Below

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*Abstracted from a paper presented before the Western Society of Engineers.

the ground line the sapwood completely decays, while above the ground line a thin shell of dry, hard outer wood remains, with the decay running up beneath it. This is entirely a result of moisture conditions. The same phenomenon often occurs in water tank staves where the outer face is too dry, and the inner face too wet, to decay, while an intermediate zone may completely disintegrate.

A certain amount of air within the wood is absolutely necessary for decay. The organisms need it for their growth. In saturated wood the air is, for the most part, displaced by water and fungous growth is impossible. The very widespread idea that decay is due to alternate wet and dry conditions has developed through observation of the way timbers behave when exposed to the elements. Take, for instance, a railway tie partly embedded in soil. During a dry season it may dry out to such an extent that decay is very slow, then come the rains, and if only sufficient water falls to put the tie in a good moisture condition it begins to rot rapidly again, and will continue to do so as long as the moisture and temperature are favorable. If, on the other hand, there is a long-continued rainy period the tie may soon become saturated and decay will stop again and remain practically at a standstill until the stick dries out sufficiently to admit the necessary amount of air. Thus, in the alternation of wet and dry conditions, one gets at some point intermediate between the dry and wet ranges a condition at which decay is at its maximum.

The third essential condition for rapid fungous growth is a suitable temperature. For the majority of species the most favorable temperature lies between 75 and 85 deg. F. There are some exceptions to this, however, in the case of certain of our very destructive fungi. Of a series of some 50 species which we have tested in our laboratory none would grow above 118 deg. F. However, this does not necessarily mean that they would be quickly killed at this temperature.

In general, wood-destroying fungi are much less tolerant of high temperatures than low ones, which temperatures slightly above the freezing point will usually permit some growth. In fact, the writer stored a large number of stock cultures of different fungi in an ice box where the temperatures vary around 40 to 60 deg. F. Under these conditions several fungi isolated from building timbers grew luxuriantly. The fact that all the species of fungi occurring naturally in a given locality can withstand the most severe winter weather shows their extreme hardiness to low temperatures. While growth may be almost completely suspended under these circumstances the organisms will normally recover their growth capacity soon after being placed under more favorable conditions.

Mycelium in wood is often very long-lived in timber dried in the air at moderate temperatures. Once it gets well distributed throughout the wood, it is doubtful, in very many cases, whether the wood can again become free of infection as a result of natural atmospheric conditions. One case on record shows that a stick infected with one of our common species contained very vigorous mycelium after having been kept in a warm, dry room for a period of four years.

The second stage in the life-cycle of a wood-destroying fungus consists in brackets or shelves, "toadstools," or often only compact incrustations which appear on the surface of the timber after decay has become well started. Their function is to produce spores, which are comparable to the seeds of ordinary green plants. Being very minute (finer than flour) these spores are readily carried about by air currents and lodging on the surface of moist timber, at a favorable temperature, germinate to produce new infections. The number of spores produced is beyond the ordinary comprehension. According to Professor Buller's studies on *polyporus aquamosus* the number of spores produced by a single specimen of this fungus may in the course of a year be "some fifty times the population of the globe."

A large part of the infection of timbers in the open occurs through the agency of these spores, but in buildings, where fruit-bodies are less likely to develop, they play a less important rolê.

Decay in Building Timbers.—The principal causes for decay fall, roughly, under the six following heads:

1. Placing non-durable timber in moist, ill-ventilated basements or enclosures beneath the first floor, or laying sills in direct contact with the ground.
2. Embedding girders and joists in brick or concrete without boxing the ends.
3. Placing laminated flooring in unheated buildings in a green or wet condition.
4. Covering girders, posts, or laminated flooring with plaster or similar coating before being thoroughly dried.
5. General use of non-durable grades of timber in a green or only partially seasoned condition.
6. Use of even dry timber of low natural durability in buildings artificially humidified to a high degree, as in textile mills.

A further element of danger lies in the use of timber infected during storage or which has become infected through neglect after purchase and delivery.

There seems to be some divergence of opinion regarding the use of laminated flooring. In many buildings it has proven completely satisfactory. In others it has given very poor service. All the complaints investigated by the writer have shown the trouble to be due to the use of wet material. This, at best, dries very slowly in an unheated building. Covering such timber with plaster, or any other heavy coating, when moist will almost invariably cause trouble. If difficulties with laminated flooring are to be avoided the timbers will have to be thoroughly air seasoned and kept dry during construction.

This leads us to a consideration of the advisability of covering materials in mill-constructed buildings. A number of cases already investigated indicate clearly that the practice should not be recommended except with extreme caution, and a close knowledge of the condition of the timber as it goes into the building. A building was erected about 3 years ago, in which the construction was under way throughout the winter, so that the timbers were subject to periodic wetting from rains and snow, the timbers being for the most part, of poor quality, low density, mostly rapid growth, very knotty, and often with a large proportion of sapwood. Laminated floors of mixed quality, usually sappy and wide-rimmed southern pine, scant 3 ins. by 6 ins. in size, were laid throughout the building, with the ends resting directly on the girders, with about 5-in. bearing. The ceiling, girders, and posts were all encased in plaster board, leaving a narrow air space between the board and timbers.

This combination of circumstances—low quality timber, high moisture content, and plaster board covering—caused the timber to rot rapidly, particularly at the bearings of the laminated floor on the girders.

How to Control Decay.—The possibility that timber may reach the consumer with infection already in it is by no means remote. Many lumber yards are in a highly unsanitary condition as regards the presence of destructive fungi. For this reason the material should be carefully inspected and all pieces bearing incipient rot rejected. Likewise, it may prove advisable to inspect the yard where the purchase is made. Upon delivery of the material it should not be thrown about on the ground, but should be carefully placed on skids and kept dry. The soil is often a prolific source of infection.

Such timbers as are to be placed in situations favorable to decay should either be select grades of naturally durable stock or else treated with a good wood preservative. Neither non-durable timber or sapwood is objectionable when used in a dry condition and kept dry. Hence, every effort should be made during construction to keep moisture away from the timbers, and especially the joints.

Moist timbers should never be cased in, nor should timber of any sort be embedded in concrete or brick walls without boxing. In all cases thorough ventilation of moist, stagnant basements should be provided.

Whenever timbers begin to fail, the need of a thorough inspection of the building is indicated. If poor ventilation is the cause, the building should be opened up to secure rapid drying of the timbers. At the same time tests should be made to determine whether the wood contains living fungus. In is also important to know what species the fungus is, as further control measures may hinge on its identity. For instance, the true dry-rot fungus, *merulius lachrymans*, being a low-temperature organism, can be controlled by the application of heat, while such a procedure would be useless with most other species. Some fungi may prove susceptible to a certain amount of drying, where others would not.

Where serious and active decay exists, without the exact method of control being indicated, the timbers should be carefully removed and replaced with select durable stock or with lower grade material treated with antiseptics. Likewise all incipient infection which appears in timbers which it is not considered necessary to remove should be given two or three applications of a wood preservative. Either a hot 3 to 4 per cent. water solution of sodium fluoride or a cold 1 per cent. alcoholic solution of mercuric chloride is well suited to interior timbers. Exterior timbers, where odor and color are not objectionable, can be satisfactorily treated with a good grade of hot coal tar creosote.

CABLE STREET RAILWAYS.

Cable street railways, which came into extensive use in American cities to replace horse cars in the '80's and early '90's, but were superseded almost everywhere by the electric railway in the next decade, are still in extended use in San Francisco, Calif., and Edinburgh, Scotland. The cable lines that still remain in San Francisco are those which run on streets crossing the San Francisco hills with grades so steep that electric operation would not be possible. In Edinburgh, however, the entire city street-railway system is operated by cable. The Edinburgh system was built by the city in 1898 and leased for 21 years to a private company at an annual rental of 7 per cent. The lease expires on June 30, 1919. The cars used are of small size and are operated at very low speed. The city plans to take over the system on the expiration of the lease and operate it by electric traction. A commission has reported in favor of operation by the overhead-trolley system, and the work of reconstruction is likely to be undertaken shortly, so that electric cars can begin running as soon as the lease expires.

The Russian Government is reported to have ordered 50,000 tons of steel rails in the United States for the Trans-Siberian Railway.

WATER FILTRATION EXPERIENCE.

By H. G. Hunter, M.Can.Soc.C.E.,
Resident Engineer, Montreal, N.Y. Continental Jewell Filtration Co.

(Concluded from last week's issue.)

Air for agitating the sand previous to washing should be supplied under a pressure of from 3½ to 4 pounds per square inch. The quantity of air should be not less than 3 cubic feet of free air per square foot per minute. A proper wash of a filter bed is often accomplished by agitating with air for two minutes and washing with water for four minutes.

Where air and water is adopted to wash filters, the wash water and air agitating equipment must be arranged to meet conditions. On small plants, that is, beds having an area of sixty-five square feet, or less, the wash water may be obtained direct from the mains, without dropping the pressure enough to cause annoyance. On plants larger than this, and up to filters having a capacity of 1,000,000 gallons, a wash water pump is usually used.

This pump should have sufficient capacity to furnish the required amount of wash water and be able to lift this water against a head equal to 16 ft. above the lip of the gutter. The most convenient power to drive the pump is electricity and where electricity is used, the starting device should be installed at a convenient point on the operating floor. Where units of a million gallons capacity or more are used and particularly in plants of ten million gallons or greater capacity, it is probable that a wash water tower will work out to be more economical in operation and more efficient in service. The capacity of a wash water tank should be sufficient to wash one-quarter of the filter units in succession. The storage capacity, necessary for this quantity of water, should be a point 16 ft. above the lip of the gutter. In connection with the storage tank, there should be a regulating tank, or regulating device, that will drop the pressure of the water above the 16-ft. level to 16 ft. and maintain it at this level. Another factor that may work in and make a wash water tank desirable is the load that can be thrown on to the power available.

A centrifugal wash water pump for a million-gallon unit will usually require a 50-h.p. motor. This load of 50 h.p. may be thrown on at any time during the day, for a matter of four or five minutes. When using a wash water tank, a very small pump and motor is required. This pump and motor should have a capacity to restore in six hours, the amount of water estimated for washing. This pump is started and stopped automatically by the pressure of water in the wash water tower, or by a float. Filtered water should always be used for washing.

The air for agitating in all plants up to one million gallons capacity, may be supplied direct from a rotary blower. Electric current is the most convenient for the motive power. The blower should deliver the air against a pressure of 3½ to 4 pounds. A blower of sufficient capacity to agitate a million-gallon unit, will require practically a 50-h.p. motor and it may be, as stated above, that the available power will not permit of throwing as great a load as this on to the power. In connection with the wash water tower, an air storage tank can be arranged. This tank is simply an inverted tank, similar to the arrangement for a gasometer, in the wash water tower. The air is supplied to this tank by rotary blowers of small capacity, working the same as the smaller wash water pumps. The storage capacity should be for sufficient air to wash one-quarter of the filters in succession. The required air pressure is easily obtained by loading the tank with concrete.

