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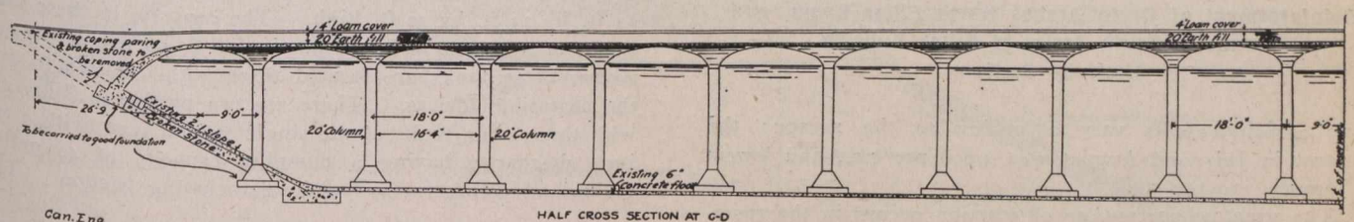
MINNEAPOLIS MECHANICAL WATER FILTRATION SCHEME.

By A. W. ELLSON FAWKES, C.E.

The Minneapolis mechanical water filtration scheme is now nearing completion, which will fill a long-felt want as regards the city's water supply. In the early stages Minneapolis had under discussion two projects, i.e., mechanical water filtration, and piping of the water from Mille Lacs, a distance of eighty-one miles. The vital points were: pure water, quantity, description of project, and cost.

The present average consumption of water in Minneapolis is twenty million gallons with a population of 316,000, with a per capita consumption of sixty gallons per day, quite a low figure at a glance, but a study of the analyses of the Mississippi water is explanatory. On account of the evaporation, run-off, and shrinkage of the water on Lake Mille Lacs, also the estimated cost of $3,913,414, approximately $48,915 per mile, the Mille Lacs scheme was abandoned in favor of the mechanical filtration scheme, by this means utilizing the existing pumping stations with an increased pumping capacity of 80,000,000 gallons per day.



Section Through Clear Water Reservoir.

The mechanical filtration system having been decided upon, various analyses of the water were taken to determine the extent of the mechanical scheme. Briefly the water of the Mississippi River contains:

Chemical analysis (sanitary)—Free ammonia, alb. ammonia, chlorine, alkalinity, hardness.

Physical analysis—Suspended matter, (a) mineral, (b) organic; rate of sedimentation, color, suspended and dissolved matter, (a) organic, (b) inorganic.

Biological analysis—Bacteria, plankton.

Mud analysis—Mineral, clay, silica, organic (dead and living.)

Chemical Analysis.—Free albumnoid and ammonia varies from .430 in May to as low as .059 in October.

Alkalinity and permanent hardness: The average total hardness reached a maximum of 173 and a minimum of 139. The maximum is during the months of December, January, February. The minimum during April.

Chlorides: These vary greatly with the heights of the water, and follow directly the alkalinity and total hardness. During the past ten months the chlorides have varied in about the same relative amount as the permanent hardness.

Color: The Mississippi River varies greatly in color at different points along its course. These changes in color are caused by the confluence of contributary streams. Along some of the highly-colored tributaries are large swamps, the water of which shows a color as high as 700 to 800. This color is derived from macerated vegetable matter, and persists as a considerable factor in the total color of the Mississippi at Minneapolis. The greatest reduction of color occurs during the months of August and September, and very little in the winter. This is coincident with the greatest and least amount of plankton. When copper-sulphate was used to destroy plankton, the bleaching process at the reservoirs was interfered with.

Suspended and dissolved matter: The organic residues are greatest in summer months. The inorganic residues follow the alkalinity and chlorides. The mineral residue varies from 113 to 162. The organic from 62 to 75.

Turbidity: The turbidity of the Mississippi River water at Minneapolis is usually low—so low, in fact, that it has been regarded as a negligable quantity in the earlier analysis. In occasional instances it has for a short time risen to 25 or 30, but quickly subsides. It is safe to assume that in 350 days of the year it is in the neighborhood of 10.

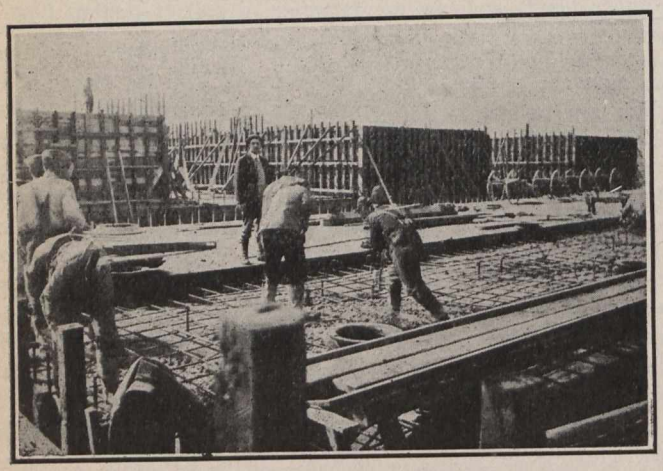
The Mississippi water deposits on an average .13 cubic yards of sediment per million gallons of water during a period of four days of sedimentation. In the process of sedimentation, the algae and diatoms are the first to be deposited; at the end of 24 hours, only fine clay remains suspended in water, and at the end of 96 hours but 36% of the original turbidity remains.

The following is an analysis of deposited matter taken from the city reservoir recently:

Organic matter	19.3%
Alumina	13.6%
Silica	50.3%
Iron (ferric-oxide)	6.5%

The most objectionable feature of the Mississippi River water at Minneapolis is the bacterial content. Colon bacilli are constantly found in the water. This indicates the presence of animal contamination. The high rate of typhoid

fever in Minneapolis among the users of the river water of the Mississippi goes to prove this. The fact that typhoid bacillus has been isolated from the waters of the Mississippi at Minneapolis, and the fact that above Minneapolis are situated several large towns contributing sewage directly into the river indicates the dangerous character of the raw Mississippi River water. It has been stated by engineers that typhoid fever germs will live in the same water for ten days. The Mississippi water passes several towns, such as Grand Rapids, Anoka, St. Cloud, Little Falls and Brainerd. The water that passes these towns reaches Minneapolis in less than eight days. The contamination of the Mississippi at Brainerd is sufficient to give colon bacilli in every cubic centimetre of the water throughout the course of the stream. The absolute numbers of bacteria in the



Reinforcement of Groin Arches North Filter Basin, and forms to South Series of Filter Built in Alternate Sections.

water at Minneapolis vary according to the season; the greatest in July and August was 3.000 per c.c., and lowest in January 150 per c.c.

The greatest percentage of reaction occurs in the reservoir also during July and August. These are the months of the maximum of plankton, when the range is from 400 to 1,200; in January 75 is an average.

Softening the Water.—The alkilinity of the Mississippi River water is due to the bi-carbonates of calcium and magnesium. This means the presence of carbon dioxide gas (Co 2). To reduce the alkilinity of the Mississippi water to about normal (66) after a treatment of 24 hours will be possible with lime treatment in about the quantities of 7.26% grains per gallon of raw water during November and December.

Color.—The color is due to vegetable substance which is slightly lessened by the lime treatment, and is further treated by alum as a bleaching medium. The slight precipitation soon settles with two grains per gallon, assisted with four grains of sulphate of aluminum. The Mississippi water will continue to bleach with longer storage.

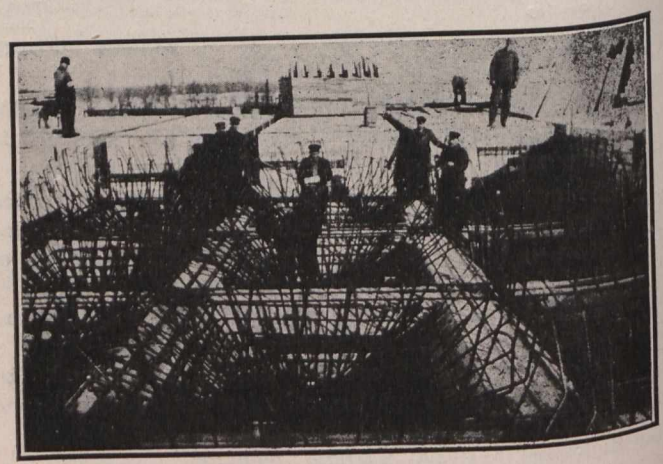
Sterilization.—The water in the reservoirs: 90 million gallons was treated with copper sulphate (50 lbs. to the 90 million gallons three times a week, and as a result the plankton was decreased 80% in 30 days. Bacteria was reduced 40%, turbidity 20%. Also the color was slightly reduced. These experiments were conducted during July and August, the usual time for these organisms to be on the increase.

The purification of the Mississippi River water having been solved, and the amounts and kind of purifying mediums to be administered, the constructional part of the work was started late in the fall of 1910, and has progressed very rapidly. The work was done on the day labor plan, the city of Minneapolis being the contractors.

The layout of the plant is as follows: The raw water or settling reservoir is of concrete and has a capacity of 75 million gallons. The water passes from this reservoir after sedimentation into a 60-inch intake pipe through a venturi meter into the chemical controlling chamber. There it receives the chemical treatment, measured by automatic devices according to the flow of the water. The water then passes into the mixing chamber, and is thoroughly mixed by flowing around a large number of wooden baffles. It then passes through controlling chamber No. 2 into a centre passage and is distributed into the two coagulating basins, again flowing against baffles, then passes over a skimming weir into the upper portion of the centre passage through a 60-inch influent pipe passing through the south side of the head house into the pipe gallery. The water is then passed into the filters ranging along each side of the pipe gallery through 24-inch branches off the influent pipe. The water passes through the filters into a network of pipes below, through a controlling meter into the clear water basins below, there to be turned into the large covered reservoir with a capacity of 47 million gallons, or into the city's distributing mains.

Head House.—The head house is of concrete and brick construction with several floors, and contains the mechanical devices for the operation of the plant. At grade 300 are located the two boilers for heating purposes, having a heating capacity of 15,000 square feet.

Alum Tanks.—These tanks are of concrete, reinforced with ¾-inch rods, both vertical and longitudinal. They are 13 ft. by 12 ft. by 12 ft. high. The concrete in these tanks was a 1:2:4 mix, and was put in for $7.00 per cubic yard. Above these tanks are located three 3-h.p. motors to drive the agitating devices. There are two pumps in connection with these alum tanks of the single section type, with a two-inch discharge having a pumping capacity of 40 gallons per minute against a 45-foot head including friction. They



Reinforcement of Concrete Storage Bins.

are operated by two single 2-h.p. motors. These pumps have bronze shells, runners, and diffusion vanes, and monal-metal shafts with especially designed packing to resist the action of the acid solutions. Switches for controlling these pumps are connected with the operating room at a point convenient to the pumps.

Hypo Tanks.—These tanks are similar to the alum tanks in construction, except that they have a concrete cover over them. The motive power, pumps and controlling devices are the same as in the alum arrangement.

Lime Tanks.—These tanks are of steel plate construction, three in number, 12 ft. 6 ins. in diameter and 13 ft. high. They have an agitating device driven by three 5-h.p. motors. There are two lime solution pumps in connection with these tanks of the single suction type with a 3-inch discharge especially designed for a 7% solution and pumping a thick, gritty liquid. They have a pumping capacity of 40 gallons per minute against a 45-ft. head. These pumps are also operated and controlled at the operating room as well as at the tanks, and are driven by two 2-h.p. motors.

Mixers.—There are two concrete mixers with a mixing capacity of 40 cu. ft. each for mixing the lime solution which is dumped into a trough in front of the tanks and flows through a screen of a ¼-in. mesh into the lime tanks. These mixers are driven by two 20-h.p. motors. The floor at grade 300 is sloped to a grade of 1 in 20 to drain the floor to a sump. In this sump is placed a vertical submerged pump with a pumping capacity of 200 gallons per minute against a 15-ft. head, and a suction of six feet. It is slow speed and automatic in operation. The pump and motor have a combined efficiency of 35% driven by a 3-h.p. motor.

Wash Water Pumps.—There are two of these pumps of the single stage centrifugal type with an eight-inch discharge, having a capacity of 1,600 gallons each per minute against a 50-foot head. These pumps are for the purpose of feeding the wash water tank with water to wash the filters. The water is taken from the clear water basins as it is necessary to wash with filtered water. Upward wash is used, the wash water flowing into the drain provided. These pumps are intermittent in action and are each controlled with an electrical controlling apparatus which will automatically stop when the water reaches a certain elevation in the wash water tank. These pumps are driven by two 40-h.p. motors.

Flushing Pumps.—These pumps are of the two-stage, 50-h.p. centrifugal type, with a pumping capacity of 500 gallons per minute when flushing, and operated against a pressure of 100 lbs. per sq. in. They are driven by a 50-h.p. motor.

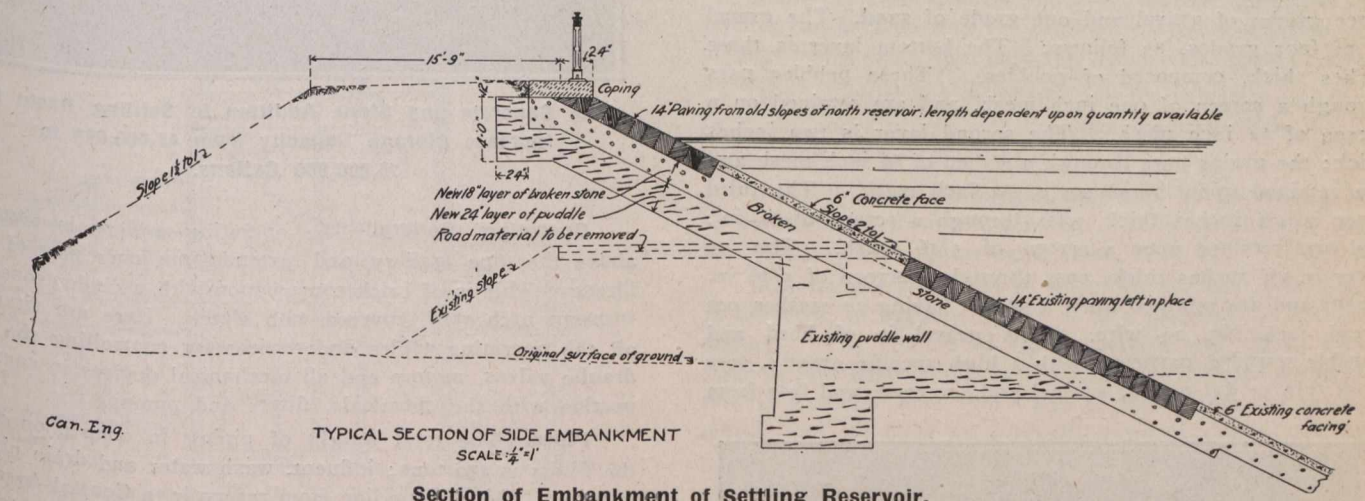
Pressure Tank Pumps.—These pumps also take water from the clear water basins and deliver water to a small steel tank in the tower of the head house. They are of the single suction type, discharging 30 gallons per minute against a head of 80 feet. They are operated by two 3-h.p. motors. These pumps are intermittent in service and are started and stopped by means of floats placed in the tank. Each float operates a Cutler Hamar series relay self-starter. It starts and stops the corresponding pump with a positive and certain maximum difference of not over six inches in the rise and fall of the water in the tank.

Sample Pumps.—There are twelve of these pumps of ¼ h.p. each with a pumping capacity of two gallons per minute against a 20-ft. head. These pumps are situated on brackets secured to the walls of the operating gallery, one under each of the 12 operating tables. They take their suction from the corresponding influent pipes near the filter gallery wall, and are controlled by switches on the corresponding table.

Lime Crusher.—The lime crusher has a capacity of 15 tons per hour, the crushed lime to pass through an iron ring of one inch in diameter.

Concrete Storage Bins.—These bins, twelve in number, are for the purpose of storing the alum, lime and hypochlorite. The various chemicals are conveyed from these bins by a bucket with a recording gauge to register the weight. The bucket travels along a suspended track to the lime, alum and hypochlorite tanks. The concrete to the storage bins is heavily reinforced with steel work. The concrete was of the 1:2:4 mix and cost $9.00 per cubic yard. The forms to this work came rather high, averaging 9 cents per square foot.

Chemical Feed Tanks.—These tanks are situated on floor grade 328, and consist of the lime, hypo. and alum



Section of Embankment of Settling Reservoir.

water, and are controlled by a set of lime, alum and hypo. controllers.

The offices, laboratories, preparation rooms, lockers, lavatories and bath rooms are on this floor grade 328.

Ash Storage.—The ash storage is located on floor grade 340.

Controlling Chamber.—This chamber is 28 ft. by 7 ft., in which is situated a venturi meter to gauge the flow of the water from the raw water basin. The chemical supply is admitted at this stage, controlled and governed by a device in connection with the venturi meter. The controlling chamber and venturi meter is of concrete.

Mixing Chamber.—This chamber is 141 ft. by 47 ft., is connected to Nos. 1 and 2 controlling chambers, and is divided into 47 spaces by wooden baffles for the water to flow around; these baffles being fixed with an alternate space at the ends. This chamber is of concrete at 1:2:4 mix, and cost $6.00 per cubic yard.

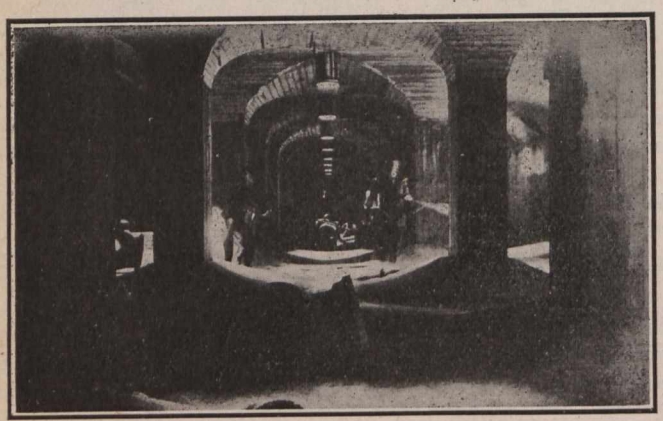
Centre Passage.—This passage is 7 ft. wide, 192 ft. long, and separates the mixing and controlling chambers from the coagulating basins, and has an upper and lower compartment. The water passes into the lower portion to the coagulation basins, and returns over a skimming weir into the upper portion of the centre passage to the filters.

Coagulating Basins.—There are two of these basins, each 120 ft. by 96 ft., with three sets of concrete baffles and two skimming weirs. These basins have a flat concrete roof supported by 126 concrete columns.

Gate House.—The location of this building is over the entire length and width of the centre passage. Here are located the controllers in connection with the valves that control the flow of water in the mixing chamber, coagulating basins and centre passage. This building is of brick construction with a cinder concrete roof covered with slate.

Filters.—The filters are twelve in number, each 28 ft. by 53 ft., situated six on either side of a pipe gallery. These filters and gutters are of concrete reinforced with ⅝ steel. The mixture is a 1:2:4, and cost $10 per cubic yard. The filters are divided into two sections with a 2-ft. 6-in. centre gutter running north and south with lateral gutters running east and west supported on the 6-inch centre gutter walls. The water flows into the centre gutter. At elevation 310.50 it passes into the lateral gutters and sprays on to the filter beds below. Each filter has a filtering capacity of three and a quarter million gallons per day. The water, after passing through the filtering medium, passes into the pipe arrangement below, through a rate controller into the clear water basins or to the clear water reservoir.