A combined wash water and air tank, as described above, is used at the Montreal Water and Power Co.'s plant. In fact, this was the first combined air and wash water tank ever constructed and the outfit as installed is satisfactory.

Controlling, Operating and Indicating Devices.—It is necessary to control the effluent from the filters to a desired quantity of water, or desired rate of filtration. This is done by placing on the effluent line from the filter a controller. There are a number of different makes of controllers that operate satisfactorily. Most of them are of the venturi type and the operation of controlling is actuated by the velocity head through the throat of the meter. The writer is more familiar with the Simplex Valve & Meter Co.'s type of controller than any other, and finds that this controller can be set to deliver the desired quantity of water and that it will maintain this quantity very closely. It apparently is unnecessary, after a controller is once set, to readjust it at all. Like any other machine having moving parts, the packing around the spindle of the controller must be kept in condition and oiled so as to produce the minimum amount of friction.

The operating valves for the filters may be either hand-operated or hydraulically operated. On units of a capacity of one million gallons or more, hydraulically operated valves must be used in order to get efficient operation. It is probable that on beds of this size it will be necessary to use valves as large as 12 ins. and 14 ins. and you can understand that it requires considerable time and labor to operate these valves by hand. On the smaller plants, hand-operated valves are entirely satisfactory, and all that are necessary. Where hydraulic valves are used, operating tables are necessary. These tables are preferably constructed of marble and on the top of the table is arranged the levers for operating the several valves. The levers operate a pilot valve, which directs the water under pressure to the bottom or the top of the hydraulic cylinder on the valve. An indicator is attached to a spindle on the top of the hydraulic valve, by wire and chain and through an arrangement of gears indicates the movement of the valve, on the table. The operating table is usually placed directly in front of the filter. It is not necessary that it be placed in this exact position.

The only other accessory necessary in connection with the filter, is the loss-of-head gauge. This gauge serves the purpose of indicating the loss of head on the filter; that is, as the filter begins to collect the matter being removed from the water, it requires that more pressure be released by the controller to drive the water through the bed, or through the collected matter on the surface of the bed. This pressure is termed loss of head. The gauge is usually arranged with two float tubes; one connected directly to the filter and the water level in this tube coincides with the level of the water in the filter.

The other tube is connected to the effluent controller and the water level in this tube varies according to the pressure in the effluent main. The difference in level between the water in the two tubes is transferred from floats by cords to the mechanism of the gauge and is indicated by a pointer worked over a graduated dial. It is necessary to know what the loss of head on a filter is, for in this way the proper time for washing the filter is ascertained. There is arranged on the gauge an electric alarm which will advise the operator when the bed is run out. These gauges may also be of the recording type, but the writer believes an indicating loss-of-head gauge is to be preferred over a recording loss-of-head gauge. An indicating loss-of-head gauge is more simple in construction and requires less attention. By manually instead of automatically keeping the records of the loss of head on the filters, the operator is required to pass through the operating room and to each filter every hour. If the operator does this, it is assurance of more efficient operation. On the other hand, with a recording loss-of-head gauge, it is not necessary for the operator to go to the filters every hour and for this reason the tendency is to neglect frequent inspection of the filters in operation. It has occurred, after washing a filter and placing it in operation again, that through a blunder, the influent gate lever has been moved. This means that no water is coming to the filter and that the filter will run dry. With the recording loss-of-head gauge, not requiring the operator's presence in the operating room, this filter could stand dry for several hours. A visitor to a plant might move the levers on the operating tables and throw the filters out of operation and for these reasons, as above stated, a device requiring the operator to take records every hour is preferable.

Clear Water Basin.—The clear water basin must necessarily be located, as to elevation, below the filters, and it is good designing to keep the high-water mark in the clear water basin below the level of the pipe gallery floor. The outside lines of the basin should, if possible, be worked in to make the whole plant symmetrical or to coincide with the lines of the outside of the filters and operating room. The capacity of the basin should be designed to meet local conditions. In a direct pumping system, it should be sufficiently large to take care of a normal fire draft, after being drawn down to take care of the hourly daily variation. It is not necessary to provide against the contingencies of the filter plant being out of commission. With duplicate low lift pumping machinery or reasonable assurance of getting raw water to the plant, the possibility of anything happening within the plant to put it out of commission is very remote. Extensions to the clear water basin outside of the limits of the plant are often made, where increased capacity is desired. It is necessary in a clear water basin to be sure that the design will permit of circulation through the basin. The downdraft tubes from the several filters will greatly assist in the circulation, but in large basins it will probably be necessary to install circulating baffles.

Some engineers, and some state boards of health in the United States, require that the clear water basin be a separate structure and well removed from the coagulating basin, influent flume, pipes conducting raw water, or the drain for wash water. This means that they would not permit of a clear water basin being constructed adjacent to the coagulating basin, with only a wall between. In designing, it is often convenient to place the clear water basin so that the coagulating basin wall forms one wall of the clear water basin. Care must be taken, however, that this wall be watertight and the design often calls for an extra thickness of concrete at this point. Experience indicates that this is good practice. It is not necessary to provide a drain from the clear water basin, nor is it necessary that there be an overflow. Automatic equipment can be placed on the filters that will shut them off when the basin is full. It is believed, however, that a high and low-water alarm and a suitable indicating depth gauge is all that is necessary.

General.—The arrangement usually adapted in the layout of a filter plant has been to construct the filters on the opposite sides of a pipe gallery. Arranging filters on two sides of a pipe gallery appears to be economy in piping. On the other hand, it means a complication of piping and it is very difficult to arrange same so that the pipe gallery is accessible.

Generally, the influent main or influent flume is arranged in the centre of the gallery and at the top. Under this and usually in the centre is arranged the air main. Under this again, the wash water main and on the floor of the pipe gallery, the sewer. It is necessary that branches from all of these mains be carried to the sides or across the gallery to enter the filters and it can be easily understood where the interruption to free access to the gallery occurs. Besides, the pipe gallery is usually dark, without windows or proper ventilation. It is quite certain that in any pipe gallery as above described, the valves operating the filters do not get proper attention and that at least four out of five valves will be leaking at the stuffing boxes. It is only another case where "out of sight is out of mind," and therefore proper attention is not given to the piping equipment. The writer prefers a design where all the filters are arranged at one side of the pipe gallery. This will often admit of the opposite side being an outside wall, where windows and proper ventilation can be arranged. It means that a clear space can be provided in front of the piping and that all valves and other equipment can be conveniently reached. It also provides a place that is decidedly not out of sight, and the tendency is to keep the stuffing boxes on the valves tight in order to keep the floor free from water. It is possible to arrange a plant up to twenty million gallons capacity in this way.

In the housing of the filters in this climate, the writer would not again deck over a part of the filters. It is better practice to arrange the house to cover the entire area of the beds. Where filters are decked over and are covered with 2½ feet of earth, in severe weather, colder than 15 degrees below zero, they will freeze at the back. Again, where the filters are arranged on one side of a pipe gallery, the design will probably work out so that the water from the coagulating basin will enter at the back of the filters. In this case it is necessary that the hydraulic influent valve be placed at the back of the filter and this valve must be protected against freezing.

The raw water supplied to the plant may in some cases reach it by gravity. It is, however, more often the case that pumps are required to lift the water into the plant. In filtration work, these pumps are called low-lift pumps. Usually the low-lift pumping machinery is a part of the design of the filter plant and space must be provided for this equipment. There is very little to be said about the arrangement of low-lift pumping machinery, other than it should be arranged in duplicate and that the capacities of the pumps should be arranged for economical power consumption. Electrically driven centrifugal pumps are in every way satisfactory. Where interruption in electric service is liable to occur for any length of time, stand-by of some other convenient power should be arranged, or storage of clear water provided to carry over such interruption.

The control of the water from the low-lift pump or from a gravity supply is necessary. The water level in the coagulating basin should be maintained at a constant level and this is usually accomplished by placing at the end of the raw water main, in the inlet chamber to the coagulating basin, a butterfly valve. This valve has an extension rod at the top of which, or at the high-water mark, is arranged a float for operating the valve. This arrangement is not altogether satisfactory. It is difficult to keep the water in the inlet chamber from freezing around the float and putting the controlling apparatus out of commission.

A better way to control the flow to the basin is by arranging a float chamber inside of the plant. This chamber can be arranged at any point where the water from the coagulating basin can conveniently be conveyed to it. The chamber only need be large enough to accommodate the required number of floats and deep enough for them. In the raw water discharge main from the low-lift pumps and beyond any pump connection a hydraulic valve should be placed in the line. At the float chamber a pilot valve for operating the hydraulic valve can be arranged. The float operates through the pilot valve, the hydraulic valve cramping or opening the discharge from the pumps as required to maintain a constant level in the basin. This arrangement is satisfactory in every way.

Almost every filter plant in operation to-day is treating the filtered effluent with a sterilizing agent; hypochlorite of lime or liquid chlorine most often being used. Hypochlorite of lime, however, is being replaced by the use of liquid chlorine. The writer's experience has been altogether with the Wallace & Tiernan chlorinators. Their solution feed machines are entirely satisfactory, and for small plants the machine operating with a pulsating meter is particularly satisfactory.

The feeding of chlorine gas to the effluent passing from the filter plant, proportional to the amount of water flowing, is a problem requiring a good deal of study. There is no question but that the ideal way to chlorinate would be to chlorinate the effluent from each filter, or to collect the effluent of all the filters into a comparatively small area and chlorinate the water as it passes to the storage in the clear water basin. Any such arrangement as this, however, runs into so many complications that it does not seem feasible. Where a venturi meter can be arranged on the discharge line from the high service pumps, the velocity head through the meter can be used for operating the chlorinator and the chlorine solution fed to the suction of the pumps. Where such a meter cannot be arranged, a special venturi tube can be installed at the outlet of the clear water basin and the velocity head at the throat utilized, feeding the solution through a distributing pipe, directly in front of the outlet. It is, however, important and much to be preferred that an automatic proportional feed machine be used on plants of large capacity. On smaller plants satisfactory results can be obtained with manual control machines.

In any filter plant, space should be provided for an office, or store-room, a room where small tools and supplies can be kept and where a sink and bench can be arranged, to facilitate the making of alkalinity, turbidity and color determinations. These small plants can arrange to have the bacterial work done at the laboratories of the board of health. In large plants, office space, tool and storage-room, lavatories and rooms for a complete chemical and bacterial laboratory are real necessities and the arrangement of this part of the plant should be carefully laid out.

It requires very little labor to operate a filter plant. One man to a shift will handle a plant up to four million gallons without any difficulty. Two men to a shift will handle a plant from four million gallons to ten million gallons, and three men to a shift seems all that is necessary for a plant up to thirty million gallons. On a plant, however, of this size it is well to have an extra man on the day shift, a good mechanic or handy man. This man should spend most of his time in keeping the equipment in first-class condition. The operators and help should wear white suits while on duty. Careful records of the operation of a plant should be kept and in large plants it is not only necessary, but it is economical to have a chemist and bacteriologist in charge of the plant.

The writer has yet to assist in building a plant which in general appearance and finish is up to what in his opinion an ideal plant should be. The inside finish of the operating room, for instance, is usually a concrete floor; brick walls, steel roof trusses and painted roof boards. The outside of a filter plant is usually constructed of brick, with slate roofs. Extra money spent for tile floors; marble, tile or terra cotta walls; parapet walls in front of the filters; attractive lighting schemes; ornamental receptacles for flowers or ferns; ceilings; and attractive radiators with concealed piping, would be money well spent.

It is possible to design the lines of the buildings to have some desirable architectural features and an architect should be employed for this purpose. The ground outside of the plant should be beautified to the fullest possible extent. Every possible consideration should be given to building plants of better appearance and finish. The incentive would be to keep such plants clean and attractive.

SCIENTIFIC AND INDUSTRIAL RESEARCH.

THE plan which has been adopted by the Dominion Government for the promotion of scientific and industrial research in Canada may be briefly outlined as follows:—

The work will be under the direction of a committee of the Privy Council consisting of the Minister of Trade and Commerce, the Minister of the Interior, the Minister of Agriculture, the Minister of Mines, the Minister of Inland Revenue and the Minister of Labor.

The Minister of Trade and Commerce is the chairman of the committee, to whom all reports are to be made and who will be the medium of communication between the advisory council and the committee.

This committee will consider and decide upon the plans and recommendations submitted by the advisory council, the system under which the work is to be done and the expenditures that are to be made.

An Advisory Council of Experts.—To assist the committee, an advisory council of scientific experts and representatives of the business and industrial interests has been appointed by the government.

The members constituting the council are as follows: Dr. A. B. McCallum, University of Toronto, Toronto, chairman; Dr. A. Stanley Mackenzie, Dalhousie University, Halifax; Dr. F. D. Adams, McGill University, Montreal; Dr. R. F. Ruttan, McGill University, Montreal; Prof. J. C. McLennan, University of Toronto, Toronto; Prof. S. F. Kirkpatrick, Queen's University, Kingston; R. Hobson, Hamilton; R. A. Ross, Montreal; Tancrede Bienvenu, Montreal; J. B. Challies, Ottawa, secretary.

These gentlemen serve in an honorary capacity, and following in this respect the splendid example set out by the British Advisory Board, place their time, their scientific knowledge and experience and their business ability at the disposal of the government for the purpose set forth.

Procedure.—The Advisory Council matures its plans, organizes its methods of procedure and reports to the committee of the Privy Council. When these are approved, the Advisory Council supervises and directs the work so authorized.

Plan of Work.—The work of the Advisory Council, acting in conjunction with the committee, will be along the following general lines, to be varied and extended as experience dictates:—

(*a*) To ascertain and tabulate the various agencies in Canada which are now carrying on scientific and industrial research in the universities and colleges, in the various laboratories of the government, in business organizations and industries, in scientific associations or by private or associated investigators.

(*b*) To note and schedule the lines of research or investigation that are being pursued by each such agency, their facilities and equipment therefor, the possibilities of extension and expansion, and particularly to ascertain the scientific man-power available for research and the necessity of adding thereto.

(*c*) To co-ordinate these agencies so as to prevent overlapping of effort, to induce co-operation and team work, and to build up a community of interest, knowledge and mutual helpfulness between each other.

(*d*) To make themselves acquainted with the problems of a technical and scientific nature that are met with by our productive and industrial interests, and to bring them into contact with the proper research agencies for solving these problems, and thus link up the resources of science with the labor and capital employed in production so as to bring about the best possible economic results.

(*e*) To make a scientific study of our common unused resources, the waste and by-products of our farms, forests, fisheries and industries, with a view to their utilization in new or subsidiary processes of manufacture and thus contributing to the wealth and employment of our people.

(*f*) To study the ways and means by which the present small number of competent and trained research men can be added to from the students and graduates of science in our universities and colleges, and to bring about in the common interest a more complete co-operation between the industrial and productive interests of the country and the teaching centres and forces of science and research.

(*g*) To inform and stimulate the public mind in regard to the importance and utility of applying the results of scientific and industrial research to the processes of production by means of addresses to business and industrial bodies, by the publication of bulletins and monographs, and such other methods as may seem advisable.

Proceeding along these lines carefully and wisely, the government hopes to render valuable assistance to a movement, the side expansion of which is not only vital to the proper development of our rich resources, but which is absolutely necessary in order to enable us to compete with progressive countries in the great race of national expansion.

For the year 1916 the Prussian State Railway authorities have ordered 1,600 locomotives, 1,700 passenger vehicles, 400 luggage vans and 38,000 goods wagons, and with a view to executing these requirements every locomotive and railway rolling stock firm in the country has received orders according to their highest capacity for output, but operations are seriously curtailed on account of the shortage of workmen. In several factories prisoners of war, mostly French and Belgians, are working under military supervision. They are mostly skilled laborers, who, before taking up arms, were employed in work of a similar kind. In normal times the German locomotive manufacturers can produce in the aggregate about 3,000 locomotives annually.

HAND AND MACHINE PLACED MORTARS

ABSTRACT OF AN ADDRESS WHICH WAS DELIVERED BEFORE THE TORONTO BRANCH OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS, DECEMBER 15th, 1916, AND ILLUSTRATED BY MOVING PICTURES AND SLIDES.

By **BRYAN CHEVES COLLIER, M.Am.Soc.C.E.,**
Chief Engineer and General Manager, The Cement-Gun Co., Inc.

It has always been the policy of the engineering profession to develop ways by which machines could supplant the hand methods of previous days, since it recognizes—perhaps more clearly than any other profession—the necessity of providing against the continually decreasing supply of labor. It thus took up with avidity the use of concrete mixers, with the result that over 300,000 of these mechanical appliances have been manufactured and sold in the last twenty-five years. The same is true in the case of the pneumatic drill, the pneumatic painting machine, and a number of similar contrivances, in very many of which compressed air has proven itself the flexible and powerful medium for accomplishing the desired results.

TESTS OF HAND AND MACHINE-PLACED MORTARS IN IRRIGATION DITCH, LOS ANGELES, CAL.

Front Section Built by Hand, Rear by Machine.

Trench Excavated Along the Ditch.

Filling Trench to Apply Hydraulic Head.

It very frequently happens, however, that although engineers are those most vitally interested and affected by these improvements, the inventions do not emanate from engineers, and the device to which the writer calls attention is an example of this, since not only was its origination by a man not connected with engineering, but also its first use was one in no wise related to engineering.

In 1908 Carl E. Akely, who is widely known not only for his lectures and writings on the big game of Africa, but also for his exhibits of those animals killed and mounted by himself, was engaged in mounting, for the Field Museum of Natural History in Chicago, a herd of elephants that had been shot by his wife and himself. In preparing the plaster of paris frame upon which the skins are stretched, he felt the need of some more flexible and easier way of doing this than by hand, with the result that he turned to compressed air and hit upon the expedient of forcing his dry material to the nozzle of a hose by pressure, and having it meet a stream of water at that point, thereby securing hydration and deposit coincidently, so that the mortar not only could be sprayed on in a thin coat, but could be built out to such thickness as was necessary. The success was so marked that Mr. Akely and his associates saw the advantages to be gained from the principle, and the result has been the development of the device now known under the trade name of the Cement-Gun. Its use, however, has not been limited to the application of cement mortars. It has proved its adaptability in the depositing of mortars made of lime, plaster of paris, fire clay, magnesite, etc. It is of interest that Mr. Akely was recently awarded the John Scott Medal of the Franklin Institute for this invention. (In 1816 a Scotch chemist named John Scott died in Philadelphia and left to that city $4,000, the interest on which was to be used to pay the cost of an annual award of medal to "ingenious men and women who had made inventions that are of benefit to mankind.")

The machine as now used, is identical in general type with that first built by Mr. Akely. It consists of two hoppers separated by a cone-shaped valve operated by a lever, with a similar valve in the top of the upper chamber. The operation is based on the ordinary principle of a caisson with the upper chamber as the "locking-in" chamber, and the lower the working chamber. In this way, with the upper chamber opened to the outside atmosphere, the lower can still be held under pressure thereby assuring continuity of operation. In the lower chamber there is a conical-shaped feed wheel with pockets on the periphery, which wheel revolves by being driven by an air-motor connected with a shaft to which it is keyed. As this wheel revolves these pockets are brought underneath an additional jet of air admitted through a "goose-neck" which acts in a dynamic capacity in addition to the static pressure, and forces the dry material through an outlet valve and the distributing hose to the nozzle.

This nozzle is a chambered affair with needle holes in the inner walls through which the water is admitted to the stream of dry material, thereby accomplishing the purpose originally devised of having the hydration take place coincidently with the deposit, ensuring the full chemical action. The writer would call attention to a feature in connection with the deposit. When the material is forced under pressure against a surface, there is a considerable rebound, and if an examination be made of this rebounded material, it will be found that it is almost entirely free from cement. This means that the cement has adhered to the surface as a matrix of neat cement into which the particles are driven by the pressure of those following. The result of this is that a mortar of exceedingly great density and of absolute imperviousness is produced.

There are several modifications of this machine in order to render it more adaptable to use for various purposes. They are mounted on mine trucks; are built with combined units of the compressor and water pump on one frame; and are of various sizes. One of the most interesting developments was recently designed for an European government, with a view toward its being used by them not only for present war purposes but also for the restoration of their invaded country. This consists of an automobile truck, with the compressors, pump, and Cement-Gun mounted on the chassis, and having the compressors connected with a sprocket and chain to the main transmission shaft. By attaching a trailer to this truck it is possible to carry sufficient material to do considerable work, and thus have a very portable and self-contained unit.

Preventing "Falls" in Mine Entries.

It is also proposed to use this machine in connection with repairs on concrete roads. The method by which such repairs can be made has been a very serious problem. It will be possible to clean out the abraded spots by using this portable machine as a sand-blast, after which the holes can be built up and the surface restored with a material that will have perfect adhesion and be of a density greater than the original concrete.

The writer had the pleasure of listening to a lecture recently by A. L. Johnson, who has carried on a very systematic research into the question of proper hydration of concrete. In this lecture photographs were shown which proved how easily concrete is broken down through frost action on account of the porosity of the concrete. Mr. Johnson continues that on account of the introduction of excess water into the mass, voids are produced, not only because of the entrained air, but also because of the fact that more water was used than was needed to effect chemical action, and naturally the space occupied was left vacant when condensation was accomplished. The writer is entirely of Mr. Johnson's opinion in this connection, but cannot see how he expects to rectify the evil. It is the natural tendency of contractors and workmen, and even of inspectors, to add an excess of water, for otherwise there is that greater fault to be overcome,—the pressure of entrained air pockets in the concrete and the production of large and frequent surface spots in the work. One of the purposes of this article is to show some photographs illustrating the use to which the Cement-Gun has been put in protecting the surface of concrete against porosity, as well as in restoring to a condition better than original a number of such works where disintegration has occurred.