Filtering Mediums.—The filtering mediums consist of three grades of gravel and one grade of sand. The gravel is of four grades, as follows: The bottom layer is three inches thick, composed of pebbles. These pebbles pass through a screen of one inch mesh, and are retained on a screen of ⅝ inch mesh. The second layer is two inches thick; the grains pass through a screen of ⅝ inch mesh and are retained upon a screen of ⅜ inch mesh. The third layer is 1¾ inches thick, pass through a screen of ⅜ in., and are retained upon a screen of 5/16 mesh. The top layer is 1¼ inches thick, pass through a screen of 5/16 in. mesh, and are retained upon a screen having 10 meshes per lineal inch No. 20 wire. This gravel is of hard and durable rounded particles, with a high specific gravity, free from thin or flat pieces, washed and screened, and free from



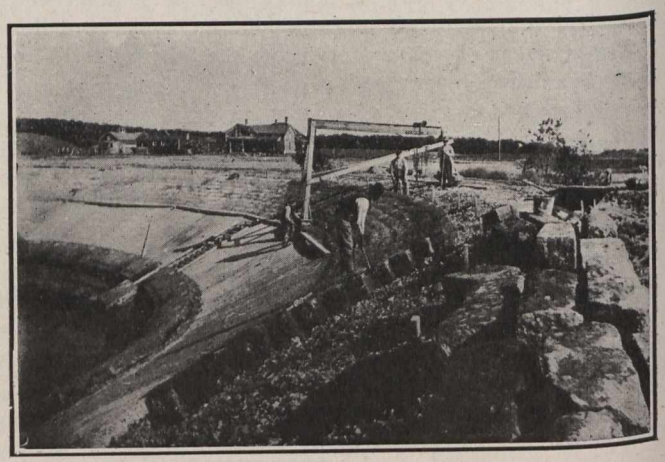
View of Groin Arches, After Removal of Forms.

sand, loam, dirt and organic impurities. This gravel, without being ground or crushed, is digested for 24 hours in cold, strong hydrochloric acid, and 95% must remain insoluble.

The filter sand is placed above the gravel, separated by a wire screen, to a depth of thirty inches, and is of a hard and durable kind, free from clay, loam, organic matter and flat particles, and stands up to a similar test as the gravel above. This sand has an effective size of not less than .35 or more than .44 of a millimeter, and a uniform coefficient of not more than 1.65. Not more than 1% is finer than .25 of a millimeter, and 90% is finer than .8 of a millimeter. The diameter of the sand grains is computed on the spheres of equal volumes, and all percentages are calculated by weight.

Clear Water Basins.—These are two in number, situated below the filters, and are 151 ft. 6 in. by 53 ft., with a concrete groin roof that supports the filters. This groin roof is supported by 26-inch concrete columns at 14-foot centres.

Pipe Gallery.—This pipe gallery is situated between the clear water basins and the filters, in which are situated the hydraulic valves, influent pipe, wash water pipe and wash water drain.



The Concrete and Stone Addition to Settling Basin to Increase Storage Capacity from 45,000,000 to 75,000,000 Gallons.

Operating Gallery.—The operating gallery is situated above the pipe gallery and extends out over part of the filters. This is of brick construction with a cinder concrete transept arch roof, covered with slate. Here are situated all the operating tables and devices for controlling the hydraulic valves, motors and all mechanical devices in connection with the chemicals, filters and pumps.

Pipes.—The total weight of piping in connection with the filters is 150 tons; influent, wash water and drain pipes, 365 tons; 48-inch pipe line from reservoir to Central Avenue, one and a quarter miles, 2,550 tons. Lead used, 80 tons; bolts, 6,500, assorted, for flange joints.

Clear Water Reservoir.—This is an immense covered concrete tank with a concrete groin roof supported by 960 20-in. concrete columns at 18-ft. centres. The length of the clear water reservoir is 877 ft. 6 in. by 413 ft. 6 in. by 24 ft. deep, with a capacity of storage of 47 million gallons. The total amount of concrete in this roof and columns was 15,000 cubic yards, put in at the following cost:—

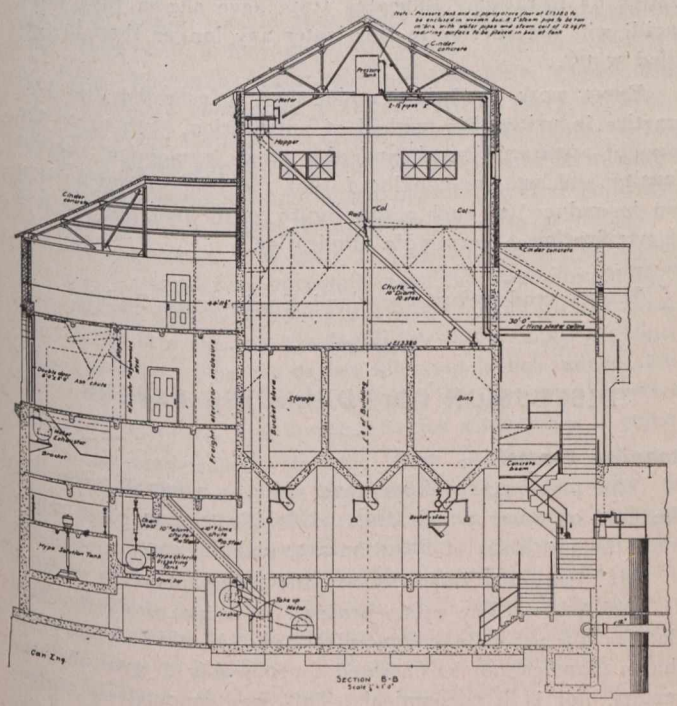
Cement	$2.00
Crushed stone	1.35
Sand	.28
Mixing, transporting, placing	.82
Form building, 2c. per sq. ft.	.10
Wrecking and placing	1.40
Total per cubic yard	$5.95

Wash Water Tower.—This wash water tower is circular in construction, 46 ft. in diameter, built of concrete from grade 296 to grade 369. Elevation 296 to 340 is used for storage rooms, and elevation 340 to 353 is for water storage. The outside facing above the grade of fill is of brickwork. This wash water tower is for the purpose of water storage with sufficient pressure for an upward wash to the filters.

Brickwork.—The brickwork facing of concrete and solid walls above the grade fill to the head house, filter building, gate house and wash water tower is laid in cement mortar. The panels are laid with dark headers and light stretchers, which give the buildings an effective appearance. All interior walls are coated with ½ inch of plaster. The cost of the labor for the brickwork was $4.00 per 1,000. All copings and window sills are of terra cotta of such a shade to blend with the brickwork.

Carpentry.—All interior doors and frames are of red oak, exterior door and frames of clear white pine; the floors to offices and rooms at grade 328 are ⅞-in. by 3-in. tongued and grooved, close grained, long leaf, yellow pine fixed to bevelled strips embedded in the concrete floor. These bevelled strips stand above the concrete 1½ inches, the intervening space being filled with cinders. A ⅞-in. by 7-in. moulded base goes around all the rooms that have lumber floors.

Laboratory and Chemical Benches.—These benches are of hard maple, made up of 1½-in. by 3-in. strips, with the thin edge up, bolted together and secured with waterproof glue. A gas machine of 150 cubic-foot capacity per hour is installed to furnish gas for laboratory purposes. The water pipe lines stand up to a pressure of 150 lbs. per sq. inch. All other pipes 50 lbs. hydrostatic pressure.



Cross Section Through Head House.

Steam Heating.—Steam heating is furniished by two boilers situated at grade 300 with a heating capacity of 1,500 square feet, capable of supplying steam for 8,000 square feet of radiation surface with a steam pressure of 25 lbs. per square inch. The radiators are of the peerless two-column type.

Vacuum Cleaner.—The vacuum cleaning system is of the rotary pump type, having a displacement of 85 cubic feet per minute when operated at a speed of 220 revolutions per minute.

Earth Fill and Embankments.—A fill is placed around the head house, filters, wash water tower and coagulation basins, from grade 301 to 323, with a 12-foot crown and a 1 in 1 slope. This embankment is to keep the water in the coagulation, filters and tower from freezing. The roof to the clear water reservoir is covered with 3 feet of earth, which will be planted and laid out in an artistic manner. The embankment to the raw water of settling reservoir has been carried up another ten feet to overcome the loss of head in the filtration plant, and to give the same pressure to the city's distribution system.

Total quantities:—35,000 cubic yards of concrete, 500,000 cubic yards of excavation, 260,000 cubic yards of fill and embankments, 900,000 pounds of reinforcement to concrete, 600,000 bricks.

Embankment and fill, watered and rolled, cost 85 cents per cubic yard. Excavations, 65 cents per cubic yard.

The accompanying illustrations show the work during construction, which was carried out under the supervision of Mr. A. W. Ellson Fawkes, C.E., chief assistant engineer on the works for the city of Minneapolis. Messrs. Hering and Fuller, consulting engineers, New York, designed the system.

PURIFICATION BY OZONE.

By R. M. Leggett.

(Continued from last issue.)

If the pre-filter removes the gross matter, the ozone will remove the bacteria and the organic matter in solution, the effluent being clear, pure and free from odor, color or taste.

Ozonization is but another name for oxidation and it is by rapid and more or less complete oxidation that the desired results are accomplished.

Ozone is allotropic oxygen expressed by the symbol O_3, as distinguished from oxygen, O_2. It is an unstable form that tends to give up its extra atom.

Bacteria are composed of about 86 per cent. water and 18 per cent. of organic matter, 6 to 8 per cent. of which is carbon. The contact of these bacteria with ozone spells their instant destruction, as the carbon is reduced by oxidation to carbonic acid, the water is freed from the organic matter and we have as a result, water, carbonic acid and nitrous and nitric oxides.

In water highly contaminated with mineral salts, these gases may very slightly increase the nitrates and carbonates, but on such a minute scale as to be hardly detectable by analysis.

It has been estimated that one million bacteria represent one-sixteenth of a milligram total weight, of which, as stated, 80 to 86 per cent. is water and the rest carbon.

The average untreated natural water contains from 1,000 to 10,000 bacteria per cubic centimeter, which represents so small an amount of carbon as to make its products of oxidation negligible.

Various devices are in use for the production of ozone, but in all, the object is to bring a current of air in contact with the silent discharge of a high-tension current of electricity.

The ozonizers in use in the Ann Arbor plant are of the tubular type, and consist of 109 tubes. They are 35 inches long and 24 inches in diameter. There are three of these ozonizers, two of which are in operation all of the time, and one is kept ready in case of emergency. The ozonizers are simply steel shells, containing 2-inch aluminum tubes, about 30 inches long, rolled in, and have the appearance of small fire tube boilers. Inside these tubes are mica tubes for the dielectrics and inside the mica tubes are other aluminum tubes. The discharge takes place between the two aluminum

tubes and the dielectric. The space in each case is about 1/16 inch, through which the air is passed.

The ozonizers are enclosed in steel tanks which have a circular dam in the middle, which forms two compartments. One compartment is the receiving end, where air under pressure from an air compressor is taken in and passed through the ozonizer. Part of its oxygen is converted into ozone and the air then passes along, as required, to the sterilizing towers.

After the air is compressed, it is passed through a cooler, thus preventing any heating of the ozonizer due to the discharge. It must be explained that only a small percentage of the energy applied to the ozonizer is utilized in the production of ozone. The greater part is lost.

Just as ozonizers are various in their form, so are, to no less extent, the means for applying the ozonized air to the water. The problem is evidently to produce a thorough mixture and in the methods in successful use there are two fundamentally different ways of doing this. In one the water is finely subdivided and passed through the ozonized air and in the other, on the contrary, the air is subdivided and passes through the water. The Ann Arbor plant belongs to the second class.

The ozonized air is conveyed to the sterilizing towers, which are built in batteries of a size to meet the capacity demanded. These towers are built on steps, with a fall of 3½ feet between each step. The water is taken in at the top of No. 1 tower, at the bottom of which are arranged suitable spray nozzles for the introduction of the ozonized air. Each tower contains four baffle plates that compel the water to travel 57 feet in each 13 feet of tower. This prolongs the contract of the water and ozone and enhances the efficiency of the system. The water leaves the bottom of No. 1 tower and enters the top of No. 2 tower, 3½ feet lower, where the same operation is repeated, and so on to No. 3 and No. 4 tower.

The chief advantages of the ozone system over any other known system of water purification lie in economy of operation, constancy of action, and freedom from costly repairs and renewals.

Nothing is added to the water to cause it to have an unpleasant taste.

No deleterious by-products are formed and odors and tastes due to organic matter are destroyed. Filtration by any means is only a greater or less reduction in the bacteria contained in the raw water. This percentage may be as high as 99 per cent. when everything is working right, but the remaining 1 per cent. in a highly polluted water may represent a grave danger. Filtration exerts no selective action. It removes the same percentage of pathogenic organism as it does of the harmless ones.

Ozone, on the contrary, has a selective action, killing all the pathogenic germs and practically all of the others. This is due to the low power of resistance to oxidation of the pathogenic germs and is confirmed by the statistics of various places where ozonization has been introduced. Paderborn, Germany, had a typhoid rate of about 1,500 per 1,000,000 population. Filtration reduced this rate to 290, and ozonization still further reduced it to zero. This plant was built in 1897 and has been in continuous operation since that time. Similar results have also been recorded in Paris, Dinard, Chartres, Nice, Weisbaden and other European cities.

In conclusion, it may be stated that any municipality using surface water may render this water safe by ozonization properly applied as outlined above.

THE ELECTRIC PURIFICATION OF WATER.*

By D. D. Vincent.

The pollution of the sources from which our great cities draw their water, and the sickness and loss resulting from the use of impure water, has drawn the attention of scientists and engineers to the various methods proposed for the purification of such water as is available.

Your attention is invited to the electrical purification of water, as practised by the Electra Pure Water Co., of this city, with which I am associated, as this method produces an ideal table water, free from organic matter, but not devoid of the necessary mineral salts.

Water purified by this process is taken from the city mains under pressure and passed between aluminum plates which are connected to a suitable source of electrical supply. It is then filtered through crushed quartz while still under pressure. We do not know to-day all of the changes which take place in the presence of the current. We do know, however, that a small percentage of the water is decomposed and that the organic matter in the water is oxidized and coagulated by the oxygen which is released and that the hydrogen combines with minerals in solution forming flakes of solid matter which can be removed with the organic matter by filtration. Repeated tests have shown that colon bacilli will not survive in this water any longer than in distilled water.

Exact work is being undertaken to establish the best practice in using this method of purification, both as to the form of apparatus used and the most economical current density and we are convinced that the cost of purification can be reduced to such a low figure as to give this method of purification a very wide application.

*Paper read before Cleveland Engineering Society.

DISCUSSION ON FOREGOING PAPERS.

Langdon Pearse*:—

The previous speakers have given a general review of the field of water purification. Mr. Pratt has shown you what the processes of filtration are, and the cost.

Mr. Leggett's paper covers the ozone plant as erected at Ann Arbor. The ozone process, as a means of sterilization, is not yet on a commercial basis in this country, in that a plant cannot be operated continuously to give uniform results, nor is it economical. This was conclusively shown by careful independent tests, made at Jerome Park reservoir, for the city of New York several years ago. Sterilization by hypochlorite of lime is much cheaper and more dependable. Ozone treatment was considered for the city of Montreal, but Messrs. Hering and Fuller in their report distinctly state that it is not yet on a basis to mertit recommendation.

The paper by Mr. Vincent describes a process for the purification of water, based on making electrolytically aluminum hydrate. Instead of adding sulphate of aluminum the hydrate is made by passing an electric current between two plates. This simply coagulates the water, and a filter is essential both to remove the turbidity and the bacteria. There is no virtue in the electric current. It is cheaper to buy the sulphate of aluminum and apply it in the usual way. In the Louisville report, in 1896, Mr. George W. Fuller ex-

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amined this general process very carefully, with extended tests, and concluded that it was impracticable, and extremely uneconomical.

Sanitary engineers to-day recognize that the only tried and effective means of treating a water supply to remove bacteria and turbidity, are sedimentation followed by slow sand or rapid filtration. A coagulant may be used at times with a slow sand filter, and is always required for the rapid filter. As a finishing process, chloride of lime is available to sterilize. Alone it serves as an emergency process. It does not affect the turbidity.

The situation in Cleveland is of great interest to me, as I represented Mr. Whipple for two months, in 1903. I have followed the situation since. At that time we felt that filtration would undoubtedly be required. How soon, we could not say, as the four-mile crib had only been in operation two or three months, and the sewage had not been intercepted, as originally planned. With the data available, Mr. Whipple reported that filtration would probably be required in a few years. Even if the sewage was removed from the Cuyahoga and the water front and discharged at a point some nine miles to the east of the crib, the crib would still be exposed to occasional pollution. Sewage is still flowing into the Cuyohoga in amount some 40 per cent. of the entire discharge.

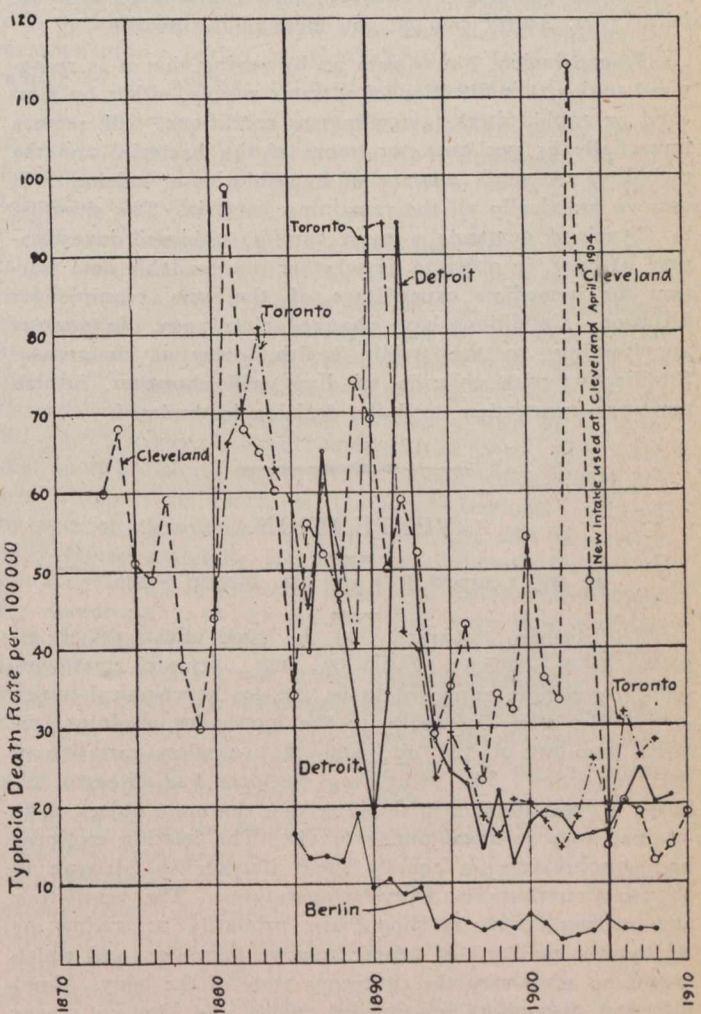
Personally, I have never understood why the four-mile crib in Cleveland was located directly in front of the Cuyahoga, even though four miles off shore. Recent tests for the Lake Michigan Water Commission have shown that under favorable conditions a sewage stream may work out even ten miles from shore before finally dispersing. The Cleveland water supply is turbid at times, and is undoubtedly open to suspicion on the ground of bacterial pollution. I have not had a chance to examine the data at hand. I do feel, however, that if there is conflicting data, all hands should get together at once and urge the appointment of a disinterested expert, a sanitary engineer of high standing, to examine into the case in the light of developments since 1903, and report whether or not filtration is not immediately advisable, particularly as the sewage has not been diverted from the Cuyahoga, and may not be for some years to come.