One of the most interesting cases of this character is of the pivot pier of the bridge of the Atlantic City and Shore Railway over the inlet at Atlantic City. The tide at this point runs very rapidly, with the result that through tidal and ice action, the concrete had become very badly disintegrated. The usual condition of porosity along the work-stoppage lines was very marked, and the pier was becoming dangerous. The engineers were naturally hesitant to go to the great expense and disturbance of traffic that would be necessitated by tearing down the structure, and consequently sought some other method. The result was that after having made a thorough examination of work that had been done in repairing the concrete bulk-head walls along the Delaware River at Philadelphia, they decided to employ the gun to make the repairs. The loose particles of concrete were first removed with pneumatic chisels, the surface thoroughly cleaned by sand-blasting (the gun being used as a sand-blast machine) after which the mortar was shot into place between tides. The results have been most satisfactory and the pier has been restored at a cost of a few hundred dollars, without disturbance of traffic and with a saving of many thousands of dollars. There are a great many similar cases, but one of the most interesting is that of a reservoir at Allentown, Pa. This basin was leaking badly and it was decided to use this method to waterproof it. A number of porous seams were shown on the surface which, upon being opened up with a chisel or point were found to be due to very porous concrete through which a chisel could be driven without effort to a depth of several inches. These loose spaces, as well as the entire surface, were cleaned by a sand-blast, and then covered with mortar one-half inch thick, applied in two coats.

There are numerous cases such as this, notably among which is the reservoir at Elmira, N.Y., which was erected in 1911, and which had so far disintegrated this past summer as to show the reinforcing steel in numerous places. This has been entirely restored by the methods indicated.

Lining Illinois Central Railway Tunnel.

One of the most serious problems that presents itself to engineers to-day is the preservation of steel from corrosion due to moisture and gases, especially the fumes of locomotives. No city in this country is free from this trouble, and this machine seems especially adaptable for the preservation of such steel. It is a well-known fact that the surest preservative of steel is cement. This machine allows the application of a real cement mortar under pressure, and in such way that the pores in the surface of the steel are entirely filled with the fine cement particles; and the entrained air which always accompanies hand-placed mortar concrete, is removed, so that the highest degree of efficiency in this connection is obtained. It is always necessary to clean thoroughly the surface of the steel before any application, and this machine combines the qualities of a sand-blast machine with its capacity to place this mortar.

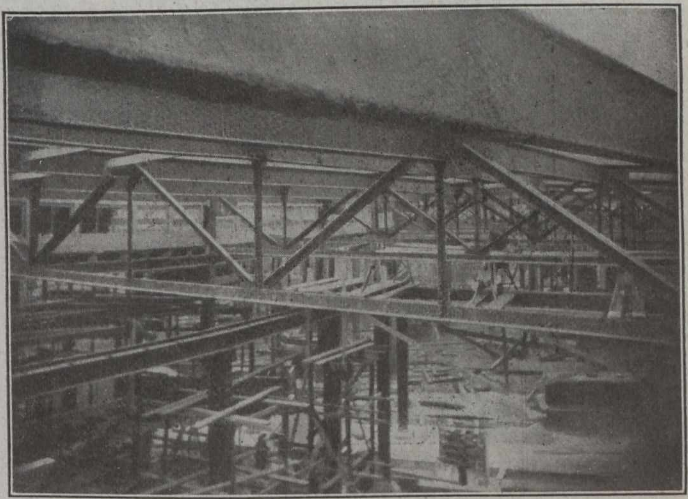
It will be noted from the various photographs the numerous places at which this process has been used. At Grand Central Station, New York City, over one million square feet of steel surface has been covered at a cost less than the usual cost of forms for pouring concrete and at an enormous saving of the dead load. The same thing can be said of the bridge over the B. & O. tracks at Calvert Street, Baltimore; three viaducts over the railroad tracks at Columbus, Ohio; the ferry bridge of the Pennsylvania Railway at Cortland Street, New York City; the girders over the tracks at the West Philadelphia Station of the Pennsylvania Railway; etc.

There is a considerable diversity of opinion among engineers as to whether it is necessary to provide a reinforcing mesh in connection with this work. At Grand Central and other places they have believed such a mesh necessary to obviate the possibility of vibration causing a break-down prior to set, but on the other hand the Pennsylvania Railway engineers do not use the mesh. Prior to doing the work at Cortland Street very exhaustive tests were made regarding dampness, freezing and thawing, with the result that reinforcement was deemed to be a needless expense. The engineers of the Pittsburgh & Lake Erie Railway also took the same risk in the protection of the steel in the new freight house at Pittsburgh.

An unusual adaptation of this work was the case of a bridge near Worcester, Mass., some girders of which were covered with this mortar and afterwards transported a distance of several miles before being placed in position.

One of the most interesting uses of this method of placing mortar is that of protecting the exposed surfaces of cuts and tunnels against the action of the atmosphere. It has been found that on account of the imperviousness of the material, the gases and moistures have been excluded from the surface, thereby preventing the breaking down so commonly present. Accompanying photographs of the work done on the surface of the rock-cut along the New York Central Railway at Spuyten Duyvil, and on the tunnel of the Illinois Central Railway at Unionville, Indiana, are illustrative of this.

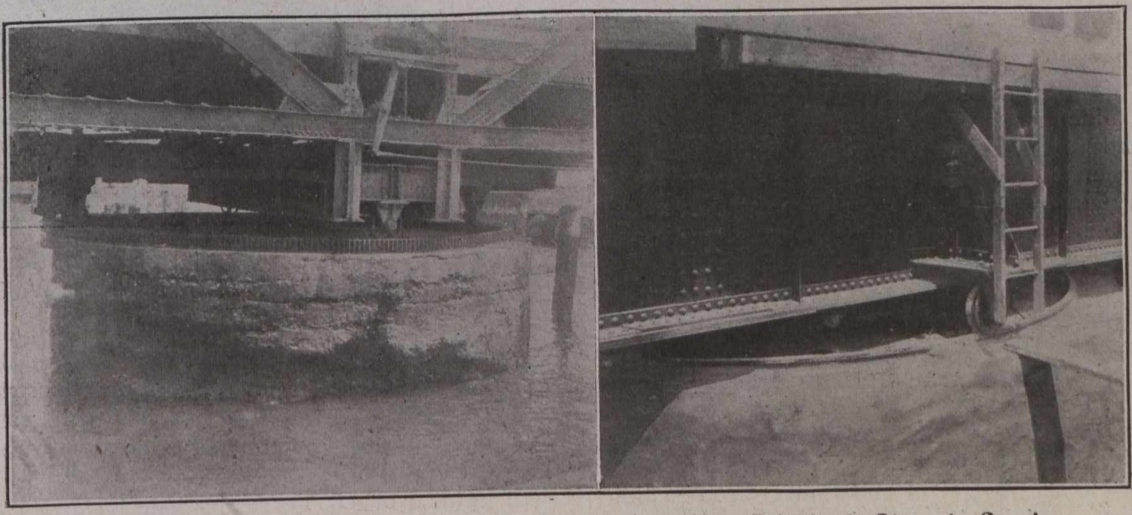
One of the most important adaptations of this principle, however, is in the work being done in the preservation of the roofs and sides of mine entries and rooms against such deleterious agents. The writer has had the experience recently of having examined a number of coal mines where the losses due to this slacking have been very serious, both in life and property. Especially in the summer months, the stream of warm air from the outside meeting the cooler air of the mine, causes great condensation to take place on the roof, with the result that the moisture and gases act very rapidly on the superimposed stone, shale or slate, causing rapid disintegration and consequent dropping. It has been found that by applying a coat of this impervious mortar to a thickness of about one-half inch, the moisture is excluded and this breaking-down action prevented.


Gunite Over Mesh—Worcester Bridge.

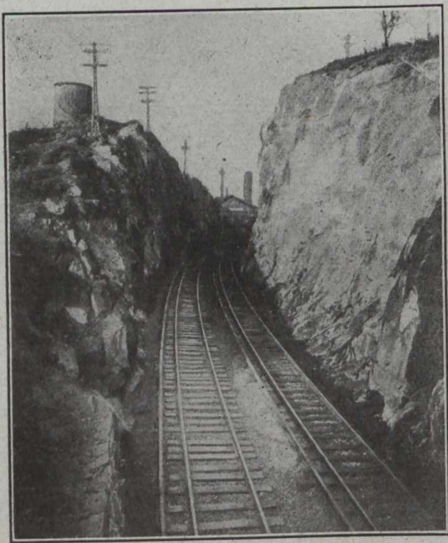
It is the confident assertion of a number of the most prominent coal engineers that this will mean the saving of hundreds of thousands of dollars worth of steel and timber, besides enabling the operators to reduce the size of their entries.

Another interesting development of this method of placing mortar is the lining of irrigation ditches and

MACHINE-PLACED MORTAR REPAIRS TO ATLANTIC CITY RAILWAY BRIDGE PIER.


Condition of Pier Before Applying Mortar. Pier, Repaired, Stays in Service.

canals. A test was made recently in Los Angeles, California, to determine the comparative efficiency of this mortar against hand-placed mortar. A ditch was dug in a gumbo formation four feet deep, with a bottom width of six feet and with side slopes of one to one. Seventeen feet of this ditch was covered to a thickness of one inch with one of these machines in one hour, three men being engaged in its operation. Practically the same amount of material was used as was required by five men to cover the same amount one and one-half inches thick by hand, but it took those five men two hours and forty minutes to cover this same space. The costs, therefore, were about 40 per cent. less for the machine-placed mortar.



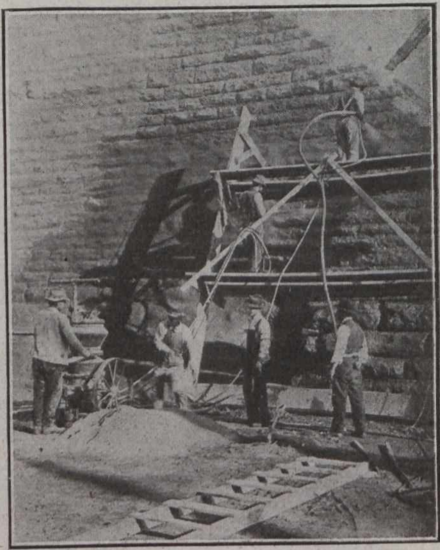
Rock Cut Gunite-Sealed, Spuyten Duyvil Cut, N.Y. Central Ry.

This ditch was then allowed to stand for one week, when test holes were dug behind the walls to a depth of about one foot below the bottom. These holes were then filled with a puddle of clay and water. When this puddle reached a height of 3½ feet above the bottom, the mortar that had been placed by hand broke up entirely. The machine-placed mortar, however, withstood the entire head of five feet with no effect other than a raising of the bottom about ⅜ inch. This development should mean a great benefit in the economical reduction of the great losses to which our western irrigated regions are being subjected, due to loss of water in delivery.

On account of its imperviousness, ease of application and great strength, this machine-placed mortar has met with great success in the construction of new buildings. The walls of the machine shop of the Seaboard Air Line at Portsmouth, Va., are indicative of the character of such work. This building was originally designed to be covered with galvanized iron over the steel frame, but after investigation the engineers decided to change to this machine-placed mortar, with great satisfaction, since a wall has been produced which is fireproof, dampproof, weatherproof and permanent, at a cost not greatly exceeding the cost of a galvanized iron building, which would naturally be of a more or less temporary character. One of the latest uses of this machine in this connection is the work that is now under construction in the erection of two sheds for thawing coal cars at Port Reading, N.J., for the B. & O. and P. & R. Railroads. These great coal-delivering railroads have been subjected to great inconvenience and expense in the past due to the danger of spontaneous combustion in the cars that are thawed with the old steam point method. To obviate this, these sheds are now being erected so that the cars may be subjected to a uniform heat of about 300°, delivered by pumping hot air through ducts in the walls to overhead sheds or tunnels and out through radiators in the floor. Naturally, to maintain this heat it is necessary to provide well-insulated walls, which has led to an unique design by the engineers and contractors who are responsible for the work.

Six-inch channels are used as columns and are spaced about six feet apart, connected with tie rods. Another wall, about 1½ inches thick, reinforced with wire mesh attached to the flanges of the channels, is built up of gunite, or machine-placed mortar, by shooting from the inside against movable wooden panels. A middle wall about one-half inch thick is then built up along the line of the tie rods by hanging tar-paper and light reinforcing mesh and covering same with machine-placed mortar. An inner wall similar to the outer is then built by shooting mortar against a surface of reinforced tar-paper attached directly to the channels over which the reinforcing mesh is hung. This is providing a wall with two insulating chambers and with very strong panels of six-foot space.

The writer cannot close this article without referring to the wide use that has been made of this method of placing mortar in the construction of hundreds of buildings. The buildings of the model Hospital for the Insane at Whitby, Ont., are erected almost entirely with this machine-placed mortar at low cost and with great satisfaction. Also, the numerous buildings that were constructed in such extraordinarily quick time at Camp Borden. Of special interest are the hundreds of buildings that have been erected in the vicinity of Los Angeles, California. The contractors there have developed some very ingenious methods and have successfully competed in price with hand-placed mortars. A comparative examination of the two methods has convinced the writer of the very great advantage to be gained by the use of the machine-placed mortar, for almost without exception the buildings that have been covered with hand-placed mortar show very badly cracked and porous surfaces, whereas those built by the machine method are almost universally without cracks or flaws.



Repairing Reservoir, Nashville, Tenn. Waterproofing Old Masonry Wall.

This work is generally done by attaching a fairly heavy tar-paper directly to the studs. Then, over the paper is placed a reinforcing mesh, usually expanded metal of about No. 12 gauge, and then about ¾ inch of mortar is shot. The especial reason why the contractors have preferred expanded metal is because it presents a true plane and aids in keeping a true surface. These surfaces are shot to definite lines and then screeded to true planes, after which finishes of various types are employed. Cornices, mouldings and other ornaments are shot directly into place without the use of any forms.

INSTALLATION OF A 13,000-FOOT SUBMARINE POWER TRANSMISSION CABLE.*

To bring electric current from the mountain hydro-electric power plants direct to the city of San Francisco necessitated laying of a power transmission cable system under water across Golden Gate at a point where the channel is 13,000 feet wide. For this work contract was let to A. J. Pahl, San Francisco, who, some years previously had devised the method described below, and who, on this contract, gave evidence of skill and ingenuity in surmounting many difficulties.

Method of Installation.—In considering the installation it was known that the cable of the size required could not be made in one continuous length, and that it would be necessary to make at least ten splices for the completed cable. Furthermore, the problem of how to reduce splice and joint tension in the laying of the cable became a most important problem. This is due to the fact that experience has well demonstrated that it is impossible to lay successfully a cable which has been spliced on shore and mounted on a reel, because the tension in the joints invariably results in electric failure of the splice.

Not only this, for in making this installation consideration had to be given to the six-knot tide which prevailed in this channel, to the depth of the water, which exceeded 200 feet, and to the possibility of ships' anchors fouling the cable in the event of having to drop anchor in the vicinity. The question of repairing the cable should failure at any time occur was also important, since the strain in lifting it from a two hundred-foot bottom would be excessive.

It was, therefore, determined to use the messenger method of installation, which had been successfully developed by A. J. Pahl, of San Francisco. In this system a steel rope, known as the messenger, is first laid from shore to shore and anchored securely at both ends. This rope can be laid quickly when tide conditions are favorable and serves as a guide line for laying the power cable. When ready to lay this cable, the messenger is picked up at the shore end and is laid across a barge on which are mounted the reels for the power cable and an ordinary grip, such as were formerly used on street railway cable cars.

The messenger cable passes over sheaves and through the grip, which is operated by one man. At his will the messenger is allowed to slide through or to be clamped in the grip, and thus the operator absolutely controls the movement of the barge while it is being towed across the water by a launch. It should be understood, of course, that the messenger cable must be of sufficient size to withstand all strains imposed upon it, and that the power of the launch towing the barge must not be in excess of the holding power of the grip.

With the messenger laid over the barge, the launch proceeds to tow at a rate determined by the man at the grip. As the power cable is paid out, it is attached to the messenger until a whole length of cable has been sunk. At this point the barge is anchored fast to the messenger, a splice is made at sea, and the towing proceeds.

This operation is continued until the barge (which in this case held four reels of cable, approximately 5,000 feet in length) is empty. The free end of the cable is then sealed with a special lead sealing cap, securely attached to the messenger, and lowered into the water, after which process the barge returns to shore, underrunning the messenger to receive another load of cable.

When ready to start laying again, the messenger is picked up at the free shore end, laid across the barge, and underrun until the free end of the cable comes up, when the splicing and laying is repeated as before. In this manner, the messenger takes all the strain and relieves the cable and all joints of tension.

The Messenger and Anchors.—The messenger in this case was a thirty-seven wire, galvanized steel strand, 1⅜ inches in diameter, in one continuous length of 14,000 feet, having a breaking strength of 90 tons, and weighing about 4½ pounds per foot, so that the total weight of each messenger on the reel was approximately 30 tons

Since there is no beach on the Marin shore, and since the bluff rises in almost perpendicular fashion for over 120 feet, the landing at Yellow Bluff was by no means ideal. In order to anchor the messengers at the base of this bluff and just above the water's edge, short heading tunnels were driven into the rock about fifteen feet, and in these the anchor sheaves were located and held in place by concrete enclosure. The two tunnels, one for each cable, were located about 100 feet apart.

The anchorage on the San Francisco shore was constructed on a sandy beach about 100 feet from the water's edge. On this account, the design was somewhat different from the others, although the iron structure in all the anchorages was the same.

To hold the messenger in the anchorage, a series of three-bolt and single-bolt clamps were used, and over these a mass of melted zinc was poured in order to assist the clamps. The bridge socket type of anchor was not used, for the reason that it might be desirable to change the tension in the messenger at some later date. The anchorages were designed to withstand a tension equal to the maximum strength of the messengers.

The Power Cable.—The submarine cables were three-conductor, 250,000 C. M. copper, each conductor having an insulation of 6/32-inch thirty per cent. Para rubber, over which was placed a 4/64-inch layer of varnish cambric. These three conductors were laid together in circular form with a jute filler, and over all a 10/64-inch varnish cambric belt was applied. The enclosing sheath was 5/32-inch layer of pure lead, over which two ⅛-inch layers of jute were applied. The latter substance was used in order to form a cushion for the wire armor, consisting of forty-two wires of No. 4 B. W. G. extra galvanized iron wires. Over all was placed a ⅛-inch layer of jute, with a layer of sand and asphaltum for mechanical protection. The shore ends were of the same specifications as the main submarine cables, except that the conductors were 350,000 C. M.

The shore ends were each 800 feet long, the main power cables being manufactured in lengths of 1,275 feet to the reel. The length of each completed cable was 13,250 feet. The 250,000 C. M. cable was four inches in diameter and weighed 19 pounds per foot, whereas

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*Abstract from an article by S. J. Lisburger, E.E., in the "Pacific Service Magazine," published by the Pacific Gas and Electric Co., San Francisco.

the shore end was 4¼ inches in diameter and weighed approximately 22 pounds per foot. The weight of the cable and the reel was approximately 15 tons, and the combined weights of the messenger cables, power cables and the reels approximated 380 tons. Incidentally, it required 15 flat cars to transport the entire shipment from the factory.

Cable Terminals and Anchorages.—For a distance of 30 feet from the Marin shore the power cable was not attached to the messenger, but was conducted through a channel which had been dug through the rock. From this position, moreover, the cable was housed in an iron pipe and completely embedded in the water at the shore line to protect it from wave action. As mentioned heretofore, the bluff on this shore is very steep, and it was on this account necessary to erect along the face of the bluff a series of concrete pillars approximately every ten feet. To these piers a channel iron was fastened, and to this were clamped the cable and a cover of heavy galvanized iron. At the top of the bluff the cable was laid in a concrete trench beneath the ground line.

Cable-Laying Equipment.—The barge used in the laying of the cable was of 125 tons capacity, 70 feet long, with a beam of 30 feet, and when loaded had a freeboard of about 5 feet. When laying the messenger the axis of the reel was parallel to the short axis of the barge, and a 100 horse-power launch was used for towing. The same barge was used when laying the cable, but the cable reels were mounted with their axis parallel to the long axis of the barge; in this way the barge was least affected by the prevailing action of the tide and the waves in the channel. The tow for the cable-laying equipment was a 50 horse-power launch. However, during very heavy tide run, two launches were necessary for towing the equipment.

On both sides of the barge grooved cast-iron sheaves, 40 inches in diameter, were securely fastened to the deck, a rigging being provided to prevent the messenger cable from leaving the sheave, no matter what position the barge might take. The cable was fed from the reels around rolls through the serving machine, together with the messenger cable, the two being tied together by the machine in question.

This serving machine, which was driven by a gasoline engine, consisted of two circular iron rings mounted in an iron frame, the rings being made to revolve by a friction drive so arranged that the machine could be stopped or started by the movement of a handle. Removable jaws in the cast-iron rings were provided so the machine could be slipped over the cable and the messenger.

Two spools of No. 6 galvanized iron wire were held between the rings and the outer edges. In this way when the cable and the messenger were allowed to travel through the serving machine, the rings were made to revolve and the machine would wind around the cable and the messenger a serving of the two wires.

Every 20 feet the movement of the barge was stopped by means of the grip and a considerable number of turns wound around the cable and the messenger at one point. This was done to secure the attachment of the cable to the messenger at least every 20 feet in the event of the breaking of the serving wires between these wraps. Formerly the work of serving was done by hand entirely, and was a slow and tedious process. However, with the development of the serving machine for this installation the work was greatly facilitated and much better performed. The speed of cable laying was about 8 feet per minute.

The Joint.—After a length of cable had been laid out, the messenger was made fast in the grip on one side of the barge, while on the other side the messenger and the cable were lashed to the sheave, and the joint made with the next reel of cable. This being done. the serving machine was again brought into action as before, except that the serving wires were now fed through slotted bars attached to one side of the circular revolving cast-iron rings.

Since the barge was held fast to the messenger, the serving machine was mounted on rollers, and as the serving wires were laid over the joint, the machine forced itself along. Every twelve inches the serving wires were soldered together to protect against the wire unwrapping for any distance in case of its breaking. Here again the serving machine accomplished in one hour the work that was formerly done in eight hours by hand.