In the meantime, systematic data should be collected daily, particularly on the turbidity of the lake water, as taken from the tunnel at Kirtland street pumping station, its temperature, alkalinity, and bacterial content, in order to have data on hand to help in determining the filter problem. Possibly Mr. Pratt proposes to do this. It would also be very easy for him, in connection with a sewage experiment station, to build two or three small experimental water filters, and try out slow sand and mechanical filters at Kirtland street, in order to have a line on their adaptation to Cleveland conditions.

About eight months ago, in a talk at Detroit, and later before the Illinois Water Supply Association I showed a diagram on which was plotted the typhoid fever death rate of Detroit, Toronto, Cleveland and Berlin. Toronto and Cleveland both have an uneven rate. Berlin has a rate extremely low and consistently so. (See diagram.) At that time I pointed out that the Cleveland supply was open to suspicion. From what I have heard during the last two days I am convinced that immediate steps should be taken to determine whether filtration is required, at once, and to make the proper moves to finance the project, if it is required. Chloride of lime is an excellent emergency expedient to sterilize the water, and is now in use at the temporary plant.

With the modern standards of sanitation it is essential that a city have a clear water supply, always free from turbidity, and above suspicion of bacterial pollution. This is not only a valuable asset, an advertisement of progressiveness, which appeals alike to commercial men and homeseekers, as well as to residents, but is also a distinct gain to the public health, since abundant statistics point to a marked reduction in the general death rate with the accompanying reduction of the typhoid rate, when a pure water supply is introduced. The yearly saving in lives, if estimated at $5,000 each, would easily pay the interest on the cost of a filtration plant in many cases. If 40 lives can be saved yearly, this would amount to $200,000, which capitalized at 5 per cent., is $4,000,000.

The situation in Cleveland is not unique, but is a common one around the Great Lakes to-day, where a city has to



Typhoid Fever Death Rate per 100 000 at Cleveland Detroit Toronto and Berlin

discharge its sewage into the source of water supply. Chicago is the only city which can successfully divert the sewage. That is the scheme we are following to-day, as laid down by Mr. Hering in 1885. Recent investigations have shown that, with the unexpected increase in industrial wastes as well as human pollution, the rate of 3.3 cubic feet per second per 1,000 population is not sufficient. We feel, however, that the work was excellently planned, and has fulfilled its purpose. A recent report by Mr. Wisner, our chief engineer, has outlined the means open to us to increase the dilution capacity by settling the sewage in Emscher tanks. Some work must be done at once on the industrial wastes and the city sewage, since the capacity, in accordance with our legal ratio of dilution, will be exhausted in 1922. We have been operating a testing station

for over two years, and carrying along preliminary studies in the various schemes.

Milwaukee is now facing the problem. There the entire sewage of the city is flushed out into the lake, two and a half miles from the water intake. Filtration of the water has been recommended, with the removal of the sewage from the river and its diversion to a point about nine miles from the intake, where, later, settling basins, and finally, sprinkling filters will be required.

In Toronto the water supply is to be filtered, with slow sand filters, recommended, by the way, by Messrs. Hazen and Whipple, and the sewage is to be diverted to a point some three and a half miles to the east, where it is to be settled and perhaps disinfected before discharge into the lake. Dr. Amyot can tell you more of the details.

In conclusion, I may sum up by saying that it is recognized to-day that filtration of a water supply, either by slow sand or rapid filters, according to conditions, will remove impartially 95 per cent. or more of the bacteria, and the turbidity. A small amount of hypochlorite of calcium will remove practically all the remaining bacteria. The situation in Cleveland demands a most careful, unbiased investigation, at once, in order to fix whether the available data warrant the immediate expenditure of the sum required for filtration. Conditions have changed since 1903. In matters appertaining to the public health, delay is dangerous. Sterilization with chloride of lime will, however, furnish temporary protection until the decision is rendered.

VENTILATION.

By Dr. Leonard Hill and Dr. Martin Flack.*

The authors remarked that the good effects which resulted from efficient ventilation and open-air treatment, though generally supposed to be due to the chemical purity of the air, were due really to the movement, coolness, relative humidity of the air, and the ceaseless variation of these qualities. The ventilating engineer had hitherto followed a great illusion in thinking that the main object to be attained was chemical purity of air. The heating engineer had sought after an equally great illusion in striving to obtain a uniform summer temperature. The ventilating and heating engineers should aim primarily at giving air which was cool and of proper relative humidity, and which moved so as to vary the cutaneous state of the body. Comfort and discomfort in crowded rooms and shut-up places depended, not on the chemical purity of the air, but to a minor degree on the influence of the smell of the air on the olfactory sense, and, to a vast degree, on the influence of the temperature and relative humidity, and the variations of these qualities of the air, which acted on the great field of cutaneous sensibility.

The chemical purity of the air might be considered from three points of view—the concentration of carbon dioxide, the concentration of oxygen, and the supposed presence of organic poison exhaled by the breath.

Owing to the fact that a percentage of carbon dioxide exceeding a very few parts per 1,000 was not legally permissible in factories, it was commonly supposed that any greater excess acted as a poison. The truth of the matter was quite otherwise, for whatever the percentage of carbon dioxide in the atmosphere might be, that in the pulmonary air was kept constant at about 5 per cent. of an atmosphere by the action of the respiratory centre. It was impossible any excess of the gas should enter the body even in breathing the air of the worst-ventilated room, in which the percentage of carbon dioxide assuredly did not rise above 0.5 or at the outside 1 per cent.

The oxygen in the worst-ventilated theatre, school-room, or chapel was never lessened by more than 1 per cent. of an atmosphere, but all the evidence went to show that only when oxygen was lowered below a pressure of 14 to 15 per cent. of an atmosphere did signs of oxygen want arise. A diminution of 1 per cent. of an atmosphere had not the slightest effect on health or comfort.

There was no positive evidence which demonstrated the poisonous nature of the condensation water obtained from the breath, as suggested by Brown-Sequard and d'Arsonval; further, there was at present no trustworthy evidence of the existence of any such poison in exhaled air.

As to the general principles which ought to control the practice of the heating and ventilating engineer, the old English methods of open fire and open window had very much to recommend them. By the open fire air was kept moving and cool air was brought in; the heating was by radiation, and uniformity of the conditions of temperature in the room was prevented. On the other hand, the impulsion of hot air into a room was the most objectionable of all the systems employed. A cool air and radiant heat were the ideal; the hot air system gave neither. In cold weather the heated air became excessively dry; the vigor and health of children in America had been seriously undermined by the impulsion of hot "desert air" into the schools.

Uses of Ozone.—In the concluding part of their paper the authors discussed the uses of ozone in ventilation, basing their remarks on experiments carried out with an ozonizing apparatus put at their disposal by the Ozonair Company. They stated that by the smell concentrations of ozone of far less than one part in a million could be detected, and the gas should be present in the air for continuous breathing in concentrations not greater than that scarcely perceptible to the smell. Concentrations of even one part in a million were too irritative. Very weak concentrations, barely perceptible to the smell, had no ill effects, but destroyed the effect of unpleasant smells and gave a certain tang or quality to stuffy air which relieved its uniformity. It was in this respect that ozone had its use. There existed in modern conditions of life so many trade shops, tube railways, cold meat stores, etc., where the employes were exposed to a persistent, uniform, and depressing smell. The air in many buildings was made to smell by the heating appliance used. The addition of ozone took away the smell and relieved the monotony of such air, and as the Ozonair apparatus could, by the turning of a switch, be put in or out of use, the uniformity of the atmospheric conditions could thus be frequently changed. The ozone, no doubt, exerted its effect both on the cutaneous and respiratory nerves. They thought that the addition of ozonized air to the Central London Railway had improved the conditions, the unpleasant characteristic smell of the tube being diminished, and the monotonous quality of the air improved.

* Abstract from a paper read before the Society of Arts, London, Eng., on "Influence of Ozone in Ventilation."

The Harbor Commission, Los Angeles, Cal., have decided that the harbor improvements, consisting of a 2,600-foot fireproof wharf and wharf structures are to be constructed of reinforced concrete.

ECONOMIC LIMITATIONS UPON THE DEVELOPMENT OF TRANSPORTATION BY ELECTRIC RAILWAYS.*

By Guy E. Tripp.

The evolution of electric railways from the horse cars, cable cars and steam dummies of the late 80's has produced many changes in our social and industrial life. The man who formerly had to locate his home near a steam railroad line that he might go to the city each day with certainty and comfort while his family enjoyed the benefits of suburban life can now locate almost anywhere within a reasonable distance and be served safely, cheaply and expeditiously by the electric street railway. This has produced a complete change in the distribution of the suburban population of our cities and has added greatly to the value of land which was hitherto comparatively inaccessible, and the electric transportation system has become so indispensable to every large city that the loss of its service would be a public calamity which would paralyze a large part of the city's industries. Electric transportation has, in fact, become so closely interwoven in our social and economic fabric that any attempt to adjust its financial or administrative problems is far reaching in its effects and provokes vigorous opposition. It is as when one touches a spider's web; the spider is sure to rush from a dark corner to devour the disturber.

It has been generally realized for a number of years that, while some favorably located street railway properties have made a satisfactory return on the capital invested in them, many are on the border line, so to speak, while others again would show an actual deficit if their accounts were carefully analyzed and all reserves provided; yet so fearful are we of public opinion, so willing to let sleeping dogs lie, that little active and concerted effort has been made to adjust such cases and to put the properties upon a firm financial footing.

The electrical traction business was an unknown field when the horse railroads were electrified, and it has grown so rapidly during the past twenty years that its promoters and operators did not realize that in the enormous extensions of track and mileage and improvement of service they were giving the public quite another commodity than that which had been furnished by horse car lines. Settlements were made beyond the ends of lines, which soon required further extension, and the process was repeated; so, step by step our city systems have extended out into the country until, in some cases, they reach to a distance of 10 miles from the centre.

At the beginning most of the patrons of these lines lived near the city, but as the territory gradually built up the centre of density kept moving toward the outer end, constantly increasing the average haul. Further than this, the people were not satisfied with being carried to the centre of the city; they demanded that they be carried to any portion of it that they might elect; that is, that they be given transportation from any part of the system to any other part. In many cases, however, this service was traded for something else or was a wholly voluntary concession on the part of the street railway. This demand was met by the free transfer, which introduced a condition which did not exist to any considerable extent in the old horse car days and which has contributed more than almost any other single factor to the increasing cost of operating our city roads. With all these changes there has been no change in the rate of fare.

The Increase of Haul and the Transfer.—The pushing out of the centres of population and consequent increase of average haul at a fixed rate of fare and the universal transfer are the most subtle and most difficult factors to isolate and to which assign a value—much more so than mere over-extension of trackage.

It is evident that all these changes must have increased relatively the expenses of operation, but this increase has been somewhat obscured by improvements which have been made in engines, generators, motors and, in fact, in all street railway apparatus, which have tended to reduce the cost of operation and maintenance. While the operating ratio of individual companies may have shown considerable variation over a period of years, there has been no marked change in the average ratio of all companies.

This evolution in the service has also, of course, necessitated corresponding increase in the equipment, so that the investment has grown rapidly, more rapidly, in fact, than have the earnings.

The attitude of the public toward the transportation companies has changed as their service has become irrevocably established. In the beginning the agency which furnished transportation so much more rapid and for so much greater distance than had previously been possible was courted and favored. Every inducement was offered to attract anyone who was ready to electrify an existing system or to build into new territory. Small communities vied with each other in their efforts to attract extensions which would put them within easier reach of the larger sections. Almost any sort of construction and almost any sort of service was accepted gratefully and under this stimulus lines were built long before they should have been from a sound business standpoint; and the deficits that have thus accumulated must be met either by the public or by the investor who fails to receive a fair return from the beginning. The public, however, has withdrawn from the old partnership, leaving its partner to pay the debts of the concern while it retains considerable jurisdiction over the assets, upon which it proposes to base a new deal.

The efforts of the public service commissions and of the legislatures have been to secure more and more for the public, which means less and less for the transportation company. Such an attitude is but natural in light of their conception of their duty to protect the public and to advance its interest solely, while the railroad is left mainly to defend itself and its investors. It is unfortunate that many people seem to think that a public service corporation is subject to economic laws which are different from other lines of business. Now, an electric railway property is not an eleemosynary institution; it is a business enterprise. In the last analysis it is a manufacturing concern. Its product is transportation and its customers are the people who ride upon its cars. It is governed by the same economic laws as any other line of manufacture. In order that any growing business may prove a commercial success its earnings must be sufficient to pay the operating expenses and maintain the property in good condition, to meet taxes and similar charges, to replace worn-out or discarded equipment and to yield a return on its capital which is of sufficient amount and sufficiently stable to attract such additional investment as is required by the growth of the business. If all these conditions are met over a period of years, the business will prosper. If one or more of them cannot be met, the success of the whole enterprise is in danger.

*Abstract of paper delivered to American Electric Railway Association, January 26th, 1912.

The street railway business requires larger amounts of capital than it is possible to supply from its earnings, and we must turn to the investing public to secure the funds necessary; and there is nothing which attracts the public to an investment in street railway enterprises in preference to other lines of business. If the profits of the business are decreasing beyond that point, what is to be done about it?

Economies in Operation.—It is evident that the returns will be increased if we can reduce the expenses without changing the earnings or the investments, so during the last decade the efforts of every street railway manager have been directed toward securing economies in his operation. Power stations, transmission lines, car equipment, carhouses —every part of the system has been considered with a view to reducing the cost of operation and of maintenance, and the savings effected in these directions have been very satisfactory; but, as I have pointed out before, the average length of haul at the same time has been increasing steadily with a consequent increase in the cost of operation. Further than this, the cost of living has been increasing, so the final result has been that the gain by economy has been practically offset by the increase in the expenses which were beyond the control of the management. The forty-third annual report just issued by the Board of Railroad Commissioners of Massachusetts shows an average percentage of expenses to earnings in 1902 of 67.75 per cent., while that of 1911 was 65.35 per cent. I think you will agree with me that an improvement of a little les than 2½ per cent. in nine years is not, by itself, of great economic significance.

It is evident, too, that the return on the investment will be increased whenever we increase the earnings of the property without a corresponding increase in the expenses and investment. This, however, would have to come from an increase in the rate of fare, or by reducing the amount of transportation which is given for a single fare; that is, we might adopt some form of zone system or we might charge a passenger for a transfer. These sources of relief have been tried to only a very limited extent in this country.

The third factor entering into the return on the investment, and one which is not generally understood, is the ratio which the investment bears to the gross earnings of the business. Many know, in a general way, that in a street railway the investment may profitably be four or five times the gross earnings, but it appears not to be so generally understood that this ratio varies with the operating ratio of the business, and will increase or decrease as the operating ratio goes up or down, moving always in the opposite direction.

I believe there has been a decided increase in the ratio of investment to gross earnings (and please note that I say investment and not par value of capitalization) in our street railway enterprises. I base this idea largely upon the returns which are made to the Massachusetts Railroad commissioners, for these returns are unusually complete; they cover companies doing a railway business only and the capitalization is carefully supervised by the Railroal Commissioners and is based on the investment in the property.

Ratio of Investment and Earnings in Massachusetts.—I find that in 1891 the net investment in the traction system of the State was approximately $27,500,000, while the gross earnings for that year were $8,900,000, so that the investment was 3.1 times the annual gross earnings. Ten years later, in 1901, the investment was approximately $99,500,000 and the earnings $23,000,000, so the investment was 4.3 times the gross. In 1911 the investment was $172,100,000, and the gross earnings approximately $37,000,000, a ratio of 4.65 to 1. This increase in the investment ratio without a marked reduction in the ratio of operating expenses has, of course, produced a reduction in the amount available for interest, depreciation and similar charges and, since the property must be maintained, it must mean that the return on the investment has been reduced.

For example, a company earning $100,000 in 1891 represented an investment of 3.1 times the gross, or $310,000. If we assume the operating expenses at that time were 70 per cent., $30,000 was left to take care of taxes, interest, depreciation, etc., this being 9.65 per cent. on the investment. In 1911, however, a company earning $100,000 gross would have an investment of $465,000 and, if operated for 65 per cent., there would be $35,000 to apply against the above charges, which is at the rate of 7.55 per cent. of the investment.

The profit may be improved by proceeding along one or all of three general lines. We may reduce the ratio of the investment to the earnings, or reduce the operating expenses, or increase the earnings, and if we can do the last without an increase in the investment, we will have accomplished the first automatically; that is, the ratio of investment to earnings will be reduced. You will agree with me that we cannot reduce the investment which we have already made and I am slow to believe that our effort to reduce expenses will be more successful in the future than in the past. Trackless trolleys, pay-as-you-enter cars, campaigns against accidents have promised good results, but the effect of their adoption has not been marked. I believe that our city lines cannot secure additional business at a rate of investment less than the present average. It would seem, therefore, that the only solution of this vexing situation, and the one which will put the street railway business upon a firm and equitable basis, is a readjustment of our system of fares. Just what this readjustment should be I am not prepared to say, but I believe that the situation should be well understood, and an educational campaign should be carried on. The problems which confront us are not new. The horse railroads had the same difficulty and their fares were made 6 cents or 7 cents or 8 cents or 9 cents, as circumstances justified, and the people paid these fares, not without grumbling, it is true, but nevertheless they paid.

Effect on Electric Railway Development.—I have seen it stated that there has been a decided letting up in the development of electric railway enterprises during the last ten years, and tables showing the total mileage of electric lines in this country have been quoted to show that this is the case. Statistics of this sort are extremely difficult to obtain and still more difficult to check with accuracy, but I am inclined to believe that the figures quoted do not fairly represent the conditions; for instance, this table shows an increase of only 1,200 miles in the total trackage from 1907 to the end of 1910, yet the statistics published each year in the Electric Railway Journal show that during this same period almost 3,400 miles of new track were constructed. To bring this up to date we must add approximately 1,000 miles constructed during the year 1911, so it would appear that during the last four years over 10 per cent. has been added to the total existing track.

I have tried to analyze these figures somewhat; and, while the results are probably somewhat inaccurate, I think they show fairly well the conditions which exist. In 1907 the interurban mileage was rouhhly one-fifth of that in the cities, and during the four years I have mentioned the addition to the city track was 2,048 miles, or approximately 7 per cent., while the addition to the interurban was 2,419 miles, or approximately 43 per cent. As I said before, these

figures may not be strictly accurate, yet I believe they show fairly the conditions which exist.

One of the essential differences between the ordinary interurban and the city lines is that the former bases its fare upon the number of miles the passenger is carried, and is thus able to proportion its charge to the service it gives, while the city line operates upon a fixed fare and hence is often forced to take business upon a losing basis. Furthermore, our city governments and our railroad commissions have as yet failed to give the interurbans the same strict supervision that they have to the city properties, and this has tended to make the interurbans more attractive. I believe we are justified in saying that we have probably reached the limit of economic development of our city lines on the present fixed rate of fare, and not only that but further, if existing taxes, prices and service are not to be reduced, there must be a readjustment of the fixed 5-cent fare and universal transfer in order to insure a fair return even on the present investment.

SOME REFRACTORY SUBSTITUTES FOR WOOD.