After the joint had been served it was carefully paid overboard, every effort being used to protect it against undue strains. The cable was not attached to the messenger for a distance of about 8 feet on each side of the splice, and thus the splice was allowed freedom of movement independent of the messenger. With prevailing wind and tide conditions it required on an average 24 hours to pay out one length and to make a splice. There were 11 splices for each completed cable.

Laying the Last Length.—Cable laying was continued in the manner described until within approximately 800 feet of the shore, at which point the cable was sealed, attached to the messenger, and dropped overboard. The barge was then towed to shore and turned around, after which the messenger was again picked up and the shore end pulled into the beach. After the shore end was made fast cable laying was resumed, the shore end being paid out until the end that was dropped overboard appeared. At this point, the final splice was made; the cable and the messenger were then underrun to a point midway between the two splices, hoisted over the reels and then gradually lowered to the bottom by means of ropes. This method was pursued, since it was the easiest way by which the shore end could be handled. Furthermore, there was no difficulty in handling this because enough slack had been left near the shore to allow hoisting overboard as above described.

Progress of the Work.—As the prevailing trade winds and fogs are at their worst during the summer months, and as the winter storms usually commence early in December, it was necessary to prosecute the cable laying during the months of September and October. All equipment being provided and having consulted all tide tables, the first messenger was laid on the morning of September 18th, 1915. Laying of the power cable was commenced September 26th and was finished on the afternoon of October 7th. The work on the second cable was started October 16th and completed and tested on October 30th.

Extremely heavy tide runs occasioned considerable trouble, the force of the tide being strong enough to cause the messenger to slip in the temporary anchors while the barge was near the centre of the channel. This indicated that the force of the tide was sufficient to move the messenger cable, which between bar and shore amounted to a weight of twelve tons, in addition to the friction of the cable on the sandy bottom and the holding power of the temporary clamps. In the meantime work on the terminal house and the land cable connections was being rushed, and the tie-in between sub-station "F" and the submarine cables was completed and the voltage applied from San Francisco on November 5th.

The Engineer's Library

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

CONTENTS.

Book Reviews:

BOOK REVIEWS.

Water Supply. By William P. Mason, Professor of Chemistry, Rensselaer Polytechnic Institute, Troy, N.Y. Published by John Wiley & Sons, Inc., New York; Canadian selling agents, Renouf Publishing Co., Montreal. Fourth edition. 495 pages, 6 x 9 ins., cloth. Price, $3.75. (Reviewed by R. O. Wynne-Roberts, consulting engineer, Toronto.)

One sure proof of the popularity of this book is that the fourth edition has just been issued. The subject of water supply is here discussed principally from a sanitary standpoint, and abundant information is presented for the use of the engineer, and all who are interested in the question of pure supply of water. The book is divided into eleven chapters with three appendices. The introductory chapter deals with many interesting historic examples of water supply and it is instructive to note what precautions were adopted in early times to safeguard the health of the people. Hippocrates who lived about 2,300 years ago even then advised the boiling and filtering of a polluted water before using it for drinking.

The importance of a good supply of water was appreciated by Romans, Egyptians, Singhalese, Chinese and others many centuries ago, and as the population to-day is vastly greater than it was in those days and the dangers of serious pollution have increased, such a book as this one serves to guide us in our efforts to procure a supply which shall be as immune as possible from the lurking and potential troubles of impurities.

The second chapter deals with "Drinking Water and Disease." Peaty water is supplied to many cities, often without treatment, and whilst the coffee color is disagreeable to the sight it is not found to be unwholesome. Mr. E. H. Richard points out that peaty waters which "are found unwholesome may owe their toxic qualities to the presence of materials other than the brown coloring matter." The notion, which is common, that hard waters are not as good as soft waters, is not confirmed by health statistics, for the average annual mortality per 1,000 inhabitants is much alike whether the water is soft, moderately hard or hard.

The great question is that of sewage pollution, and this Prof. Mason discusses in a very agreeable manner. The opinion held by many that water possesses the capacity for self purification is one which should be studied carefully, because so many factors have to be considered. A rapid stream may carry the pollution for several miles without removing the danger of causing disease, whilst a sluggish stream may deposit the sludge in pools and eddies until a flood occurs and washes the filth downstream. Detroit suffered a serious epidemic of typhoid in 1892; the cause was found to be the disturbance of the filth from Port Huron which had deposited in the Black River (page 229). The city of St. Louis sued the authorities of Chicago for polluting the water supply and yet the distance between these cities is 357 miles. A study of the bulletin of the Illinois State Laboratory of Natural History, by Stephen A. Forbes and R. E. Richardson, shows that the river is polluted for a long distance below Lockport. The question is whether water once polluted with sewage material can again be used for human consumption. Prof. Mason deals with the matter in an excellent manner.

The influence of pollution on the health of the consumer is dealt with very fully. Reference to several outbreaks of typhoid fever are made and these are worthy of careful perusal. In the State of Connecticut the typhoid statistics for the past 43 years show a continual improvement which must be due, at least in part, to the abolition of old private wells for new and better water supplies. The number of deaths (for the entire State) from typhoid per 100,000 population fell from 83 in 1865-9 to 14 in 1910-12. In Massachusetts the typhoid death rate fell from 79 in 1859-68 to 38 in 1878-89 because of better water supplies. Whilst it is acknowledged that the excrement of human beings is a source of serious pollution, Dr. Rideal states that "we have yet to learn that the excrement of healthy, much less diseased, animals and birds is altogether harmless to man," (page 64).

The longevity of the typhoid bacillus in water is another subject of grave importance. Houston maintains that "uncultivated typhoid bacilli die much more speedily in raw river water than their cultivated brethren." Percy Frankland stated that "the longevity of these pathogenic bacteria was inversely proportional to the bacterial population in the waters into which they were introduced." Hence we see that a relatively pure stream, if a rapid one, might carry infection over long distances (page 69). Tavel points out that although B. typhosus does not live long in the water of streams and lakes, yet it can exist for considerable periods in the mud upon their bottoms and sides, and he asks attention to the consequent danger possibly lurking in the "blind" ends of water pipes (page 73). Owing to an outbreak in London, Eng., investigations were made by the medical officer with the result that suspicion fell upon "dead ends" and these were afterwards eliminated where practicable. Otherwise the mains were flushed out periodically.

Barwise supplies the following statistics to show the effect of sanitation in London, England. Houses with privy system, 1 case of typhoid for every 37 houses; houses with pail system, 1 case of typhoid for every 120 houses; houses with watercloset system, 1 case of typhoid for every 558 houses (page 81). There is no doubt that sanitation pays. If additional evidence is needed Prof. Mason furnishes it in his book.

Purification of water by filters—slow and rapid—is handled in considerable detail. The efficiency of slow and rapid filters, based upon the removal of bacteria, is nearly the same, but the relative cost differs according to conditions. Other things being equal, slow sand filters are best suited for clear waters and rapid filters best for those of turbid or colored character (page 180). It is difficult to understand why Prof. Mason refers to rapid filters as mechanical filters when, as a matter of fact, they have very few mechanical parts. The early types had mechanical scrapers, etc., hence the old name; but to-day the name is a misnomer. The drifting sand filters of Toronto are referred to, but the author states that they are "almost too new to allow of much being said with reference to their fitness for the work assigned to them" (page 184).

Sterilization and aeration are dealt with with care.

This book deserves a place on the shelf of every water engineer and waterworks superintendent, as it covers the whole subject of the quality of water according to the best knowledge available up to the present moment.

Applied Electricity for Practical Men. By A. J. Rowland. Published by McGraw-Hill Book Company, Inc., New York. First edition, 1916. 375 pages, 323 figures, 5 x 7½ ins., cloth. Price, $2.00 net. (Reviewed by R. L. Hearn, Ontario Hydro-Electric Power Commission.)

As the author states in his preface, this book has been written for practical men; that is, men who are working with and installing electrical machinery and equipment. It has been in the process of making during his twenty years of experience in teaching applied electricity to practical electrical workers.

The book does not in any way touch the actual design of electrical apparatus and pure theory is carefully avoided, except where it has a direct bearing on the practical problem in hand.

A clear statement of fundamental principles and explanation of apparatus is given only insofar as it is necessary, in order to present clearly the essential elements of the subject.

The book abounds with excellent numerical problems that bring out clearly the practical use of the principles and apparatus given in the text.

The apparatus and equipment shown in the cuts are up-to-date and well chosen.

The following headings of each chapter will show to some extent the ground covered and contents of the book: Chap. 1, Fundamental Principles; Chap. 2, Electromotive Force and Ohm's Law; Chap. 3, Magnets and Magnetic Flux; Chap. 4, Direct Current Dynamo, E.M.F.; Chap. 5, Drum Armatures and Multipolar Machines; Chap. 6, Electric Heating and Electric Power; Chap. 7, Direct Current Systems of Distribution; Chap. 8, Direct Current Motors; Chap. 9, More principles that were not included in Chap. 1; Chap. 10, Alternating Current Principles; Chap. 11, Alternating Current transformers; Chap. 12, Polyphase Current Principles; Chap. 13, Alternators; Chap. 14, Alternating Current Motors; Chap. 15, Other Alternating Current Machinery; Chap. 16, Storage Batteries; Chap. 17, Electric Lights; Chap. 18, Wires and Wiring.

Qualitative Analysis.—Vol. 1 of Analytical Chemistry. By F. P. Treadwell, Ph.D. Published by John Wiley & Sons, Inc., New York City; Canadian selling agents, Renouf Publishing Co., Montreal. 538 pages, 6 x 9 ins., illustrated, cloth. Price, $3.00 net. (Reviewed by C. H. Heys, Thomas Heys & Sons, technical chemists, Toronto.)

This work covers in clear and comprehensive details the science of elementary chemistry, suitable for students with some preliminary studies.

The pages covering the general principles of chemical examination, theory of electrolytic dissociation, nomenclature of ions and equilibrium of solids and liquids, is fully and concisely written.

The chapters on solubility, electromotive series and hydrolysis, are worthy of mention.

Part II. (Reaction of Metals, Their Recognition and Chemical Characteristics) is an outstanding feature of the book. A stimulating attraction of this part is the information regarding the occurrence and origin of the elements.

The methods, and in a number of cases, the cuts of required apparatus for complex detection of metals, is comparable with many of the recent works on advanced chemistry.

In Part III. the author deals with the reactions of acids or anions. In this case I may reiterate what has been said of Part II.

Systematic analysis, which is taken up in Part IV., is a clear and concise explanation of the separation and detection of metals and their compounds. The tabulated forms are well arranged.

Reactions of the rarer metals are fully described and brings the work well up to date in this field of chemistry.

Passenger Terminals and Trains. By John E. Droege, general superintendent, N.Y., N.H. & H. Railway. Published by the McGraw-Hill Book Co., Inc., New York City. First edition, 1916. 410 pages, 220 illustrations, 6 x 9 ins., cloth. Price, $5. (Reviewed by J. R. W. Ambrose, chief engineer, Toronto Terminals Railway Co., Toronto.)