At the meeting of the American Society of Mechanical Engineers held in Boston, November 16, 1911, the Boston Society of Civil Engineers and the Boston section of the American Institute of Electrical Engineers coöperating, a paper was presented by Prof. Charles L. Norton, Mem. Am. Soc. M.E., of the Massachusetts Institute of Technology, on Some Refractory Substitutes for Wood. An abstract of the paper follows:

The common use of wood in and around our buildings is responsible for a considerable part of the annual fire loss, and the discovery or invention of a satisfactory substitute which would possess the desirable properties of wood and yet be non-combustible has been long hoped for. It is clear that in order to be accepted as a substitute for wood in building construction, a new material must approximate in lightness, strength, elasticity and ease of working, the natural woods, and further, since the variation in natural woods fits them for special details of construction, the substitute must be had in different grades of hardness, toughness, fineness of texture, etc. Moreover, the ease of working, sawing, boring, nailing and so on, leads to a wide use of natural wood, and a substitute to be acceptable must approximate the ordinary natural woods in these respects.

Many of the earlier attempts were made in the direction of altering the natural wood by some chemical treatment, so as to make it ignite with greater difficulty and burn more slowly and without much flame. These processes afforded a number of so-called fireproof woods. The principle underlying the chemical treatment was usually one of two. First, the wood was saturated with a solution which, on drying, left in the pores a salt capable of giving off a gas when heated, this gas being of such a nature as to be incapable of supporting combustion. Phosphate of ammonia and tungstate of soda were extensively used for this purpose. With thorough saturation the protection afforded the wood and adjoining portions of the structure was by no means insignificant; specimens of wood treated with phosphate of soda have been in the possession of the author for more than ten years, and after ten yearly tests show no signs of deterioration. Similarly some specimens of wood and cloth treated with tungstate of soda in 1903 have shown little or no loss in fire resistance. The main value of such chemical protection lies in its diminishing the volume of the resulting flames. When once thoroughly ignited, the fireproof wood burns more briskly than the natural untreated wood.

The second method of chemical treatment was one in which such substances as alum were used in order to supply a considerable quantity of steam from the water of crystallization and also to encase the pores of cells with a solid refractory substance.

A still earlier procedure was that of protecting wood from contact with a combustion-supporting atmosphere by coating it with thin sheet metal, usually tinned iron or copper. For doors and shutters this was found very effective. More recently hollow metallic members for doors and trim and for furniture have been extensively used, with a considerable degree of success. They are, of course, non-combustible, and under ordinary exposure keep their shape fairly well.

The wooden lath is without doubt responsible for the rapid spread of fire in many buildings of the older types of construction, and the attempts to develop a substitute have resulted in the metal lath and in the so-called plaster boards. The former are eminently satisfactory as substitutes for wooden lath, their greatest defect being their liability to become weakened by corrosion in damp places when used with certain kinds of plaster. The plaster boards are made of plaster of paris and some fibrous binding material, often wool, hair, or jute. Some are made of superposed layers of wool, felt and plaster. All, however, contain so large a percentage of plaster or other non-combustible material that combustion proceeds very slowly.

There have been from time to time, in the last 30 years, attempts to make use of boards composed only of refractory, inorganic substances. In general, such boards have been composed of some fibre and a cementing medium. The most popular fibres for this sort of experimentation have been asbestos and mineral wool, the cements used including about all the common cements of both the air drying and the hydraulic types. Oxychloride of magnesium, the value of which as a cement was discovered some 50 years ago by Sorel, has been the favorite cement for experimenters because of its simple preparation, its quick hardening and great strength. For some reason, however, a large percentage of the oxychloride cement is variable in its properties and often defective. When mixed with sand or similar dense bodies the oxychloride is often satisfactory for long periods, but the experience of the author with mixtures of this cement with fibres, both organic and inorganic, leads to the conclusion that it is unstable and unsatisfactory. This is more probably the case when the boards are used in damp places or out of doors.

There next appeared a number of wood substitutes in which a fibre was bonded by silicate of soda, commonly known as water-glass. Some were made in this country, but the most serious attempts were made in England and Russia, where the Imshenetzky process was used to make a board called uralite. It was the most satisfactory substitute for wood which had appeared up to that time. Uralite was composed of a sheet of asbestos millboard saturated with a solution of silicate of soda, which was subsequently precipitated as colloidal silica by a solution of bicarbonate of soda. For some reason not connected with the physical or chemical properties of the material, uralite has practically disappeared from the market. There have appeared from time to time a number of patents for boards composed mainly of fibres and lime, but no great use seems to have been made of them.

After much study two conclusions seemed inevitable to the author: First, no homogeneous inorganic substance was likely to prove satisfactory, but that a mixture of a fibre

and a cementing substance was necessary to give wood characteristics to the material; and secondly, a mixture of asbestos fibre with one or two cements (first oxide of magnesium or calcined magnesia, and second calcium silicate and aluminate mixture) seemed more suitable than any other combination.

The author proceeds to describe what he calls asbestos wood made under his patents and developed from the application to mixtures of certain processes of mixing, pressing and curing. It is stated to be practically incombustible, harder than natural woods, to have a transverse strength about two-thirds that of white pine with the grain, and, without being brittle, an elasticity less than that of natural woods; the coefficient of thermal conductivity has been found in English units to be between 50 and 30 B.t.u. per sq. ft. per 24 hours, per 1 deg. Fahr.

The weight of the several grades of asbestos wood 1 in. thick varies from 8 lb. to 13 lb. per sq. ft. White pine 1 in. thick when dry weighs approximately 3 lb. per sq. ft., and oak about twice as much. The transverse strength of boards and the maximum fibre stress is between the limits of 5,000 lb. and 10,000 lb. Test specimens 12 in. wide, 12 in. long and ¼ in. thick, broken by centre load when supported on two edges with 11 in. span, broke on an average at 200 lb. load. Under the same conditions clear white pine broke under a load of 300 lb. with grain and 20 lb. across it. In some cases the equality of strength in both directions is of great advantage.

The tendency of the material to absorb water varies between the limits of 4 per cent. and 20 per cent. This absorption is not of such a nature or amount as to cause disintegration from freezing and the material is not injured by prolonged soaking in fresh water. Sea water tends to disintegrate it after a time, the magnesium salts in the water replacing the calcium of the cement.

The coefficient of expansion varies with the temperature and also with the age of the specimen. It is small, being about 0.00004 at ordinary temperatures, diminishing rapidly at 700 deg. Fahr. and becoming negative at 950 deg. Fahr. where shrinkage occurs.

The operations of boring, sawing and finishing are all somewhat more difficult with asbestos wood than with the natural woods. It withstands scraping and rubbing much better. Floors and stair treads made of the material wear well, but are liable to be slippery when wet.

Many of the common wooden details of modern buildings have been successfully duplicated in asbestos wood, doors usually being hollow to save weight. Wherever there is danger of ignition of wooden framework a lining of the material has been found effective, notably in the vicinity of electric apparatus. It has been found best to mold the sheets while still in a plastic condition so as to form large pipes or ducts, and many locomotive round-houses have been equipped with smoke jackets or ventilating hoods. Shingles which have been in the weather for years have proved durable and this quality seems certain to equal that of fire resistance.

The ability to stand heat makes it available for blocks on friction brakes where a flexible material is not needed. The coefficient of friction of iron is approximately 0.3 to 0.4.

It has also been used as a mold for glass utensils during the process of manufacture, its non-conducting properties making it preferable to iron in some instances.

It is, of course, the fire resistance of the asbestos wood which gives it its greatest interest. There is nothing combustible in it, and on exposure to fire nothing can occur except a gradual dehydration of both fibre and cement. Under prolonged red heat the boards become weakened, but for such exposures as occurs in fires in buildings the resistance is ample. For instance, a sheet of ¼-in. asbestos wood may be placed over the top of an open furnace at 1700 deg. Fahr., the flame impinging directly on the lower surface of the sheet, and at the end of half an hour the sheet may be taken off and while its lower side is still white hot be plunged into cold water and then returned to the furnace for 10 minutes. It may be slightly warped and its strength will probably be diminished 25 per cent. or more, but it will still be sound and whole and free from cracks or serious weakness. Fire tests have shown the ability of the material to withstand much longer exposure, but it is not suitable for linings for furnaces or kilns which are kept constantly at red heat. In some fire tests the paint on the outside of an asbestos wood door 1¼ in. thick was not scorched after the fire inside had been burning at a temperature of 1700 deg. Fahr. for more than an hour.

BRITISH COLUMBIA'S MINERAL PRODUCTION.

An estimate of British Columbia's mineral production has been prepared by Mr. W. F. Robertson, provincial mineralogist, which is really a prelminary review of the progress made in 1911, with an approximate estimate of the quantities and value of the province's several mineral products.

The estimated mineral production is $23,211,816. If the revised statement which is made up after the receipt of all mining returns shows this amount to be approximately correct, it will then be seen the amount was smaller than that of 1910 by $3,165,250, and less by various amounts than that of any year since 1905.

The curtailment of ouput is attributable for the most part, if not entirely, to the effects of the strike of coal mine employees in the Crow's Nest district of South-east Kootenay. The suspension of work at the mines and coke-ovens lasted for practically two-thirds of the year, and prevented the production of coal and coke during that period to an extent that involved a decrease in value from East Kootenay alone of nearly $3,000,000. If to this be added the decrease in value of the production of metals of one copper producing company alone—as compared with 1910, of $1,600,000—which was the direct result of the cutting off of the supply of coke for its blast furnaces, there will be obtained a total decrease of more than $4,500,000, which was an immediate consequence of the labor difficulties at the Crow's Nest collieries.

There were other temporary obstacles to production being maintained at the ordinary rate which also in a lesser degree accounted for a decrease in the output, these either have been overcome or are likely soon to be removed. Meanwhile a settlement has been made of matters that were in dispute between the coal-mine operators and their employees, thus by the end of the year the normal output of coal and coke was being gradually restored.

British Columbia's proportion of the mineral production of Canada is comparatively large. The whole value of the production of this province to the end of 1911 is approximately $397,000,000, since the published official records of the whole Dominion do not include production prior to 1886, the present comparison must be confined to the period of twenty-six years—1886-1911. Placing the aggregate for the whole of Canada at $1,245,000,000 (which allows for 1911 a Dominion total of $115,000,000, an amount $10,000,000 greater than that of 1910), and British Columbia's proportion for the same period at $333,000,000, it follows that this Province has to be credited with nearly 27 per cent. of the value of the mineral production of the whole of Canada in the twenty-six year period under notice.

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The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

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HYDRAULIC TURBINE DESIGN.

The recent failures of water-wheel casings, as a result of which great damage was done to the power houses and electrical equipment, bring to mind the fact that water-wheel design is as yet in an elementary condition as regards the handling of certain features by the hydraulic engineer. The failures in question and the attendant results were caused by the breaking of the wheel casings. There is little excuse for failures of this nature with the present state of hydraulic theory and structural design.

A few years ago failures of this nature rarely occurred. Now, however, they are becoming increasingly frequent in number. The reason for this increase is hard to see, for the theory of turbine design has advanced very rapidly, until now we have reached a state of near perfection with regard to efficiencies, etc. Likewise, our knowledge of the strength of materials and the stresses induced has developed. Too little account, however, is paid by the manufacturer of hydraulic turbines and the hydraulic engineer to the new conditions which have arisen in connection with water-power development. Many plants are being installed having long penstocks, and these inevitably cause trouble unless handled properly. The difficulties of regulation caused by long feeder penstocks are hard to deal with, and as a result the manufacturer and the engineer have left the question to solve itself. Many plants are now struggling along with practically no regulation on account of the above. Difficulties other than regulation are liable to develop as in the above noted failures. The vibrations and oscillations set up in the penstocks as a result of change of load, or load thrown off, induce excessive pressures in the penstocks and wheel casings. When no account of such excessive pressures is taken, or means furnished to relieve the condition by the installation of relief valves, bursting plates or standpipes, trouble will certainly develop.

In a design which came to the writer's attention recently a small bursting plate was placed at the lower end of a penstock 1,500 feet long, and this was the only provision made for safeguarding the penstock and wheel casing. The specifications for the water-wheel governors did not state the minimum time allowed for full closure of the gates. On investigation it was found that the governors would have to be set for minimum time closure of eight seconds to ensure safety to the penstock. With conditions such as these, is it any wonder that the failures of wheel casings are increasing?

In order to prevent serious criticism, hydraulic engineers must pay more attention to this feature of power plant design. It is often cheaper and easier to neglect the regulation side of the design, but it will be usually found that such neglect is very costly in the end to the power plant owner as well as to the reputation of the engineer.

WATERPROOFING OF CONCRETE.

The waterproofing of concrete has become very important on account of its widespread use in building and engineering construction. For some time the opinion of engineers who have paid some attention to this phase of Portland cement and concrete has been that little benefit is gained by using the waterproofing mediums now sold on the market. It has been stated by the manufacturers that the use of these so-called integral waterproofing compounds would procure an impermeable con-

crete or mortar, and a few years ago results seemed to justify their use. However, many intelligent and comprehensive tests on the absorbtive and permeable qualities of Portland cement and concrete have been made, and these experiments almost universally show the same results.

Tests on the waterproofness of concrete are difficult to execute, for the constituents vary in absorptive qualities, porosity and percentage of voids. The Bureau of Standards of the United States has just finished a series of tests of the absorptive and permeable properties of Portland cement mortars and concrete, together with tests of damp-proofing and waterproofing compounds and materials. An endeavor was made to conduct these tests in such a manner as to make the results of practical value as a determination of the comparative values of these mediums. Forty different compounds were purchased in the open market and several void-filling materials were obtained for testing. A complete record of each compound is reported as to its character, chemical analysis, method of application, the result of physical tests, and noted peculiar characteristics.

The compounds are of two general classes, the waterproofing compounds for preventing the flow of water through masonry where subjected to a hydrostatic head, as in reservoirs, cisterns, tunnels, cellars, and the like; and damp-proofing compounds for overcoming dampness resulting from the capillary attraction and absorptive qualities of masonry, preventing dampness in habitations, and the disfigurement of exterior and interior surfaces of brick, stone, and concrete walls and interior plastering and decorations due to staining and efflorescence.

Two series of tests were made in the investigation, one of the waterproofing or water-resisting qualities of the compounds recommended for such use, and another of the damp-proofing qualities of other compounds so recommended to be used.

A summary of the results of the tests shows that Portland cement mortar and concrete can be made practically water-tight or impermeable to any hydrostatic head up to 40 feet without the use of any of the so-called "integral" waterproofing materials; but in order to obtain such impermeable mortar or concrete considerable care should be exercised in selecting good materials as aggregate and proportioning them in such a manner as to obtain a dense mixture. The consistency of the mixture should be wet enough so that it can be puddled, the particles flowing into position without tamping. The mixture should be well spaded against the forms when placed, so as to avoid the formation of pockets on the surface.

The addition of so-called "integral" waterproofing compounds will not compensate for lean mixtures, nor for poor materials, nor for poor workmanship in the fabrication of the concrete. Since in practice the inert integral compounds (acting simply as void-filling material) are added in such small quantities, they have very little or no effect on the permeability of the concrete. If the same care be taken in making the concrete impermeable without the addition of waterproofing materials as is ordinarily taken when waterproofing materials are added, an impermeable concrete can be obtained.

The damp-proofing tests as conducted would indicate that Portland cement mortars can be made not only impermeable, but damp-proof as well without the use of any damp-proofing or waterproofing compound. However, these tests should be interpreted with caution, as the evaporation may have been sufficient to care for the slight amount of moisture coming through the test pieces without indicating on the filter paper. Thus it cannot be stated that if a material were used which was damp-proof according to this test, if used as a basement wall, one surface being constantly exposed to moisture and the other surface in an enclosed room where there would be little or no circulation of air, that the interior surface would not appear damp and the atmosphere become saturated with moisture. The tests of coating materials as damp-proofing mediums can be considered as only preliminary, but the results, considered along with the chemical discussion, throw some light on their comparative merits. The mortar used in these tests was, perhaps, too coarse and too absorptive for a fair test. The purpose of the rough surface was to test the flowing qualities of the coating, and it would seem that many of the failures may be due to the poor or imperfect spreading and adhesive quality. Several of the compounds deteriorated and proved their unfitness for the purpose intended.

Well-graded sands containing considerable graded fine material are preferable for making impermeable concrete, but if such is not to be had, fine material in the form of hydrated lime, finely ground clay, or an additional quantity of cement will be found of value.

Where Portland cement mortar is used as a plaster coat, if sufficient cement be used and the sand contains sufficient fine material (or a fine material be added) and the mortar be placed without joints and well troweled (care being taken not to over-trowel, which may cause crazing), the coating will be effective as an impermeable medium without the use of any waterproofing compound.

As a precaution, under certain conditions, it is undoubtedly desirable to use bituminous or similar coatings, even on new work, as protection where cracks may occur due to settling of foundation or expansion and contraction caused by temperature changes. In large or exposed work it is practically impossible to prevent some cracks, but where cracks can be prevented no coating whatever is required to make the structure impermeable.

The permeability of Portland cement mortars and concretes rapidly decreases with age.

EDITORIAL COMMENT.

The Commission of Conservation have begun the publication of a monthly paper called "Conservation." The March issue, which has just come to hand, states that it will be published during eight months of the year. This bulletin will be invaluable to the press, containing as it does authoritative information on conservation matters.

* * * *

Commercial peat seems to be very nearly a realization now. The method of treatment heretofore has not been economically successful. That difficulty, however, has been overcome, and a thoroughly successful method of treating peat has been practically demonstrated at the Government laboratories near Ottawa during the last two years. All that remains now to make the immense peat bogs of the Province of Ontario available for fuel is a reasonable amount of commercial enterprise devoted to the work of development.

* * * *

Toronto has decided to build a sewage purification experimental station. The results to be obtained from the operations of such a station are very valuable, and

no doubt the local sewage disposal problem will be greatly cleared by the proposed experiment. The sewage disposal problem of the cities bordering on the Great Lakes has come to be a serious one, and it is only by experimental work that the degree of clarification necessary for preserving the water supply will be discovered. It is sincerely hoped that the experimental work will be prosecuted energetically in order that the resulting data may be of immediate service before the building of sewage treatment works.

GENERAL NOTES.

Precipitation during March exceeded the average very locally in Ontario, and in Eastern Quebec, Northern New Brunswick, and Eastern Districts of Nova Scotia. Elsewhere in Canada it was deficient, and in British Columbia and the Western Provinces, to a marked extent. Practically no reports regarding the amount of snow on the ground in British Columbia have been received, but it is apparent that there is a considerable amount on the mountains, although it is probably less than at the end of February. In the Western Provinces there is comparatively little snow on the ground, the depth in Eastern Saskatchewan and Manitoba being from two to four inches, while in other districts the ground is practically bare. A large amount of snow, between thirty and forty inches, lies on the ground in Northern Ontario and over the greater part of Quebec, but this depth decreases southward to a trace near the shores of Lake Ontario and near the Bay of Fundy.

The table shows for fifteen stations, included in the report of the Meteorological Office, Toronto, the total precipitation of these stations for March, 1912:

	Depth in inches.	Departure from the average of twenty years.
Calgary, Alta.	0.3	— 0.44
Edmonton, Alta.	0.4	— 0.37
Swift Current, Sask.	0.1	— 0.76
Winnipeg, Man.	0.3	— 0.95
Port Stanley, Ont.	2.6	— 0.26
Toronto, Ont.	1.97	— 0.23
Parry Sound, Ont.	1.7	— 1.31
Ottawa, Ont.	1.5	— 1.03
Kingston, Ont.	1.6	— 0.70
Montreal, Que.	2.0	— 1.90
Quebec, Que.	2.2	+ 0.61
Chatham, N.B.,	3.7	+ 0.57
Halifax, N.S.	6.7	+ 1.36
Victoria, B.C.	1.4	— 1.40
Kamloops, B.C.	0.0	— 0.42

FREE ASSISTANCE IN DRAINAGE.

During the exceptionally dry season of 1911 land that was underdrained produced on an average about $16.50 more per acre than land that was not drained, according to data collected by the Department of Physics at the Ontario Agricultural College.

Reports were received from a large number of farmers, of whom twenty-five were able to give definite figures on yields on drained and undrained land. Three of the number said they saw no difference, but all the others reported increases. Eleven counties were represented in the reports, from Durham in the east to Essex in the west. The value of increases, including straw, was figured at October, 1911, prices, and March, 1912, prices. The former showed an average of $15.97 per acre and the latter $17.04, and both together an average of $16.50. The three who reported no increase were counted in obtaining the averages.

In wet seasons the results are even more marked, but even at $16.50 per acre, drains more than pay for themselves in two years.

The O.A.C. is again renewing its offer of assistance to farmers in laying out their drainage systems. The Department of Physics has a special staff of drainage advisers for this work. There is no charge for the services of these men, the only outlay to the farmer being the travelling expenses, which are low. As the railway fare is only one cent a mile for this work, and as several surveys are always made on one trip the expenses are divided among the several parties concerned. Anyone wishing to have a drainage survey made should drop a card to the Department of Physics, O.A.C., Guelph, whereupon regular application form will be sent, and later on one of the department's drainage advisers will make the survey.

PROFESSIONAL DEGREES IN ENGINEERING.

In the year 1896 the University of Toronto passed a statute establishing professional degrees in civil, mining, mechanical and electrical engineering.

Candidates for any of the said degrees were required, in addition to three years' professional experience, to hold the diploma of the School of Practical Science, and also the degree of B.A.Sc. The latter requirement being imposed upon those only who graduated from the school subsequent to June, 1895. Since the passing of the above act a large number of men have graduated who, through their professional activities, have found it impossible to meet the latter requirement of the statute. Some of those of this number have turned their attention to other activities, and many have already made good in their profession, and it has been felt that at least a measure of relief should be given to the situation. The University, therefore, recently amended the statute by changing the date up to which the B.A.Sc. degree would not be required from June, 1895, to June, 1905. By this amendment statuary difficulties at least in the way of proceeding to a professional degree have been removed from about 190 graduates.

OIL-BURNING LOCOMOTIVES.

The Canadian Pacific Railway has decided to use oil in its locomotives on Vancouver Island. The reason for this is because of the stringency of the forestry regulations, which makes a railway responsible for fires originating on its right-of-way. Recently in the supreme court at Nelson, the finding of the jury was that the Canadian Pacific Railway was responsible for the damage done to timber limits of the King Lumber Company, and awarded $140,000, the amount sued for. In that case, the fire started on the right-of-way. smouldered for some days, then was swept by a wind across the Moyie River and later carried by another wind into the timber. It is fairly convenient to burn oil on the coast lines, since transportation from the oil fields is by water, but the question of using oil in the interior has not yet been taken up for definite settlement. With many waterpowers available throughout the whole of the interior, electrical power will probably be utilized when a change is made from the use of coal in locomotives.

SURFACE TREATMENT OF PARK ROADS.*

By Col. Spencer Cosby, U.S.A.

The greatest friend of the American road builder of to-day, the much maligned and loudly abused automobile, has undoubtedly been the chief single factor in the wonderful advance that has taken place during the last decade, both in the art and in the extent of our road making. Through the instrumentality of the motor car many thousands of our most influential citizens have had carried home to them the conviction that the necessity for good roads is not merely a local issue but is a question of nation-wide importance, and never before in our history has the interest in it been so great nor have such large sums been spent in the making and upkeep of our roads.

But while other factors than the automobile have contributed an important share towards achieving this result in the general case of country and suburban roads, the improvement that has taken place in our park roads during the last few years can be attributed almost solely to the automobile. Until its advent the traffic on these roads was in most cases confined exclusively to light vehicles, so that ordinary macadam, or even well compacted gravel roadbeds, met all requirements.

Here in Washington our roads were thoroughly gone over and all defects repaired once each spring, and this, with frequent watering, sufficed to keep them in good condition for many years—in fact, they never seemed to wear out. The yearly repairs cost comparatively little, the chief item of expense of maintenance being the watering. This averaged about 3.2 cents per sq. yd. of road surface per annum. No watering was done during the three winter months, while in the early spring and late fall the roads were watered once a day in dry weather; during the remaining six months of the year the watering carts went over each road twice a day during dry weather, and three times a day in periods of drought. As long as the roads were kept fairly smooth and reasonably free from dust, everyone was satisfied. No attempt was made to clean the roads, though the gutters were swept from time to time.

But this happy state of affairs ended with the coming of the automobile. The number and average weight and speed of the vehicles using the parks rapidly incrased, the combination of horses' hoofs and driving wheels with wide soft tires quickly raveled the road surfaces, and at the same time their users became more particular—they wanted not only dustless but mudless roads and could not see why a hole which developed in the fall had to wait for the annual spring cleaning to be repaired. They even complained when a road became occasionally dusty during the winter months. In other words, they wanted the park roads to be good at all seasons and in all weathers, and that is what we are now trying to give them.

On the new roads that have been built and on the old roads that have been resurfaced in the last few years a heavy oil or tar binder has been used with most satisfactory results, the penetration method being employed in applying the binder. But most of our work has consisted of the surface treatment of existing macadam roads. We have never attempted to apply any treatment to the old gravel roads but are resurfacing all of these as fast as possible with broken stone. For our surface treatment we have experimented with emulsions, with waste sulphate liquor, with coal gas and water gas tars and with asphaltic oils, and have come to the conclusion that, under present conditions, the latter give the best results.

Our experience with emulsions has not been very extensive. We found that the effect of each application lasted only two or three weeks, the time depending largely on the amount of rain, and we soon reached the conclusion that the cost of labor and material for the repeated applications that were necessary made the cost of this method greater in the end than that of the others. It has the advantage that the road never has to be closed to travel even while the material is being applied, though there is some objectionable tracking for about a day afterwards.

We have also used sulphite liquor, but to only a limited extent, owing to the fact that the first cost of the material is much greater than that of either oil or tar, while its effect is not so lasting. It possesses the advantages of allowing the road to be used immediately after application, of not permanently darkening the color of the road surface and of not staining.

In this market water gas and coal gas tar cost about the same, but the former has given better results in use on roads, as the coal gas tar does not retain its elasticity and so does not have as good binding power. We have used the same method in applying water gas tar and light asphaltic oil, and have found the effect to be about as lasting in each case, one application a year being sufficient to keep the road in good condition. The oil has, however been slightly cheaper than the tar in this market, and it requires a smaller quantity to be used per square yard on the second application; it is also more absorbent of the triturated material that forms on the surface of the road under traffic, and so makes a more nearly dustless road. For these reasons we now prefer it ta tar, though I confess to some misgivings as to the ultimate effect of the crust formed upon the road surface by the commingled oil and dust. Even now, where the traffic is heavy the crust is picked up in places, forming occasional ruts and waves.

Our method of applying oil to macadam roads is as follows:—

All ruts and holes in the surface of the road are first repaired by cleaning out the cavity, filling it with coarse stone, which is covered with a coating of hot, heavy, asphaltic oil, then sprinkling a light coat of screenings over the oil, and finally compacting the mass by ramming. When all holes have been repaired, the surface of the road is thoroughly cleaned with rattan brooms, care being taken to remove all loose materials and caked dirt or dust so that the stone forming the wearing surface of the road shall be exposed and clean.

When the road is entirely free from moisture, and during warm, dry weather if possible, a light asphaltic oil is spread, without being heated, over its surface by means of special sprinkling wagons. One-third to one-half gallon of oil to the square yard usuall yforms this first application. To allow it to penetrate into the surface, the road is closed to traffic for at least forty-eight hours after the first application. At the end of this time the surface of the road is covered with a thin coating of clean, coarse, sharp sand or broken stone screenings, free from dust; it is then rolled and traffic allowed to go over it. A cubic yard of sand or screenings usually covers from 75 to 125 sq. yds. of road surface.

In this climate and under the conditions of traffic obtaining on our park roads, the oiling treatment described above keeps the surface in excellent condition for a year. It is never dusty and is only muddy when, for a few hours after a heavy thaw, the skid chains of automobiles tear up the surface. The subsequent passage of automobiles with-

* Paper presented before Section D of the American Association for the Advancement of Science.

out chains soon irons out the roadway. At the end of the year the surface of the road is again thoroughly cleaned, from ¼ to ⅓ gal. of oil per sq. yd., under normal conditions, is spread over it and the road closed for forty-eight hours and covered with sand or screenings as before. This treatment is continued from year to year. .

Instead of handling the oil in barrels, we have found it much cheaper to buy it delivered in tank cars, from which it is unloaded into the sprinkling wagons. A pressure tank wagon was used to advantage for the first application of oil to the road surface, but ordinary sprinkler wagons with an oil distributing attachment and a squeegee fixed behind the distributor were found more economical and equally efficient in spreading the oil the second year. To insure coating all parts of the road with an oil layer of uniform thickness, men with stiff brooms followed the sprinkler.

The following are the specifications under which we have been purchasing asphaltic oil for the surface treatment of park roads:—

(1) The oil shall be a viscous fluid product, free from water and showing some degree of adhesiveness when rubbed between the fingers.

(2) It shall have a specific gravity of not less than 0.940 at 25° C.

(3) It shall be soluble in carbon bisulphide, at air temperature, to at least 99 per cent. and shall show not over 0.2 per cent. of inorganic matter insoluble.

(4) It shall contain not less than 3 per cent., nor more than 10 per cent., of bitumen insoluble in 86° paraffin naphtha at air temperature.

(5) When 240 c.c. of the oil is heated in an Engler viscosimeterto 50° C. and maintained at this temperature for at least 3 minutes, the first 50 c.c. shall flow through the aperture in not less than 10 minutes, nor more than 20 minutes.

(6) When 20 grams of the material is heated for 5 hours in a cylindrical tin dish aproximately 2½ ins. in diameter by 1 in. high, at a constant temperature of 163° C., the loss in weight by volatilization shall not exceed 20 per cent. The residue should be decidedly sticky.

(7) Its fixed carbon shall be not less than 3.5 per cent.

The following table, taken from the year's report of the Office of Public Buildings and Grounds, shows the cost of surface treatment of the macadam roads in the Washington parks under that office from July 1, 1910, to June 30, 1911, oil or tar being the material used:

No. of road.	Material used.	Quantity. Gallons.	Area of road. Sq. yds.	Length of road. Feet.	Sq. yds treated per gal.	Cost of oil and applying per sq. yd. Cents.
1	Oil	2,300	7,500	1,300	3.26	‡2.8
2	"	4,000	19,000	3,500	4.75	†2.2
3	"	1,000	3,400	650	3.40	†2.7
4	"	700	8,600	2,300	12.23	†1.2
5	"	5,000	25,000	5,000	5.00	†2.1
6	"	10,600	43,560	9,000	4.11	†2.2
7	"	3,400	19,450	3,800	5.72	†1.9
8	"	350	4,000	1,200	11.43	†1.3
9	Tar	1,000	1,680	700	1.68	*4.6
10	"	6,000	11,400	3,500	1.90	*4.4
11	"	650	1,500	1,600	2.30	*3.8
12	"	1,600	3,560	1,600	2.23	*3.8
13	"	2,580	7,740	2,800	3.00	*3.1
14	"	2,400	8,100	2,100	3.39	*2.8
15	"	875	2,000	700	2.38	*3.8
Totals		43,455	166,490	38,650	Av. 3.83	Av. 2.5

*1st application. †2d application. ‡2d ard 3d applications.

	Cents.
Cost of labor per square yard	0.8
Cost of oil per gallon	6.5
Cost of tar per gallon	6.8
Average cost in past years of watering roads, per square yard	3.2

In the above table the cost of the sand or of the stone screenings used after the application of the oil has not been taken into account, as it is considered part of the cost of repair of the road.

Road No. 1 in the table had been worn down so that the crown had practically disappeared, leaving the road so flat that the water did not readily drain off. This did no special harm in warm weather but the alternate freezing and thawing that occurred during the winter months allowed the heavy traffic to churn up the surface so that it became necessary to give it a second application of oil in the early spring. The small amount of oil applied to road No. 4 was due to the light traffic on this section, while on road No. 8 an unusually heavy application of oil, 1½ gals. per sq. yd., had been made the year before, a few months after the construction of the road. The large amount of oil absorbed by the new road on the first application made only a light second application necessary.

It is only fair to add that one reason why our park roads have been in so much better condition since we started the use of the surface treatment I have described is that we have abandoned the old method of repairing them once a year and now have a system of regular and frequent inspection and repair. Supplies of broken stone, screenings, oil and tar are kept constantly on hand in the vicinity of the roads, and holes and ruts are repaired as rapidly as they develop, usually before they have become large enough to be noticeable to traffic. We have practically no hills on our roads, so the greatest amount of repair work has to be done on the few sharp curves. The roads are also kept clean, being swept by hand sweepers at fairly frequent intervals.

I have confined myself to giving a brief description of the methods we have tried and the results we have obtained in the surface treatment of the roads in the parks within the city limits of Washington. It is almost needless to say that the conclusions we have now reached should not be considered as final or of general application; they represent simply the result of a limited number of experiments carried on for a limited time under the conditions existing in the Washington parks. The value we have provisionally found for "x" in the solution of our road problem may be quite a different one from that arrived at in another locality where the quantities entering the equation are not the same. The whole matter of road construction is in the development stage, and it is only by feeling our way carefully and comparing the results of many and varied experiments that we can hope to approach a final decision.

SELF-PROPELLED CARS.

On Friday evening, January 19th, W. B. Potter, chief engineer railway department, General Electric Company, read a paper on self-propelled cars before the New York Railroad Club. He described his company's gas-electric cars, which weigh 40 tons to 50 tons and are capable of a maximum speed of 60 m.p.h. Electric control and transmission were used to utilize the inherent characteristics of the gas engine to the best advantage and to relieve the engine from mechanical strain and shock. Series-parallel motor control and regulation of the generator voltage gave a wide range of speeds. The tractive effort at the slower speeds was 12,000 lb. or more. As there was no mechanical connection between the engine and driving wheels, the engine could be slowed or shut down without regard to the control system. With the car standing still or moving the power of the engine could be safely applied in either the forward or reverse direction.

Mr. Potter stated that the engine used on these cars had eight 8-in. x 10-in. cylinders and at the normal speed of 550 r.p.m. would deliver 100 kw. to the motors with some margin to spare. The gasoline most used was "painters' naphtha," which could be purchased for about 6 cents per gallon.

The motors, which were standard 600-volt railway machines, were mounted on the forward truck under the engine, thus placing about 65 per cent. of the total weight of the car on the driving wheels. As the traction voltage varied from 200 volts to 800 volts, the current for lighting the car was supplied by a separate gas-electric generating set. The two-cylinder engine of this set also had an air compressor cylinder for supplying compressed air to start the large engine. The cars had both straight and automatic air brakes, the latter for handling trailers. The engine compartment is in the forward end and is about 12 ft. long.

Performance curves of a 70-ft. car, as submitted by Mr. Potter, showed that with stops two miles apart the schedule speed would be about 25 m.p.h. and the maximum speed on level track about 60 m.p.h. He also presented the following table, showing the comparative cost of operating a train of two coaches and a steam locomotive and of a gas-electric car on a daily run of 150 miles, except Sundays, amounting to 3,900 miles a month:

Two-Trailer Steam Train vs. One Gas-Electric Car.

	Steam Train per Mile.	Motor Car per Mile.
Wages of crew:*		
Engineer or motorman	$0.0400	$0.0400
Fireman	0.0240	.....
Conductor	0.0280	0.0280
Baggagemaster	0.0183	0.0183
Total wages of crew	$0.1103	$0.0863
*Based on no overtime allowance.		
Fuel, water and engine lubrication:		
Coal for locomotive, 67 lbs. at $2.25 per ton	$0.0750	.....
Water for locomotive	0.0050	.....
Painters' naphtha, 6 gal., at $0.06 per gal.	.....	$0.0360
Engine lubrication	0.0025	0.0050
Other expenses:		
Locomotive, repairs	$0.0850	.....
Locomotive, engine house expenses	0.0050	.....
Coaches (2), repairs and expenses	0.0250	.....
Gas-electric motor car, general overhaul	.....	$0.0215
Gas-electric motor car, running repairs and expenses	.....	0.0210
Other supplies	0.0025	0.0050
Superintendence	.....*	0.0065
Total cost per train mile	$0.3303	$0.1813

*For steam locomotive this is assumed to be included in items of locomotive repairs and engine house expenses.

Saving per train mile	$0.1490
Saving per diem (except Sunday), 150 miles a day	22.35
Saving for twenty-six-day month	581.00
Gross yearly saving	6,970.00

Note.—When no baggage and express is handled and when operating conditions will permit, the gas-electric motor car can be operated without the third man.

Mr. Potter also gave the following table for three months' operation on the Minneapolis, St. Paul, Rochester & Dubuque Electric Traction Company ("Dan Patch" line), which operates five of these cars. The stations on this line are 1.4 miles apart. The figures cover operation over 37.5 miles between Minneapolis and Northfield for July, August and September, 1911.

Three Months' Operation of Gas-Electric Cars.

Number of days actual service		92
Total mileage, five motor cars		39,352
Number of trailers hauled occasionally		1 or 2
Total mileage trailer cars		7,879
	Total.	Per Train Mile.
Total wages of crew	$2,249.40	$0.0573
Fuel and lubrication, engine:		
24,944 gal. of gasoline at $0.062 per gal.	1,534.20	0.0391
755 gal. of gas engine oil at $0.25 per gal.	189.76	0.0048
Running repairs and expenses:		
Total running repairs, material and labor	410.36	0.0104
Car cleaning, materials and labor	135.70	0.0035
Other supplies	81.83	0.0021
Total expenses	$4,601.25	$0.1172

Mr. Potter further suggested certain forms for keeping an accurate record of the cost of operating such motor cars with or without trailers.

In conclusion Mr. Potter said that a special study has been made to secure a light-weight car for this service. The body weighed 28 tons, the trucks 6 tons and the motive power equipment 15 tons, a total of 49 tons for a 70-ft. car. This was equivalent to 1,000 lb. per seated passenger. The gas-electric car had proved very reliable in the coldest weather. The "Dan Patch" line had operated during very heavy snow with the temperature 15 deg. to 30 deg. below zero when steam trains in the same territory were helpless. This line was using painters' naphtha at 5½ cents per gallon.

PUBLIC UTILITIES IN LONDON, ONT.

There is in Canada at the present time a growing movement tending toward the municipal control and ownership of all utilities dependent upon the public for their revenue and existence. In many municipalities the public have acquired the management of these, and in the majority of cases the results have justified the wisdom of municipal ownership. This has been exemplified in a pointed degree in London, Ont., according to a report just issued by the municipal commissioners of that city on the operation of the water works. The report shows an item of $48,398.23 to the credit of revenue account for the year ending November 30th, 1911. The revenue derived from the sale of water totalled $112,588.93, and the receipts from other sources brought the income to the sum of $173,733.88.

The commissioners have been active in new main laying and general improvement to the plant; the sum of $44,000 being spent on mains and new pumping equipment.