The author declares that it is the purpose of the book not to consider public regulation, etc., but the passenger service itself, to take up the design of the massive terminals through which the passenger traffic passes, to determine what is good and bad in the operation of these terminals and to deal with the operation of the trains which use them.

One has only to peruse a few pages to learn that the author is thoroughly conversant with passenger terminals and their operations.

The descriptions of the various stations are exceptionally accurate and exhaustive. The author does not criticize to any extent the weak points in each terminal, but the subject is put in such a clear manner that even the layman can pick and choose for himself.

The book, containing numerous illustrations and plans, is written in a very clear, interesting and readable manner and will be of exceptional value to architects and engineers who contemplate terminal work, and to the student making a study of railway management.

Treatise on Hydraulics. By Professor Mansfield Merriman, M.Am.Soc.C.E. Published by John Wiley & Sons, Inc., New York; Canadian selling agents, Renouf Publishing Co., Montreal. Tenth edition, 1916. 545 pages of text, including numerous illustrations and tabulations and ten appended tables, cloth, 5¾ x 8¾ ins. Price, $4 net. (Reviewed by H. G. Acres, hydraulic engineer, Ontario Hydro-Electric Power Commission, Toronto.)

Owing to the fact that Merriman's Hydraulics has been the *vade mecum* of every civil engineering student in America for the past twenty-five years, any extended analysis of the latest edition is not only unnecessary but unfitting. It is gratifying to perceive, however, that Professor Merriman has adhered consistently to his former practice, and in the tenth edition has been satisfied to maintain the status of his work as the premier American text-book on theoretical hydraulics, instead of following the lead of some of his contemporaries and diluting his working theory with a loose conglomeration of descriptive matter which would more properly be found in an engineering magazine or a manufacturer's bulletin.

As compared with the seventh edition, which happens to be at hand, the tenth edition contains 138 more pages, two more chapters, and a largely increased number of tables and illustrations. The two new chapters, entitled "Instruments and Observations," and "Pumps and Pumping," take up half of the additional pages, but otherwise the text of the tenth edition has been amplified only to the extent necessary to record the advance of the empirical branches of hydraulic science.

In his preface to the tenth edition the author mentions having rewritten the article on water hammer and the surge tank. This article contains a short summary of the theory of water hammer and a description of Joukowsky's experiments. The surge tank portion of the article is limited to a diagrammatic sketch of an ordinary standpipe and the derivation of the formula for the theoretical height of surge. The differential surge tank is disposed of through the medium of a rather unintelligible reference to a tank "with a closed top". The mathematical theory of the open differential surge tank, as developed by Johnson, would make ideal matter for study by advanced engineering students. Moreover, the theory shows such remarkable coincidence with tests made on working installations of the Johnson tank, and the practical utility of the same has been so clearly proven, that no modern text-book on hydraulics can be considered really comprehensive without an extended reference to it. It is to be hoped that Professor Merriman will make good this deficiency in the event of publishing an eleventh edition of his work.

The tenth edition of Merriman's Hydraulics should be included in the library of every civil engineering student and hydraulic engineer as a companion volume to Mead.

Wire and Sheet Gauge Tables and Metal Calculator. By Thos. Stobbs. Published by E. & F. N. Spon, Limited, London, England. 95 pages, 5 x 7½ ins. Price 3s. 10d. net.

This book seems to be very complete in a great many ways and contains much useful information, but the writer considers it to be one that is not specially useful to any merchant in the metal business, as it is thought that too much ground is being covered in the one publication. There are several books which give the same information in more concise form.

A thing that surprises one in this book is that while it professes to give information regarding gauges for sheets, no mention at all is made of the new Birmingham gauge (B.G.) which is the standard in Great Britain for iron and steel sheets and hoops. This is a gauge which is used also by the Canadian iron and steel trade for those lines, as British sheets and hoops are rolled to this gauge unless otherwise specified. The book also refers to Birmingham wire gauge, which has been obsolete for some time.

Poor's Manual of Industrials, 1916. Published by Poor's Manual Co., New York. 3,112 pages, 6 x 9 ins., bound in cloth.

Poor's manual of Industrials for 1916, which has just been issued, contains 3,112 pages of text, or nearly 10 per cent. more pages than the previous issue.

The book contains the latest income accounts and balance sheets of industrial companies. These tables are in most cases presented in comparative form, showing at a glance the growth of the business. The general information in the book is revised to August 15th. It also contains an appendix giving recent information on the steam railroads and the public utilities.

In view of the fact that the United States industrial organizations had a phenomenal volume of business during the past year, profits having broken all previous records, Poor's Manual of Industrials is particularly valuable at this time. It gives the facts regarding industrial companies without bias or opinion.

How to Make Low-Pressure Transformers. By Prof. F. E. Austin, Hanover, N.H. Third edition. 22 pages, 16 illustrations, 7¼ x 4¾ ins., board cover. Price, 40c. (Reviewed by Alfred S. L. Barnes, Ontario Hydro-Electric Power Commission, Toronto.)

This is a small book of some 22 pages, describing in very simple language, and with clear illustrations and sketches how to make small transformers suitable for use on 110 or 220-volt, 60-cycle circuits.

For anyone wishing to make a small transformer for experimental purposes, this book will prove extremely useful as the directions given are clear and concise and all necessary details appear to have been dealt with.

By bringing out taps from various portions of the secondary a considerable number of different voltages can be obtained. Two transformers are described, one having a capacity of about 100 watts and the other of 1 kw. Since this book has already passed through two previous editions, it is reasonable to assume that it has already proved its merits.

PUBLICATIONS RECEIVED.

The Flow of Water in Wood-Stave Pipe.—Bulletin No. 376 of the United States Department of Agriculture, Washington, D.C. By Fred. C. Scobey, irrigation engineer.

Regulations Respecting Highways, 1916.—Appendix to the annual report of the Ontario Department of Public Highways.

City of Saskatoon.—Annual report, 1916, of C. J. Yorath, city commissioner, Saskatoon, Sask.

Department of Labor.—Report of the Department of Labor, Ottawa, for the fiscal year ended March 31st, 1916. Price, 10 cents.

River Des Peres Plan.—A plan concerning largely the industrial and residential expansion and economic welfare of St. Louis, Mo. Prepared by the city plan commissioner, Harland Bartholomew, engineer.

Forest Products of Canada, 1915.—Lumber, lath and shingles. Bulletin No. 58a, Forestry Branch, Department of the Interior, Ottawa. R. H. Campbell, director.

Civic Improvement.—Report of conference of the Civic Improvement League of Canada. Published by the Commission of Conservation, Ottawa, 1916.

Accidents at Metallurgical Works in the United States during the calendar year 1915. Technical Paper 164, Bureau of Mines, Department of the Interior, Washington, D.C. Compiled by Albert H. Faig.

Public Roads and Rural Engineering.—Report of L. W. Page, director of the Office of Public Roads and Rural Engineering, U.S. Department of Agriculture, Washington, D.C., for the fiscal year ended June 30th, 1916.

Iron and Steel.—Report of the production of iron and steel in Canada during the calendar year 1915. Published by the Department of Mines, Ottawa. John McLeish, B.A., chief of the Division of Mineral Resources and Statistics.

Canadian Forestry Association.—Memorandum of Canadian Forestry Association, presented before the Hon. G. H. Ferguson, Minister of Lands, Forests and Mines, of Ontario, November 28th, 1916.

The Easton-Allentown Concrete Road as described by the State Highway Department of Pennsylvania. Reprinted by the Portland Cement Association, 111 West Washington Street, Chicago, Ill.

Recommended Specifications for Reinforced Concrete Design based on the regulations in the building code recommended by the National Board of Fire Underwriters and the 1916 report of the Joint Committee on Concrete and Reinforced Concrete. Published by the Portland Cement Association, 111 West Washington Street, Chicago, Ill.

Tide Tables for the Eastern Coasts of Canada for the year 1917, including the River and Gulf of St. Lawrence, the Atlantic Coast, the Bay of Fundy, Northumberland and Cabot Straits, and information on currents. Issued by the Tidal and Current Survey in the Department of the Naval Service of the Dominion of Canada. W. Bell Dawson, M.A., D.Sc., superintendent.

South African Institute of Electrical Engineers.—Transactions of the institute, together with the names of the officers and council for the year ending December, 1916. Secretary, W. J. Clarkson, P.O. Box 4563, Johannesburg.

A.S.T.M Standards.—Year-book for 1916 of the American Society for Testing Materials, containing the standards adopted by the society. Edited by the secretary-treasurer, Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.

How to Maintain Concrete Roads and Streets.—Leaflet published by the Portland Cement Association, Chicago, Ill.

Production of Spelter in Canada, 1916.—By Alfred W. G. Wilson, Ph.D. Issued by the Department of Mines, Ottawa.

CATALOGUES RECEIVED.

Storage Battery Trucks for Industrial Plants.—Bulletin No. 200 of The Jeffrey Manufacturing Co., Columbus, Ohio, containing illustrations, specifications and descriptions of their various types of storage battery trucks, which are adapted for use in industrial plants, factories, warehouses, foundries, etc.

Yeomans Electric Bilge Pumps.—Bulletin No. B-3000 issued by Yeomans Brothers Co., 231 Institute Place, Chicago, describing their electric bilge pumps for automatically raising surface water, drainage and sewage in basements below level of street sewers, municipal sewerage systems, etc. Contains 19 pages and is illustrated.

Ashford's Tube Well Strainer.—All engineers who are interested in the subject of irrigation or water supply generally will find this catalogue of value. It illustrates and describes a device that has proved satisfactory for drawing large quantities of water from sandy soil without drawing away sand. The catalogue contains 40 pages and is well illustrated. Copies can be secured upon application to Stewarts and Lloyds, Limited, Glasgow, Scotland.

COMING MEETINGS.

COUNTY ROAD ENGINEERS' ASSOCIATION OF KENTUCKY. Meeting, Bowling Green, Ky., January 17-20, 1917. Secretary, F. I. Duffy, Frankfort, Ky.

AMERICAN WOOD PRESERVERS' ASSOCIATION. Annual meeting, New York City, January 23-25, 1917. Secretary, F. J. Angier, B. & O. Mt. Royal Sta., Baltimore, Md.

TENTH CHICAGO CEMENT SHOW, Coliseum, Chicago, Ill., February 7-15, 1917. Secretary, Blain S. Smith, 210 South La Salle Street, Chicago, Ill.

AMERICAN ROAD BUILDERS' ASSOCIATION. Fourteenth Annual Convention; Seventh American Good Roads Congress under the auspices of the A.R.B.A., and Eighth National Good Roads Show of Machinery and Materials, Mechanics' Hall, Boston, Mass., February 5-9, 1917. Secretary, E. L. Powers, 150 Nassau Street, New York, N.Y.

AMERICAN CONCRETE INSTITUTE. Hotel La Salle, Chicago, Ill., February 8-10, 1917. Secretary, Harold D. Hynds, 1418 Walnut Street, Philadelphia, Pa.