During the past year the motive power of the pumping plant was changed in order that the service offered by the hydro-electric commissioners could be used. By this means the expense of operation, although two plants were in use, was reduced to a considerable extent. By the sinking of artesian wells the water pressure was improved to such an extent that the fire underwriters reduced rates on many buildings. The general superintendent states in the outset of the report that the success of the past year is due in a large measure to the system adopted in regard to the submanagement. The department heads have been given a free hand in the selection of their assistants, etc., making each and every departmental head responsible for results, and at the same time allowing no interference on account of political or personal reasons. The superintendent points out that the result of this is to increase a feeling of responsibility and makes the more valuable men take a pride in their work.

It is pointed out during the course of the report that the future will witness important expansions of the system in the direction of Springbank.

INDUSTRIAL WORKS IN INDIA.

The India office has awarded the contract for the steel work required in connection with a state railway bridge near Allahabad, India, to the Phœnix Bridge Company, of Phœnixville, Penn. There was a difference of 26½ per cent. in its bid and the lowest British tender. This company received the contract for the ill-fated Quebec bridge.

THE MATERIAL-LIST METHOD OF STORE-KEEPING.

By R. W. Heafield.

In putting before your readers the main features of this system of storekeeping, I do so with a firm belief that it is one of the simplest, one of the most effective, and, certainly, one of the least expensive systems that can be adopted. Moreover, it is one that is especially adapted to the engineering trade, both electrical and otherwise, though not necessarily confined to that trade.

One of the most commonly used systems of to-day is that known as the Card Index System, and, although successful to a great extent, as its popularity proves, it, nevertheless, has its drawbacks, one of the greatest of which is, that though the Stores Dept., and the Purchasing Dept. (or Order Section), are the two departments most concerned, they work quite independently and each one is ignorant, to a great extent, of the actions of the other. For example: In many instances the storesman (the man who has the actual handling of the material and giving out of same) if appealed to by anyone to say whether a certain article is on order or not, cannot tell you, and the foreman of a shop, or whoever it is who requires that information, has to either go or send to the Order Section to find out particulars. In many instances it happens that the Order Section is quite a distance from the shop, and the time lost by running about is very often an item of considerable importance to the firm. Another thing worthy of consideration is that this system entails the continuous employment of two, and often more clerks, in the Stores Dept., who do nothing but mark off issued material from the shop tickets on to the stock cards, a very tedious operation and one that is carried on day after day, week after week, all the year round, and, more often than not, results in a man leaving the place just as he has become thoroughly used to the work. Now, this Card Index System is supposed to give a correct statement of the amount of all material in hand or on order. This is the case theoretically, but, in practice, it is found to be faulty and, from time to time, it is found that there is a shortage of stock when the card shows a considerable amount to be in stock, so that the system becomes unreliable.

Now, it is not claimed that the Material List System is infallible, but it is claimed that it does away in large part with the above disadvantages, and, moreover, it gives a greater interest in their work to the storesmen who handle the actual stock.

Upon the securing of an order (or contract) the Engineering Dept., through its Material List Section, shall issue a material sheet or sheets, setting out in detail the quantities of material required. As a rule, no material is ordered or work started until the material list is issued. The material list is first sent direct to the general storekeeper, who shall be responsible for the marking thereon what is in stock and what is not. He shall then forward the material sheet to the Order Section, who shall issue orders for all material not carried as stock. The marking of these sheets may be left to the second man when the storekeeper is too busy to attend to same personally.

The following illustration shows a sample material list.

S. signifies stock.

M.O.S. signifies material on order for stock.

S.P.A. signifies stock part altered.

Z. does not concern stores. Order Section order this to the contract No.

This system gives the storekeeper an opportunity of using up old and perhaps otherwise worthless material, as in the case of the item marked S.P.A. He may have bolts of say 1¼ in. diameter by 14 in. long, which could be cut down and screwed at less cost than the making or purchasing of new bolts. It also enables the shop foreman to see at once what material is on order with the probable time of its arrival and enables him to plan his work accordingly.

When the material list is passed on to the Order Section they shall order all items marked X, marking on the material list the number of the requisition and the date of ordering. The material list was then passed on to the blue print room, for copies to be taken for distribution to the shops building the apparatus, the general storekeeper and all subsidiary storekeepers interested. It should be borne in mind that the shops draw their material from stores in the exact quantities specified on the material list.

CONTRACT APPARATUS — D.L. No. — C.L. No. — Sg'd — Ch'd — Mat. List No. — Date — Sheet

Item	Name of Part	Drg. No.	Pt. No.	Description	Material	No. Reqd.	Remarks	Change
1								
2	Bolts	B 246	4	½in. x 2¾in. bright. hex.	Steel	20	S.	
3	Fulcrum Brkt.	"	2	¼in. x 2in.	M Steel	1	M.S.	
4	Bushings	"	6	⅞in. od., ½in. hole, 1in. long	Fibre	2	M.O.S.	
5	Bolts	"	9	1¼in. dia. x 10in. long	Steel	4	S.P.A.	
6	Set Screws	"	10	¼in. x ¾in. cup hd.	"	20	S.	
7	Lubricator	"	15	Meltor's Mechanical	Brass	1	x	
8								
9								
10								
11								
12								

Assuming that we are dealing with a firm which employs from 4,000 to 5,000 men, there will be required considerable sized general stores, besides a number of subsidiary stores, all under the supervision of the general storekeeper. In the general stores there will be employed probable six (6) or more men; and for the sake of illustration, we will divide the general stores into two sections: 1st, bright goods; 2nd, black goods; with an equal division of all raw material, such as fibre, vulcanite, brass, copper, etc., etc. The two most capable men should be selected as the heads of these two sections. Each should be made responsible for any shortage of material in his section, and the watchword in stores work should be thoroughness and efficiency.

Each bin should be provided with a card suspended on a hook. These cards take the place of those used in the Card Index System. On these cards is kept a faithful

record of all material received, the date of receipt, and the requisition number it was ordered on. So strict a record need not be kept of issues, however, especially as regards bolts, nuts, washers and things of little value, as the date of receipt of the last consignment gives an idea of the quantity used in a given time, but in the case of instruments and anything of exceptional value, such as gold, silver, platinum, iridium, quartz, etc., it is necessary that a correct record be kept of all issues together with the contract number issued on. All invoices, whether for stock or contracts should be passed by stores, and all cards marked accordingly. This will be found to be a very considerable advantage in stocktaking, and is necessary to the successful carrying out of the system of debit and credit between the several shops stores and costs department. Debit and credit, however, do not concern us in this article.

A specimen card is given below:

A. B.				E. Co.			
RECEIPTS				ISSUES			
Date	No. Rcd.	Req. No.		Date	No.	Contract	

A red card hung on the hook over the white card indicates that material is in order, and prevents reports of "material wanted" being duplicated.

When the storesman considers it necessary to replenish any article of stock he should requisition more on a form similar to the following, keeping a carbon copy of same.

10-1-12.

STOCK REQUISITION.

Quantity	Article	Delivery	Last Req.	Remarks
200	Bolts ½ x 3 in. Bright Hex.	7 days	42681	
144	L'gts Br'ss Rod ¾ dia. x 10 ft. long	21 days	49763	
10 lbs.	Eureka Wire .0625 dia.	14 days	21364	

He then enters these items in a day-book after the style shown at head of next column.

When the delivery of any particular item is completed he shall draw a line in red ink through that item, but when only part delivery is made, the number or weight of such material shall be recorded in the remarks column.

The storesman can thus tell at a glance, when requested for information, as to whether a certain article on order has come in and whether or not the order is completed. If not in, he can tell when delivery is expected. He is, also, able to obtain his last requisition number from this book, which

Date	Article	Recd. No.	Date Recd.	Req. No.	
10-1-12	200 Bolts ½ x 3in. Bright Hex	200	18-1-12	50264	
"	144 len's Brass Rod ¾ dia x 10 ft. long	100	30-1-12	50265	44 shrt.
"	10 lbs. Eureka Wire .0625 dia.	10	26-1-12	50270	

is really a double check on the stock cards on the bins. This last requisition number is always given in ordering new material, as it is of invaluable assistance to the order section.

The subsidiary stores shall follow a similar course and each responsible storesman shall come to the head storekeeper every morning with requisitions made out. The general storekeeper shall initial all requisitions passed. If he considers any item thereon unnecessary, or in excess of what should be ordered, he shall withhold his signature until he has made personal investigation. All requisitions passed shall be sent without delay to the Order Section.

In addition to the stock material handled as above, the general stores has to receive and distribute, as wanted, all the special material ordered for apparatus being built on sales order and contracts.

A certain section should be allotted for such material in each stores, and a contract book should be kept for the purpose of recording this material in as it arrives and its location in the stores.

This can be indexed in the usual way, keeping the contract numbers in numerical order. Although generally one page suffices for each contract, in the case of a large order two or more may sometimes be found necessary. Outside of steam turbine or locomotive work, however, this is seldom the case.

The above outline covers the procedure of stock-keeping in its chief details; the minor details and changes will have to be worked out to meet the peculiar needs of the work involved.

If properly followed and manned, no embarrassment should arise from the dismissal or enforced absence of any particular individual connected with the department, as each member is more or less familiar with all the routine work.

Like all other systems, this requires alertness and unremitting attention on the part of the head storekeeper and his staff. Great emphasis must be placed upon the proper and reliable marking of the material list sheets; also to the proper checking and recording of goods received.

The writer has worked this system in two large firms with great success. In one firm it was adopted during his employment by them, consequently he worked it from its very inception.

A NEW SOURCE OF CANADIAN GRAPHITE.

Recent exploration has unearthed a large deposit of graphite in the Queen Charlotte Islands, off the coast of British Columbia. The main load appears on the Juskatia Inlet.

A STEAM WAGON FOR HAULING AND CONSTRUCTION WORK.

The wonderful sales and uses found for the gasoline trucks will shortly be competed with by a new steam truck being introduced into this country by Messrs. Jones and Glassco, of Montreal, who have kindly supplied us with this information.

The manufacturers of these trucks are Fodens, Limited, of Sandback, England, who have brought the steam propelled vehicle to a high state of perfection and utility.

Figure 1 is a side representation of one of these machines, and gives a general idea of the appearance and mechanical make-up.

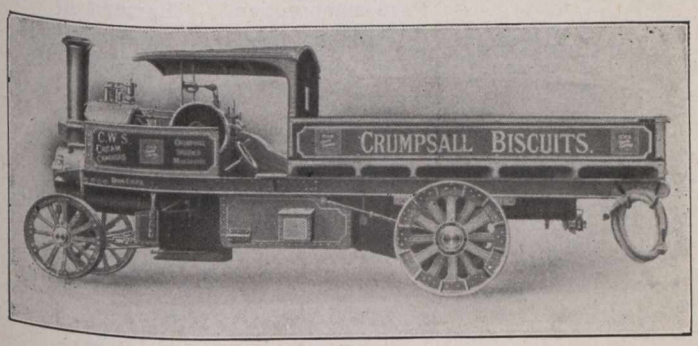


Fig. 1.—Steam Wagon.

Use has been found for these wagons in many diverse occupations in England and there is no reason why they should not compete with trucks driven by other means in this country.

The general design of this wagon is of a novel and original character. The boiler, which is of the horizontal multitubular type, forms the front part of the frame work. The sides of the frame are constructed of strong channel steel tied and braced together in such a manner as to secure great strength in the complete lorry. The platform of the vehicle is 14 ft. long by 6 ft. 6 in. wide. The boiler is fired with coke, hard coal or wood, and is without doubt the easiest steam maker of any boiler or any motor wagon. The wagon is driven by a compound steam engine fixed on the top of the boiler, so as to be readily accessible, and to work with "dry" steam. The cylinders are 4⅜ in. and 6¾ in. diameter, and are fitted with a patented high-pressure gear, by means of which both cylinders can, in case of emergency, receive live steam from the boiler, and each cylinder exhausts independently into the chimney. The reversing motion is of the ordinary link type, and the whole construction of engine and steering arrangement is so similar to the "Foden" traction engines, that any ordinary traction engine driver can easily handle the wagon. The power is transmitted by a pair of spur wheels acting on a compensating gear by an extra strong Renold roller chain. The gearing is arranged for two speeds—9 to 1 and 24 to 1. The car is mounted on laminated springs, and is capable of taking a load of 6 tons on itself and 3 tons on a trailer at an average speed of 6 miles per hour, and can travel 20 miles without taking up water. The fuel carrying capacity allows the apparatus to travel 40 miles on one loading. It can climb a hill (with slow speed) of 1 in 6 with full load. The traveling wheels are extra large, front wheels 2 ft. 9 in. by 6 in. on face, back wheels 3 ft. 6 in. diameter by 10 in. on the face, and so constructed that frost pins and paddles can be used. The tires are constructed of steel, thus doing away with the expense attached to rubber tires. The body is so constructed that the back portions may be tipped for rapid unloading; this can be accomplished by hand or from a belt driven from a flywheel. The back wheels can be made up to 14 in. on face for soft roads.

There are many points of advantage for this machine claimed by the agents and manufacturers over the gasoline trucks; among these the first to be noticed is the cost of operation; an important item to contractors and other large haulers of merchandise.

A large brewery reported a test and statement of a trial of this wagon as follows:—

Goods carried.....763 tons (2,000 lb.)
Total mileage.....2,255
Coal consumption .....2 tons 1,236 lb.
Coal consumption per mile..18.28 lb.

The management of a large leather mill report:—

154 miles per week average distance covered.
Average load .....7.75 tons
Cost per week $24.30
Cost of same haulage by horse $149.64

The management of a brick yard report that a truck of this description has transported 5,000 ton of brick over very rough country with a coal consumption of 40 tons, 640 pounds. The distance of this haulage was 6,000 miles and repairs to the machine during the year of operation totalled $115.38

This company state that they could not have attempted to do the work with horses that the steam wagon did, as the cost would have been far and away too great, and it would have taken eight good horses to do it, the greater portion of the work being beyond horse work altogether. The brick hauling accomplished by these trucks is one of the heaviest and roughest jobs an engine can be put to, owing to the unfinished condition of the approaches to the building, where the materials are to be delivered.

It will be noticed from the second illustration that these wagons differ in many points from steam tractors now in use in this counry inasmuch that the design has been

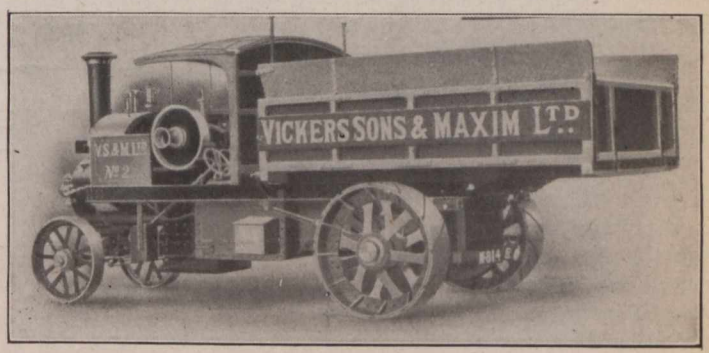


Fig. 2.—Steam Wagon.

carried out so as to give as much space as possible for the placing of merchandise and other goods, and that the space occupied by the boiler is much less than that of an ordinary tractor

The British War Office have recently turned their attention to the use of these machines for the betterment of their department, and following we give the summary of trials carried out by the officials of that department in order that the most economical means of heavy haulage could be ascertained.

The wagon entered by the Foden manufacturers went through the road trial of 257 miles without a mishap or stoppage for repairs, and was, on the conclusion of the trial, awarded the prize of £250.

Foden.

Date.	Miles.	Time.	Fuel.	Water.	Radius of action.	Fuel consumption. per ton-mile of useful load.	Diameter of turning circle.
5th	30	5 hr. 45 min.	419 lbs.	227 gals.			
6th	30	4 " 45 "	359 lbs.	205 gals.			
9th	31.7	5 " 16 "	392 lbs.	223 gals.			
10th	31.7	5 " 11 "	419 lbs.	253 gals.			
11th	32.6	4 " 40 "	393 lbs.	238 gals.			
12th	32.6	5 " 22 "	324 lbs.	273 gals.			
13th	34	5 " 27 "	400 lbs.	234 gals.			
14th	34	5 " 17 "	402 lbs.	256 gals.			
	256.6	41 hr. 43 min.	3,108 lbs.	1,909 gals.	19.54 miles	2.42 lbs.	12 yds.

Nearest Competitor.

Date.	Miles.	Time.	Fuel.	Water.	Radius of action.	Fuel consumption. per ton-mile of useful load.	Diameter of turning circle.
5th	30	5 hr. 52 min.	565 lbs.	353 gals.			
6th	30	5 " 21 "	628 lbs.	342 gals.			
9th	31.7	5 " 43 "	647 lbs.	382 gals.			
10th	31.7	5 " 39 "	672 lbs.	311 gals.			
11th	32.6	5 " 14 "	592 lbs.	480 gals.			
12th	32.6	5 " 18 "	669 lbs.	405 gals.			
13th	34	5 " 38 "	648 lbs.	401 gals.			
14th	34	6 " 1 "	667 lbs.	381 gals.			
	256.6	44 hr. 46 min.	5,088 lbs.	3,055 gals.	15.74 miles.	3.95 lbs.	18½ yds.

The trials at Aldershot have shown that these steam lorries are good and serviceable machines, suitable for present supply, and likely to be of great advantage to the transport service in countries where fuel and water in sufficient quantity is available.

Compared with horse draught, these trials have shown that self-propelled lorries can transport five tons of stores at about six miles an hour over very considerable distances on hilly average English roads under winter conditions. The load transported by each single lorry (five tons), if carried in horse wagons of service pattern would overload three general service wagons, requiring twelve draught horses, besides riding horses, whose pace would not ordinarily exceed three miles an hour. Moreover, the marching of 197 miles in six consecutive days over hilly roads would not have been accomplished by horses even at that speed without the assistance of spare horses.

There are a number of these wagons in use in Canada, and of these twelve are in Montreal, three are on order for Toronto concerns, and there are several more in the West.

The London County Council have purchased a number of these Foden trucks and the corporation of Denbigh have had one constructed for street watering with complete success.

IRON AND STEEL INDUSTRY.

The total shipments of iron ore in 1911 are reported as 210,344 tons, valued at $522,319. These may be classified as magnetite 72,945 tons, and hematite 137,399 tons. In 1910 the total shipments were 259,418 tons comprising magnetite 127,768 tons; hematite 130,380 tons and bog ore 1,270 tons. Exports of iron ore from Canada during 1911 are recorded by the Customs Department as 37,686 tons, valued at $133,411. The exports were chiefly from Bathurst, New Brunswick.

The shipments from the Wabana mines, Newfoundland, in 1911 by the two Canadian companies operating there were 1,181,463 short tons, of which 765,184 tons were shipped to Sydney and 416,279 tons to the United States and Europe.

The total production of pig iron in Canadian blast furnaces in 1911 was 917,535 tons of 2,000 pounds, valued at approximately $12,306,860 as compared with 800,797 tons, valued at $11,245,622 in 1910. Of the total output in 1911, 20,758 tons were made with charcoal as fuel and 896,777 tons with coke. The classification of the production according to the purpose for which it was intended was as follows:—Bessemer 208,626 tons; basic 464,220 tons; foundry and miscellaneous 244,686 tons.

The amount of Canadian ore used during 1911 was 67,434 tons; imported ore 1,628,368 tons; mill cinder, etc., 30,298 tons. The amount of coke used during the year was 1,121,321 tons comprising 543,933 tons from Canadian coal and 577,388 tons imported coke or coke made from imported coal. There were also used 1,190,459 bushels of charcoal. Limestone flux was used to the extent of 625,216 tons. In connection with blast furnace operations there were employed 1,778 men and $1,097,355 were paid in wages.

The total daily capacity of 18 completed furnaces was according to returns received 3,630 tons and the number of furnaces in blast December 31, 1911, was 12.

The production of pig iron by provinces in 1911 was as follows:—

Provinces	1911 Tons	Value	Value per ton
Nova Scotia	390,242	$4,682,904	12.00
Quebec	658	17,282	26.34
Ontario	526,635	7,606,674	14.44
Total	917,535	$12,306,860	$13.41

The exports of pig iron during the year are reported as 5,870 tons, valued at $271,968, an average of $46.33 per ton. Probably the greater part of this is ferro-silicon and ferro-phosphorus, produced at Welland and Buckingham respectively.

There were imported during the year 208,487 tons of pig iron, valued at $2,610,989 and 17,226 tons of ferro-manganese, etc., valued at $429,465.

The production of steel ingots and castings in 1910 is reported as 876,215 tons of 2,000 pounds of which 861,493 tons were ingots and 14,722 tons castings. The production in 1910 was 822,284 tons, including 803,600 tons of ingots and 18,684 tons of castings.

The production of open hearth and Bessemer steel has been for three years as follows:—

	1909 Tons	1910 Tons	1911 Tons
Ingots—Open-hearth (basic)	535,988	580,923	651,676
Bessemer (acid)	203,715	222,668	209,817
Castings—Open-hearth	14,013	18,085	13,982
Other steels	1,003	599	740
Total	754,719	822,284	876,215

THE PANAMA CANAL.

Mr. William McNab, principal assistant engineer of the Grand Trunk Railway system, recently returned to Montreal from the Panama Canal, where he went for the purpose of inspecting the engineering plant used, as well as other features connected with the undertaking.

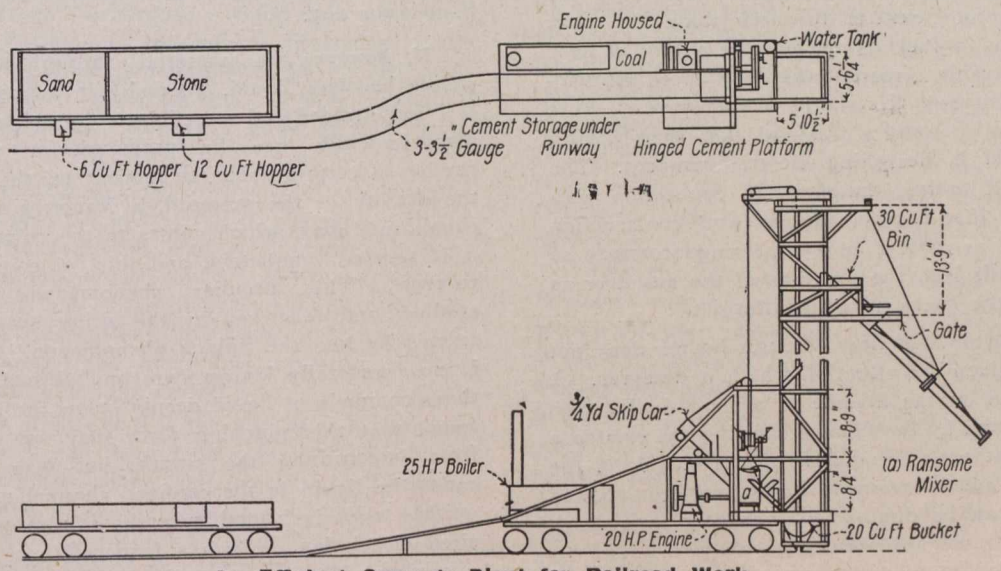
"In regard to the economics of commerce," said Mr. McNab, "there can be little doubt but that the canal will in general create an entirely new situation. Its operation will not only form new geographical features and substantially modify the complexity of the world's commerce but it will be an element of such importance that its influence will be universally felt in a more or less degree in every branch of trade. The North will be nearer and in closer relationship to the South and the South will be closer to the North. The Central American republics, too, which hitherto have been an uncertain feature in modern business and social life, will be found to fall in line with and share in such development. The fruit districts of Central America and the West Indies will also undergo rapid expansion in meeting the new order of things.

"It is unnecessary at present to quote saving in distance in certain existing sailing routes which will be effected after the canal is in use. It is obvious, among other things, that rapid growth of Pacific ports may be looked for.

"In regard to how the several transcontinental railways will be affected by the existence of the canal and the traffic it will carry, it is obvious that the most northerly ones will specially derive a direct benefit from it. The wheat fields of Western Canada are practically only beginning business, and at no far distant date will be a main source of supply of breadstuffs for not only Europe, but for the Southern States and West Indies as well. The problem of handling the fall crops in one direction within a reasonable time will then be felt. The Grand Trunk Pacific with its low gradients will be in a position to distribute its business to advantage, and take westward from Saskatchewan and Alberta a fair share of the agricultural output of these provinces for shipment via Prince Rupert and the canal."

AN EFFICIENT CONCRETE PLANT FOR RAILROAD WORK.

The accompanying line drawing shows a concrete plant which has been used with much success by a southern railway company for constructing abutments, retaining walls, culverts, etc., along its right-of-way. With a ¾-yard Ransome mixer driven by a 20 h.p. engine, 288 cu. yds. of concrete have been mixed in nine hours. The additional h.p. of the mixer engine is required to operate the hoist and the ¾-cu. yd. skip car. Steam is furnished by a 20 h.p. boiler.



An Efficient Concrete Plant for Railroad Work.

In order that the work of unloading may go on without the necessity of keeping the skip car from taking its load of material to the mixer, quick unloading chutes are attached to the flat cars in which the sand and stone are received. The skip car runs on an industrial track that is laid up an incline to the mixer. The section of the track between the end of the mixer car and the ground is hinged so that it can be quickly swung up when it is necessary to move the plant and two or three sections of the track can be readily picked up and thrown on the flat car. The skip car discharges into the fixed batch hopper of the Ransome mixer which in turn discharges the finished concrete into a 20-cu. ft. bucket, located in a wooden hoisting tower. The concrete is raised in the tower to a 30-cu. ft. concrete hopper with a Ransome gate. From here the concrete enters the swinging chute and runs to the point desired.

It will be noted that the entire plant is portable, the flat car having mounted on it the boiler, engine, mixer, and tower, while space for coal and water tank is provided. The entire plant was designed by the Ransome Concrete Machinery Company.

Metallurgical Comment

T. R. LOUDON, B.A. Sc.

Correspondence and Discussion Invited

SOME ENGINEERING FEATURES OF ELECTRIC FURNACES.*

By Carl Hering.

As it is such a simple matter to convert electric energy into heat, electric furnaces have to a large extent been designed and constructed by metallurgists and chemists rather than by engineers,† almost any crude electric contrivance will produce heat, and hence was good enough; the main question was: Will it perform the necessary metallurgical, physical or chemical reactions? Now that the latter has been demonstrated beyond question for a large variety of processes, the inevitable question naturally arises, will it pay to use electric heat? To determine this it becomes necessary to design and construct the furnaces so that they will have the highest possible heat efficiency; that is, to reduce the inevitable heat losses to the least possible. This is of far greater importance for electric furnaces than for those using the combustion of fuel, as the cost of a unit of heat is generally considerably greater when produced electrically than when generated directly by combustion. Fuel furnaces are, as a rule, so very wasteful that their design is of little or no aid in designing electric furnaces. The important problem of to-day, therefore, in connection with electric furnaces, is that of their design and construction so as to make them as perfect an engineering structure as possible; hence it falls into the province of the engineer as distinguished from the chemist or metallurgist.

The study of the flow of heat through bodies does not seem to have been given the attention which it deserves. A postage stamp pasted on the fireside of a steam-boiler tube will not even be charred by the flames, showing the existence of an enormous resistance to heat flow on the outside of the tube; a study of the phenomenon of the flow of heat showed how the resistance can be diminished, resulting in a much greater flow, hence increased steaming capacity. An excessive heat insulation of a gas-engine cylinder would result in its destruction. The over-insulation of steam pipes, which is said to be quite common practice, results in the waste of more money for the covering than the saving in steam warrants. All such engineering problems would be simplified by giving this subject of the flow of heat more attention. The lack of proper units and physical constants for such calculations is doubtless responsible in part for the neglect of due consideration of this branch of engineering.

In general, there are two classes—resistance and arc furnaces. In the former the heat is generated in the interior of a conductor, due to the resistance offered by the material to the passage of a current through it. The ordinary incandescent electric lamp is a simple illustration of the generation of heat in this way. In the arc furnaces the heat is generated by the passage of a current through a gap formed between the ends of two conductors; the bridging of this gap by the current is called the electric arc. The ordinary arc lamp used in streets and halls is a simple illustration of the generation of heat in this way.

In the resistance furnace the current may be passed through the material itself which is to be treated, or it may be passed through a permanent near-by conductor, and transmitted to the material to be treated by radiation, conduction, and convection.

When the heat is generated in the material itself, the heating becomes very efficient, practically 100 per cent. as all the heat is generated in the body itself, where it is wanted. This is therefore the most efficient method; it is also generally the most rapid, as no time is lost for the heat to penetrate by the slow process of conduction, from the outside to the inside; it is all in the inside when it is generated, and it can be generated very fast by simply increasing the current. Hence in some respects it is the ideal method. As long as the material remains solid, there is apparently no limit to the temperature which may be reached, for by continuing the passage of the current, heat continues to be generated, and if it cannot escape, it accumulates, thereby continually raising the temperature until the losses equal the input. This is the case in the graphite and carborundum furnaces, in which exceedingly high temperatures are obtained, estimated to be from 2,300 deg. C. to 4,000 deg. C. (4,000 deg. F. to 7,500 deg. F.)

If, however the material through which the current passes becomes liquid, generally in an open channel, there is a very decided and sometimes very serious limit to the temperature which can be produced, for when the current reaches a certain value, dependent on the cross-section and the density of the material, a formerly unrecognized force comes into play, which contracts the column of liquid until it is severed completely, and this, of course, interrupts the current. This peculiar phenomenon was encountered, studied, and described by the writer some years ago, and termed by him the "pinch phenomenon," by which name it is now generally known here and abroad. By submerging these channels of liquid deeply below the surface, the writer found that this pinching force may not only be prevented from interrupting the circuit, but may even be used to cause the liquid in the confined channel to flow out of it as quickly as it is heated, whereby it also produces much desired circulation. Such a furnace, then, has the desirable qualities of one with solid registers, besides some new qualities due to the rapid circulation of the heated liquid.

The characteristics of the arc furnaces are briefly as follows: The temperature of the arc is always that of the volatilization of the material of the electrodes between which the arc plays, and as these are generally carbon or graphite which have extremely high vaporization temperatures, it follows that the temperature developed in such arc furnaces are exceedingly high—generally far above what is required. This heat is, however, all generated in the arc itself, and at the surfaces between which the arc plays; hence it can reach the main body of the material to be treated only by radiation, conduction, and convection, and this necessarily takes time; the exceedingly high arc temperature aids this. In heating liquids with an arc, much of the enregy must necessarily radiate upward, hence is not utilizied, and even tends to destroy the roof of the furnace. Moreover, heating a liquid from the top surface is not the most rational way, as the heat travels downward with difficulty and quite slowly, hence taking time for the heat to penetrate; this is also the case in open-hearth furnaces. The electrodes in arc furnaces are consumed, and

* From a Paper read before the Engineers' Club of Philadelphia.

† The significance of this statement should be recognized. Metallurgists are more and more being called upon to display constructive ability.—Ed.

therefore require continuous feeding, or else the arc goes out. Some, and perhaps a considerable amount, of the electric energy, for such furnaces is necessarily consumed in volatilizing the electrode material, although part of this may be again recovered.

Heat is generated by the current in the electrode; this, generally being at a lower temperature than the interior of the furnace, flows out at the cold end. As long as the end of the electrode which is in the interior of the furnace is cooler than the heated product under treatment, heat must necessarily be abstracted from this product, and will flow out through the electrode, thereby chilling the product. This latter loss of heat could be stopped entirely if the hot end of the electrode were at the same temperature as the heated product, for heat will flow only when there is a difference of temperature. If, therefore, the electrode is given such a cross-section and length that the heat generated in it by the current raises the inside end to the furnace temperature, then this desired result of stopping this abstraction of heat from the furnace product will be accomplished.

Former practice had led to making the electrodes larger and larger, to keep them cool; this made them more and more costly and more difficult to handle. They should have been made smaller instead, so as to stop the loss of heat from the furnace product where it is wanted; the heat generated in the electrode costs less than in the furnace, as it has to be transmitted (as electric energy) over a shorter distance. Such reductions in the size of electrodes result in large annual savings, not only of power, but of electrode materials also. And it increases the valuable available space in the furnace by not chilling a more or less large part of the product.

Formerly it was claimed very positively by certain parties that graphite was a worse material to use than carbon, on account of its much higher heat conductivity; it was claimed to "chill the product too much," and therefore very wasteful of energy. The above analysis showed that this too was an error, as this chilling may be entirely prevented by proper proportioning; and when thus proportioned graphite is even less wasteful than carbon.

The explanation of this is that the minimum losses and the best proportions do not depend on either the electric or the thermal conductivities alone, but on certain relations between them. Neither property alone is a criterion. This brought out the surprising fact that the best electrode materials, from the standpoint of the least possible electrode losses and the smallest amount of electrode material were the metals; and of these, copper, the best of all heat conductors was decidedly the most economical. Hence, electrodes should be made of metals whenever possible, if economy of power and material is an object. This gives the resistance furnace an important advantage over those using the arc.

Although, as a rule, electric heat is more expensive than fuel heat, yet in electric furnaces it is generally possible to apply the heat much more economically, and greatly to reduce the thermal losses, by proper and careful design, so that the total cost of the thermal operation in many cases becomes less, and that is after all the deciding factor in most cases. When a furnace is properly designed to reduce the thermal losses to the least possible, it is believed by the writer that it will soon be economical to replace some of the present fuel furnaces by electric furnaces for commercial work, even when the electric power has to be purchased from the supply in cities. There are, of course, other factors involved also, such as the reduction of labor, the better quality of the materials produced, the rapidity of heating, etc., all of which should be taken into consideration.

COMPETITIVE CONDITIONS BETWEEN THE OPEN-HEARTH FURNACE AND THE BESSEMER CONVERTER.*

The progress of the open-hearth process may be explained from different points of view. As far as raw materials are concerned, the converter requires a pig-iron the composition of which must only vary within relatively slight limits, and the economical production of which thus depends on the natural conditions of deposits which are not met with in all iron and steel districts. On the other hand, the open-hearth process accommodates itself to very diverse working formulæ, and the proportion of pig-iron in the charge being capable of variation within the widest limits—from 100 per cent. in the ore process, where the charge does not permit of scrap, but only of pig-iron with the corresponding quantity of ore down to 30 per cent. and even 25 per cent. in the scrap process.

In the case of districts with ore moderately phosphoric, giving a "bastard pig," containing, for instance, 0.8 to 1 per cent. of phosphorus, it does not appear a priori impracticable to make basic pig by embodying in the charge a calculated percentage of phosphoric additions. Once the process was permanently established for the whole of the works (blast furnaces and steel works), such phosphoric additions could naturally be furnished by the scoria of dephosphorization itself. The basic process is, therefore, not necessarily limited to districts supplying ore of the basic class, such as the minettes in Lorraine; whilst, on the other hand, the Bessemer process is only possible when hematite ores are available. The progressive diminution of the reserves of hematite ores in the world consequently tends to restrict more and more the possibilities of the Bessemer, and, at the same time, those of the acid open-hearth processes.

With due acknowledgments of the qualities of basic Bessemer steel when properly manufactured, it must be recognized that open-hearth steel presents, cœteris paribus, a greater regularity of quality, and appears best suited for certain manufacturers, such as boiler-plates, tyres, axles, forgings, tubes etc., as well as for all pure and semi-pure steels in general and special steels. The great elasticity of the open-hearth process may also be pointed out. On the other hand, the process is disadvantageous owing to the relative slowness of furnace refining, and the price of open-hearth steel is generally higher than that of converter steel. In this connection, the price of producer coal forms an essential element in the cost of refining in the open-hearth furnace.

The United States.—The contest in the United States is limited to the Bessemer and open-hearth processes, the latter gaining on the former year by year. Two principal facts dominate the situation. On the one hand there are the growing demands on the part of consumers (particularly by the railways) from the standpoint of the purity of the metal, and on the other the content of phosphorus in the red hematites from Lake Superior. These great deposits—which have already yielded over 300,000,000 tons, and the reserves of which are still estimated by the United States Geological Survey at 3,500,000,000 tons, furnish about three-fourths of the American production of iron ore. The deposits, moreover, constitute the most important reserves, in the country, as the resources at present available are only estimated (the Stockholm Congress of Applied Geology) at 4,250,000,000 tons for the whole of the United States, of which the Lake Superior district is credited with 82 per

* Bulletin of the Société de l'Industrie Minerale.

cent. But these deposits furnish an increasing proportion of non-Bessemer ore; that is to say, too phosphoric for the manufacture of pig-iron for the acid Bessemer process. It is known that the maximum phosphorus content allowed in the ore in America for Bessemer treatment has been 0.044 per cent. for a long time past, which, with a yield of 50 per cent. of iron corresponds to about 0.09 per cent. in the pig-iron and 0.1 per cent. in the steel. The tonnage of Bessemer steel rails supplied in 1910 was only 1,949,000 tons, as compared with 3,434,000 tons in 1907, whereas the quantity of basic open-hearth rails, which was only 257,000 tons in 1907, rose to 1,743,000 tons in 1910.

Thus, through the natural conditions of the ore deposits and the greater exigencies of consumers there is a progressive diminution of the possibilities of the converter to the advantage of the basic open-hearth furnace, which has for several years furnished more than one-half of the production of steel. As for the acid open-hearth process, which depends on the scrap market, its prospects are most restricted. It is usually reserved for the manufacture of pure and semi-pure steels, with pig-iron having a very small content of phosphorus—much purer than those readily used with the Bessemer process. Thus its percentage seems likely to decrease.

Whether the basic converter will ever be established in the United States seems more than doubtful. The principal ore deposits do not yield basic ore, and the non-Bessemer hematites from Lake Superior, which are too impure for the acid converter, are much too poor in phosphorus for the manufacture of pig-iron for basic conversion. Suitable ores could only be found in some secondary deposits of relatively low production and limited reserves. Moreover, none of them appears to possess hitherto the regularity of phosphorus content which characterizes the oolitic deposits in Lorraine, and which constitutes a condition which is so essential for the economical manufacture of basic pig-iron. It therefore does not seem in the present condition of the deposits that the basic process is destined to play an important part in the American iron and steel industry.

Germany and Luxemburg.—The situation in Germany and Luxemburg is very different. The perdominance of the basic process is explained when it is considered that four-fifths of the iron ore produced in the Customs Union, the total of which amounted to 28,700,000 tons in 1910, are yielded by Alsace-Lorraine and Luxemburg; that is to say, by the minette region which exclusively supplies basic ores. Excluding the annexed portion of Lorraine and the Grand Duchy of Luxemburg, Germany proper scarcely furnishes from 5,000,000 to 6,000,000 tons, and one of her most productive deposits—that of Ilsede—yields basic ore. The output of ore in Germany, including Luxemburg, is considerably less than the consumption, and the difference between the two figures tends to increase in the direction of growing imports. In 1910 the production reached 28,710,000 tons, the imports 9,817,000 tons, the exports 2,953,000 tons, and the total consumption 35,574,000 tons.