THE NATIONAL BUILDERS' SUPPLY ASSOCIATION. Annual meeting at the Hotel Sherman, Chicago, February 12-13, 1917. Secretary, L. F. Desmond, 1211 Chamber of Commerce, Chicago.

AMERICAN CONCRETE PIPE ASSOCIATION. Annual convention, Chicago, Ill., February 12-14, 1917. Secretary, E. S. Hanson, 538 South Clark Street, Chicago, Ill.

SOUTHWESTERN CONCRETE ASSOCIATION. Annual meeting and concrete show, Convention Hall, Kansas City, Mo., February 19-24, 1917. Chairman, Show Committee, Chas. A. Stevenson, 1433 West 10th Street, Kansas City, Mo.

MID-WEST CEMENT USERS' ASSOCIATION. Annual convention, Omaha, Neb., March 6-10, 1917. Frank Whipperman, secretary, 28th Avenue and Sahler Street, Omaha.

DIXIE HIGHWAY exposition and convention at Cincinnati, Ohio, May, 1917.

AMERICAN WATERWORKS ASSOCIATION. Thirty-seventh annual convention, "The Jefferson," Richmond, Va., May 7-11, 1917. President, Leonard Metcalf.

THE SOUTHWESTERN WATERWORKS ASSOCIATION. Annual convention at Topeka, Kan., June 11 to 14, 1917. Information from E. L. Fulkerson, Waco, Texas.

Editorial

SHIPBUILDING IN CANADA.

A shipbuilding industry may soon be established in Canada. The Canadian government, with a view to granting aid to this industry, obtained offers for the building of different classes of ships, but these were unsatisfactory. A subsidy equivalent to the difference in cost of construction as between British and Canadian shipyards appears to have been under consideration. At present, however, prices are at such a high level as to make aid on that principle unsatisfactory. This is one of the difficulties at present under consideration by the government, which promises to bring before parliament a measure for the encouragement of shipbuilding with a view to increasing the available tonnage. According to the deputy minister of marine and fisheries, the average value of the vessels on the register of the Dominion at the end of 1914 was $30 per ton, and on this basis the value of the net registered tonnage of Canada at that date would be $27,972,660. The new tonnage constructed in 1914 was 43,346 tons, valued at $45 per ton, or $1,950,570. At present, Canadian shipyards in Quebec, Montreal, Collingwood and at other points are busy, but only at Collingwood are commercial vessels being built.

Some time ago the New York Chamber of Commerce formulated a scheme which it thought might well be adopted as the shipbuilding policy of the United States. Sir George Foster, Canadian minister of trade and commerce, in discussing the question of ocean transportation in the House of Commons, April 26th, 1916, outlined this scheme, and commented on the way it might be applied to the Canadian problem.

Under this plan a commission would be appointed consisting of any three members of the cabinet whose departments are interested, say, commerce, navy and finance. The government side of that commission would be the ministers of these three departments. Added to these would be a naval instructor and three practical and experienced men in shipping matters, selected by the government. That commission would have general oversight and direction of the classes of vessels to be built under the scheme, how they should be named, everything in connection with them, and to the extent that it would be possible, the regulation of the rates as well. That committee would then be empowered to enter into contracts with shipbuilding companies to build according to the plans and regulations laid down in Canadian shipyards, and the builders of ships would be allowed the difference between the cost of construction in Canada and in European ports.

The object would be to enable the Canadian shipowner to have his ships built in Canada at exactly the same cost as if he had had them built in a European port. If this tonnage could be built in a European port at a certain percentage per ton cheaper than in Canada, then the subsidy for construction would be that difference in cost, whatever it was, so as to put the Canadian shipowner on an equality, in the after-competition, with his competitor who had ships built in European shipyards. The time during which this should be carried out would be limited to a period of, say, ten years, so that during that ten years this operation of building would go on.

Furthermore, the commission would be empowered to enter into contracts with the shipowners, when the ships were built, and to guarantee to the owners the difference in cost of operating the ships under the Canadian flag and under a European flag, that subsidy to continue for the life of the ship. The commission would ascertain the difference in cost of construction and operation, and pay that difference alone. In that connection the government would place at the disposal of the commission the sum of $15,000,000 or $20,000,000 and empower the commission to guarantee the bonds upon the ships built up to 50 per cent. of the value of the ships. Such bonds would be 5 per cent. bonds, and the government commission would get one-half of one per cent. on these bonds returned to its treasury for its work and its supervision.

If the plan as outlined above could be applied practically it would go a long way towards placing the shipbuilding industry on a sounder basis and would mean the establishment of a great industry. Never was there a time when the opportunities in this field were more attractive than they are to-day.

ARTISTIC EFFECT IN ENGINEERING.

Artistic effort and mechanical craft are academically considered to be as wide apart as the poles are asunder; yet a power unit or a bridge span have possibilities from the point of view of beauty. The remarkable aesthetic differences between various structures serve to show that there is a consideration underlying not usually taken into account.

One meaning of artistic is fitting and it is conceded that design must take into account the material employed. Correct construction in stone or wood is obviously incorrect when applied to steel or cast iron which have their own methods of treatment and do not need to follow exact architectural precedent.

In this question of abstract beauty, for sins against which the engineer is too often blamed, lies a matter little realized. It is best to make this clear by definite statement and concrete example.

If a structure is designed purely economic financially, at absolute least first cost the result will be offensive and ugly. Again, if a structure is designed with strict regard to economy of material, then the result will have merit from the artistic point of view.

Proportion is one underlying factor of all art and that disposition of material giving equal stress results in natural outline and consequently must be proportionate.

The actual limitations imposed by necessity upon the designer led in the case of architecture to certain forms and proportions which are accepted as satisfying the eye. It was not so much a conscious effort after beauty as a natural evolution for sufficient strength by the economical disposition of material which gave us style in building.

The structural engineer is accused of defacing the landscape with hideous structures possessing the merits of utility and strength, but which offend the eye. In part the accusation is just and must be admitted.

If we take a much debated case—that of bridges—and compare, for instance, a flat girder commercial railway span with, say, the Forth Bridge, we are forced to a singular conclusion. The flat girder bridge is cheap, is virtually standardized, it defies all natural outline but it includes a mass of unnecessary material from the point of equal stress. The Forth Bridge is admittedly a structure which satisfies the eye, its material is deliberately disposed to afford equal strength, consequently it possesses a natural outline and is proportionate.

It would seem, therefore, that the only cases where commercial considerations coincide with pleasing outline is where the structure is large and the economic disposition of material is the method of least cost.

The stress diagram of a loaded girder is in most instances a conic section curve. Structures designed from economic material considerations must therefore embody curves such as the ellipse, hyperbola, parabola, all of which satisfy the eye more than a simple straight line.

The question of ornamentation is left untouched; structural steel work is best left without the treatment quite proper to other material. It should rely entirely upon proportion and mass.

While the utilitarian aspect of a steel structure is its primary consideration; given the necessary knowledge, beauty can be found in many engineering products.

It is worth pointing out that there was a time when elaborate mouldings were used to decorate steam engines and classic type columns supported standing loads in machines and elsewhere. It is recognized to-day that such decoration is obsolete and unfitting, making an atrocity of what otherwise would be well-proportioned with natural line.

PERSONAL.

WM. SLOAN, of Nanaimo, B.C., has been appointed Minister of Mines for British Columbia.

H. J. HUMPHREY has been appointed superintendent, Farnham Division, Quebec District, C.P.R.

GEORGE SLEEMAN, chairman of the Light and Heat Commission, Guelph, Ont., has resigned owing to ill-health.

THOMAS ADAMS, of the Commission of Conservation, Ottawa, recently addressed the Canadian Club at Quebec on the subject of town planning.

ROADMAN M. LEE, of South Vancouver, B.C., has been transferred from the sewerage office to the engineering department, as assistant to Municipal Engineer S. B. Bennett.

FRANK W. COOPER, A.M.Can.Soc.C.E., has resigned the position of superintendent, Schreiber Division, Algoma District, C.P.R., Schreiber, Ont. He will be succeeded by G. J. FOX.

FREDERICK J. BRULE has resigned from the staff of the Anaconda Copper Company to accept the position of chief engineer of the British American Nickel Corporation. Mr. Brule will reside in Toronto.

W. B. YOUNG, chief draughtsman and designer in the office of the city engineer, Vancouver, B.C., has been granted leave of absence for an indefinite period by the city council. Mr. Young has obtained a commission in the Canadian Engineers for overseas service.

W. F. ANGUS, vice-president and managing director of the Canadian Steel Foundries, is retiring from his present position to become one of the executive officers of the Dominion Bridge Company. He will, however, remain a director of both the Canadian Car and Foundry Company and the Canadian Steel Foundries.

OBITUARY.

Captain JOHN TRETHEWEY, a retired mining engineer, who for a long time was associated with the Silver Islet Mines, in the Lake Superior district, died in Toronto this week at the age of 77. He had lived retired in Toronto for ten years, coming from Owen Sound, where he was a resident for twenty years.

CANADIAN SOCIETY OF CIVIL ENGINEERS, ANNUAL MEETING.

The Annual Meeting of the Canadian Society of Civil Engineers will be held in Montreal January 23rd, 24th and 25th, 1917. These dates have been decided upon by the council of the society and further details regarding the programme will probably be issued within the next fortnight. It is expected by the members that the usual arrangements will be made with the passenger associations for return passage at single rates to all members who attend the meeting.

CANADIAN SOCIETY OF CIVIL ENGINEERS, EDMONTON BRANCH.

Mr. N. M. Thornton, general manager of the Mountain Park Collieries, was the speaker of the evening at the regular meeting of the Edmonton Branch, Canadian Society of Civil Engineers, held on the 20th inst. His subject was "Past and Present Methods of Coal Mining." Mr. Thornton dealt principally with the Northumberland coal fields of England, and from a historical point of view, tracing their development from the earliest times down to the present. The speaker is intimately acquainted with the coal fields of that district and his address was listened to throughout with the greatest of interest.

CANADIAN SOCIETY OF CIVIL ENGINEERS, VICTORIA BRANCH.

At the annual meeting of the Victoria Branch, Canadian Society of Civil Engineers, which was held on Wednesday, December 13th, with an attendance of 21 members, the following officers were elected for the ensuing year:—

Executive committee: Chairman, D. O. Lewis; vice-chairman, R. A. Bainbridge; treasurer, E. Davis; secretary, R. W. Macintyre; C. Hoard, E. G. Marriott, F. C. Gamble and H. W. E. Canavan. Auditors, Lewis W. Toms and J. B. Shaw.

On the 9th inst. the provincial division for British Columbia met in Victoria at the branch rooms for the annual meeting, and the proposal that those now in office should be re-elected for 1917 was unanimously carried. The chief business dealt with was the completion of by-laws for the division and the submission of same to both branches and headquarters for approval and adoption. The secretary, Mr. Cleveland, promised to have copies ready at an early date. The officers of the division are: Chairman, T. H. White; secretary-treasurer, E. A. Cleveland; representatives of branch—Vancouver, R. F. Hayward and A. D. Creer; Victoria, D. R. Harris and W. Young; representing outside members of British Columbia, W. K. Cwyor and A. E. Ashcroft.

K-6