The excess of imports over the exports of iron ore represent at present about one-fifth of the consumption as compared with one-seventh three years ago. Sweden remains the principal country from which ore is imported into Germany, and is followed rather closely by Spain, but the progress made by imports from France has been rapid; they now form 18 per cent. of the total imports as contrasted with 9 per cent. three years ago, and it is possible that they will occupy the first position in the course of a few years. But these imports originate almost entirely from the Briey basic, or minette district. As far as the Swedish ores are concerned, they are mostly phosphoric magnetites, which are largely used by the Westphalian works for the enrichment of their basic charges. The most important deposits in Sweden, both from the point of view of present production and that of the known reserves. are, moreover, those of phosphoric ores. But their importance is secondary as compared with the minette district, the output of which was 36,182,000 tons in 1910, and the recognized resources of which are estimated at over 5,000,000,000 tons. These deposits, which constitute the largest reserves of ore in the world, assure a brilliant future for the basic process both in France and Germany, including Luxemburg.

The production of ore in Luxemburg rather tends to decrease, and that of Lorraine progresses slowly, but that of Meurthe and Moselle is growing with enormous rapidity owing to the development in the Briey basin. However, if the increase in the output in the minette district should be considerable in the near future, the percentage of basic Bessemer steel can hardly increase very much at the expense of that of open-hearth steel. It seems, indeed, that for Germany and Luxemburg the state of equilibrum may be substantially reached between the basic Bessemer and the open-hearth processes, which divide nearly the whole of the production of raw steel. The importance of the acid processes is at present practically nil, being 1.1 per cent. for acid open-hearth and 1.3 per cent. for acid Bessemer, as compared with 37.3 per cent. of basic open-hearth and 60.3 per cent. of basic Bessemer. On the one hand the development of the basic process involves a co-relative development of the open-hearth (scrap) process for the utilization of rolling-mill waste. On the other hand, the open-hearth furnace, working with a high percentage pig-iron, is gaining increased ground even in Germany, owing to the improvements recently introduced in the methods of working, and the advantages offered by the process in districts which only yield bastard ores.

STEEL CASTINGS.

A lecture on "Steel Castings" was delivered before the London branch of the British Foundrymen's Association by Mr. H. Brearly, of the Brown-Firth Research Laboratory, Sheffield.

The lecturer pointed out that the coarse crystalline appearance which the fracture of a steel casting was supposed to have was not now a sufficient distinction between castings and forgings. Examples of the coarse crystalline fractures of steel cast in sand moulds and slowly cooled were exhibited, and also illustrated by lantern slides, side by side with portions of the same casting after heat-treatment. The exposed fractures of the latter were in all respects indistinguishable from well-wrought forgings. The lecture was mainly devoted to the processes involved and the structural changes taking place between these two extremes.

The lecturer emphasized the workshop value of careful observation of fractured and prepared surfaces with a hand lens or any other available magnifying outfit; and then showed by a series of low-power photographs the wonderfuly perfect structure of the interior of separate crystalline grains of mild steel. By the same means the defects arising in and about the crystalline grains were demonstarted, and a clear impression conveyed of the objects to be attained by annealing.

The portion of the lecture which dealt with the fragility of unannealed steel castings was well illustrated and conveyed a clear reason for their erratic behavior. The lecturer thought it highly undesirable that unannealed castings

should be brought into any kind of service where trustworthiness was called for; and showed, quite apart from the question of cooling stresses, how they might be expected to fail and how the important question as to whether or not a casting had been successfully annealed could be determined by simple means. The main object to be accomplished by annealing was said to be the elimination of the coarse crystalline structure, due to cooling from the liquid state, and the substitution of a much finer structure by methods which varied with the composition of the steel. Some very clear slides illustrated the hindrances, which occurred in uncontrollable ways, and prevented the attainment of this object, and led also to that kind of rupture between the crystals known to the foundrymen as pulling.

The pulling of metal as it passed from the fluid to the solid state was only briefly referred to, and illustrated by a few instances occurring in simple shapes usually cast in chill moulds; but more attention was paid to the manner in which castings of varying cross-section might bring themselves to an untimely end during cooling from a red heat to atmospheric temperatures. Alloy steels appeared to be very tricky in this respect, which accounted to some extent for the unwillingness of many manufacturers to utilize them for sand castings. It would appear, however, that the difficulties were of such a kind as could be overcome by intelligent care and close observation.

IRON AND STEEL INDUSTRY IN BRAZIL.

A decree has been passed in Brazil which grants power to Mr. A. Thun, or to a company which he may form, to establish in the municipal district of Ouro Preto, Minas Geraes, blast furnaces capable of producing 50,000 tons of pig-iron annually, this amount to be increased by 10,000 tons until a yearly capacity of 100,000 tons is reached. The plant is also to be suitable for the manufacture of rolled iron and steel. The contract provides for the granting of certain State privileges for the encouragement of the iron and steel industry in Brazil.

QUEBEC'S LANDS AND FORESTS REPORT.

The total revenue of lands and forests amounted to $1,229,928, states the Minister of Lands and Forests of the Province of Quebec, Honorable Jules Allard, in his introduction to a recently published report, for twelve months ending June 30th, 1911. The ground rents due on timber licenses brought in $221,215; the dues on timber cut under such licenses, $821,719; penalties for infringements $44,730; accrued interest $7,798, and bonuses on transfer $31,444, making a total of $1,126,907. On account of greater production the stumpage dues brought in nearly $85,000 more than in the previous year, although the new tariff was not yet applicable. Through the increase in stumpage dues and ground rents and also by reason of the rapid settlement of the public lands, the Minister of Lands and Forests reports that the department is sure of a yearly revenue of nearly $1,500,000. The expenditure of the department includes $85,000 for surveys, $16,523 for protection against fire, and $4,000 for the Forestry School. The salaries and disbursements of forest rangers amounted to $23,546. Woods and forests general expenses amounted to $36,199.

The area under license during the year amounted to 70,138 square miles. The amount of square timber cut was 109,406 cubic feet. The cut of spruce, hemlock, balsam, cypress, cedar, white birch and poplar, saw logs and boom timber totalled 498,624,000 feet b.m. The cut of white pine and other varieties of saw logs and boom timber amounted to 154,429,708 feet b.m. The cut of red pine, saw logs and boom timber, amounted to 21,623,970 feet b.m. The cut of white pine 11 inches and under for saw logs amounted to 62,112,914 feet b.m. The quantity of poles cut was 203,586 lineal feet. The cut of pulpwood amounted to 345,206 cords of 128 cubic feet. Of this quantity 180,803 cords were shipped out of Canada. The cut of firewood was 3,808 cords. Railway ties were manufactured to the number of 608,429, and pickets to the number of 109,734. The cut of shingles amounted to 8,373,000. Spool wood was cut to the extent of 8,981 cords. Of posts and rails, the output was 44,372 pieces, and 755 cords of lathwood were manufactured.

ENGINEERING NOTES.

St. Lambert, P.Q.—The Montreal Harbor Board did not encourage the proposal of this municipality regarding the extension of the sewer from St. Lambert.

Saskatoon, Sask.—The municipal filtration plant is now ready for the placing of the sand on the filter beds. It is expected that the plant will be in operation by May 1st next.

North Vancouver, B.C.—This municipality have commenced construction work on a new reservoir. Rice Lake is being converted for water storage in connection with this project.

British Columbia.—A start has been made on the scheme to reclaim 14,000 acres of fine land in the lower Fraser Valley, south of New Westminster. The cost will be $135,000.

Saskatoon, Sask.—There is serious talk of a forestry station being established near this city. The Dominion Government have allowed $20,000 in the supplementary estimates for this purpose.

Toronto, Ont.—The municipal council have taken the first steps toward the consideration of a new source of water supply for this city. Certain members of the municipal department have prepared a scheme that is expected to do away with the intake, as used at present, and the filtration plant. The plan is to dig a well on the lake shore and allow it to fill with water. The water having filtered through several hundred feet of sand before it reached the well, would be as pure as the most elaborate plan of filter beds could make it. From the well the water would flow to the pumping station at the foot of John Street by gravitation, as it does now from the intake in the lake. It is proposed to have the well from 70 to 100 feet deep, according to the distance required to reach rock-bottom. It will be 50 feet in diameter and will be covered. The well will be simply a big iron pipe faced with concrete. The water will filter into the tank from the bottom. It is estimated the cost of such a well would be $100,000, and that it will supply 18,000,000 gallons of pure water per day. Petrolea and London have tried the plan with great success.

PERSONAL.

Mr. T. H. Bryson, of Pembroke, Ont., has been appointed municipal engineer of Brockville, Ont.

Mr. Albert S. Goodeve, M.P., has been appointed to the Board of Railway Commissioners for the Dominion of Canada.

Mr. Lea, waterworks engineer for the city of Vancouver, B.C., has been granted a leave of absence and will seek a return of his health in the eastern portions of Canada.

Mr. Frederick L. Riggs has been appointed to the position of secretary of the Civic Guild. Mr. Riggs is the manager of the Imperial Construction Company, Quebec Bank Chambers, Toronto.

Mr. George E. Herrmann has been appointed to the management of the Vancouver branch of the engineering firm of Robert W. Hunt and Company, Ltd. The address of the new offices is 415 Bank of Ottawa Building.

Mr. Arthur Scott has been appointed manager of the Dominion Steel Company. Mr. Scott is a graduate of McGill University and has had considerable experience with the chemistry of iron and steel and substances used in their manufacture.

Mr. John A. Bensel, M. Am. Soc. C.E., state engineer of New York, on March 25th delivered an illustrated lecture on "The Construction and Maintenance of the State Roads of New York" before the graduate students in highway engineering at Columbia University.

Messrs. A. W. McConnell, B.A., Sr., and Stanley Makepeace, B.S., have formed a partnership and will enter the practice of architecture with their offices in the Kent Building, Toronto. Mr. McConnell was lecturer in architecture at the University of Toronto, and Mr. Makepeace was a member of the late firm of Makepeace and Makepeace, Syracuse, N.Y.

COMING MEETINGS.

CANADIAN INSTITUTE.—198 College Street, Toronto. Saturday Evening Lectures, 8 p.m. April 13th.—"Lantern Experiments on Reaction in Non-homogeneous Systems," by Prof. Kenrick, Toronto University. April 20th—"Chemical Interpretations of Vital Phenomena," illustrated. Prof. Leathes, Toronto University.

THE CLEVELAND ENGINEERING SOCIETY.—Special Meeting, Tuesday, April 23rd, 1912, Chamber of Commerce Bldg., Cleveland, O. "Steel and its Heat Treatment" (Illustrated), by Robt. R. Abbott, Metallurgical Engineer, The Peerless Motor Car Co. F. W. Ballard, Secretary.

ONTARIO MUNICIPAL ASSOCIATION.—Annual convention will be held in the City Hall, Toronto, on June 18th and 19th, 1912. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ont.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary, Professor C. H. McLeod.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary-Treasurer, R. W. Macintyre

QUEBEC BRANCH—Chairman, P. E. Parent; Secretary, S. S. Oliver. Meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving: Acting Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

MANITOBA BRANCH—Secretary E. Brydone Jack. Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—Chairman, Geo. H. Webster: Secretary, H. K. Dutcher, 319 Pender Street West, Vancouver. Meets in Engineering Department, University.

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

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION.—President, Chas. Hopewell, Mayor, Ottawa; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

UNION OF ALBERTA MUNICIPALITIES.—President, H. H. Gaetz, Red Deer, Alta.; Secretary-Treasurer, John T. Hall, Medicine Hat, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

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

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

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bec, Lemberg; Secretary, Mr. Heal, Moose Jaw.

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

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

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

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

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

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

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

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

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN FORESTRY ASSOCIATION —President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewit, General Manager Consumers' Gas Company, Toronto; J. Keillor, Secretary-Treasurer, Hamilton, Ont.

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

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

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

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

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

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

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

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

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

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

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. V. Ross.

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

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

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

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

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

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

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

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

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

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

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

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

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5. Beaver Hall Square, Montreal, Que.

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

SOCIETY OF CHEMICAL INDUSTRY.—Dr. A. McGill, Ottawa, President; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, J. P. McRae; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc. Printed forms for the purpose will be furnished upon application.

PLANS AND SPECIFICATIONS ON FILE.

The following Plans (P.) and Specifications (S.) are on file for reference only unless otherwise noted at the office of The Canadian Engineer, 62 Church Street, Toronto:—

Bids close		Noted in issue of
4-11	Grading, sanitary sewers, cement walks, etc., Lethbridge, Alta.....(P. & S.)	3-14
4-15	Cement sidewalks, Battleford, Sask. ..(P. & S.)	4-4
4-30	Tunnel sewer, Edmonton, Alta. .....(S.)	4-4

(Battleford and Lethbridge plans and specifications are on file at The Canadian Engineer Office, 820 Union Bank Building, Winnipeg.)

TENDERS PENDING.

In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Battleford, Sask., laying cement sidewalks	Apr. 15.	Apr. 4.	68
Calgary, Alta., concrete structures	May 1.	Mar. 28.	70
Calgary, Alta., designs for aqueduct	May 1.	Feb. 22.	70
Calgary, Alta., steel highway bridges	Apr. 15.	Mar. 14.	68
Edmonton, Alta., tunnel sewer	Apr. 30.	Apr. 4.	72
Goderich, Ont., extension to breakwater and dredging	Apr. 15.	Mar. 21.	70
Hamilton, Ont., water works extension	Apr. 10.	Mar. 28.	72
Holland Island, B.C., lighthouse	Apr. 20.	Mar. 21.	60
Kentville, N.S., academy building	Apr. 15.	Apr. 4.	59
Little Pines, Sask., school house, etc.	May. 6.	Apr. 4.	60
Lethbridge, Alta., grading, sanitary sewers, etc.	Apr. 11.	Mar. 14.	70
Lion's Head, Ont., extension wharf	Apr. 16.	Mar. 28.	60
London, Ont., cast iron pipe.....		Mar. 28.	72
Medicine Hat, Alta., church	Apr. 12.	Mar. 28.	59
Moose Jaw, Sask., water-tube boilers, etc.	Apr. 17.	Mar. 28.	59
Moose Jaw, Sask., supply of coal	Apr. 13.	Mar. 21.	59
Moose Jaw, Sask., cast-iron pipe and specials	Apr. 15.	Apr. 4.	74
Moose Jaw, Sask., sewer pipe and specials	Apr. 15.	Apr. 4.	74
Muncey, Ont., alterations to Industrial School	May. 1.	Apr. 4.	60
Ottawa, Ont., coal	Apr. 10.	Mar. 28.	60
Penticton, B.C., power station..	Apr. 18.	Apr. 4.	60
Point Atkinson, B.C., concrete tower, etc.	Apr. 20.	Mar. 21.	60
Point Grey, B.C., plans for university	July 31.	Feb. 7.	60
Prince Albert, Sask., outfall Sewer	Apr. 15.	Apr. 4.	74
Port Arthur, Ont., fire alarm system	Apr. 15.	Apr. 4.	72
Regina, Sask., water collecting pipe lines, etc.	Apr. 12.	Apr. 4.	74
Sarnia, Ont., wharf and dredging basin	Apr. 18.	Mar. 28.	60
Saskatoon, Sask., sewer pipe ..	Apr. 19.	Apr. 4.	72
St. Boniface, Man., sewer	Apr. 15.	Mar. 28.	60
St. Jerome, Que., hydro-electric installation		Feb. 7.	68
Sudbury, Ont., sewers, etc.	Apr. 17.	Mar. 21.	60
Swan River, Man., steel bridge.	Apr. 22.	Apr. 4.	74
Toronto, Ont., St. Alban's Cathedral	Apr. 22.	Apr. 4.	60
Toronto, Ont., concrete walks ..	Apr. 19.	Mar. 28.	60
Winnipeg, Man., asphalt wagons.	Apr. 15.	Apr. 4.	72
Winnipeg, Man., machine shop..	Apr. 18.	Mar. 28.	60

TENDERS.

Arborg, Man.—Bulk tenders will be received up till May 1st, 1912, for all of the works and materials required in the erection and completion of a two-roomed school, Arborg. J. P. Palsson, secretary-treasurer, Arborg, Man.

Calgary, Alta.—Tenders will be received at the office of the Canadian Pacific Railway Division Engineer, Calgary, up to noon of April 15th, 1912, for the placing of contracts for subway at Ninth Avenue East, Calgary. Form of tender at Assistant Engineer's office, Strathcona, and Chief Engineer Winnipeg, also N. E. Brooks, Canadian Pacific Railway Division Engineer, Calgary.

Calgary, Alta.—Tenders will be received at the office of N. E. Brooks, Canadian Pacific Railway Division Engineer, Calgary, up to noon of April 22nd, for the placing of concrete for overhead bridge at Anthony Street, Strathcona. Forms of tender at this office, also at Assistant Engineer's office, Strathcona, and Chief Engineer, Winnipeg.

Calgary, Alta.—Tenders will be received up to noon of April 15th, 1912, for the erection of approximately 118 miles of single circuit telephone line in the Eastern Section of the Canadian Pacific Railway Company's Irrigation Block. Full particulars may be had on application. A. S. Dawson Chief Engineer, Canadian Pacific Railway, Calgary.

Edmonton, Alta.—Tenders will be received by the City Commissioners until April 30th, 1912, for the construction of a reinforced concrete sewer. (See Advt. in Canadian Engineer).

Hamilton, Ont.—Tenders will be received at the offices of Munro and Mead, Architects, Hamilton, up till noon, April 12th, 1912, for the various trades required in the erection of a Public school at Burlington, Ont. Plans and specifications may be seen at the offices of the Architects and also at the office of Mr. Blair, Burlington.

Macdonald, Man.—Tenders will be received by H. Grilk, secretary-treasurer, Municipality of Macdonald, until noon on Wednesday, April 24th, 1912, for the grading of about 40 miles of roads in the Municipality of Macdonald, location of which may be seen at the clerk's office, Sanford.

Macklin, Sask.—Tenders for the construction of a four room brick school building, will be received up to April 16th, 1912. Plans, etc., at J. F. Cairns' hardware store, Saskatoon. A. W. A. Corscadden, secretary-treasurer, Macklin, Sask.

Municipality of St. Paul, Man.—Tenders will be received until April 18th, 1912, for the draining and grading to the East two mile road, the Hoddinott road, the East Main road, and the West Main road. Plans, etc., at the Municipal Office at Birds' Hill, or at the office of the Highway Commissioner, Parliament Buildings, Winnipeg. W. Gorman, Secretary-Treasurer, Rural Municipality of St. Paul.

Ottawa, Ont.—Tenders for the construction of a concrete retaining wall at Long Branch Rifle Range, Toronto, will be received up till noon of April 15th, 1912. Plans, etc., at the offices of the General Officer Commanding 2nd Division, 215 Simcoe Street, Toronto; and the Director of Engineer Services, Department of Militia and Defence, Ottawa. Eugene Fiset, Colonel, Department Minister, Department of Militia and Defence.

Ottawa, Ont.—Tenders will be received until April 30th, 1912, for the erection of a lifeboat house and dwelling combined, at Bay View, N.S. Plans, etc., at the office of A. Johnston, Deputy-Minister, Department of Marine and Fisheries, Ottawa, and at post offices, Digby, Annapolis, Yarmouth, Weymouth, and Westport.

Ottawa, Ont.—Tenders will be received until April 22nd, 1912, for the construction of an 80-ft. single screw steel tug. Plans, etc., at the office of J. G. Sing, Esq., District Engineer, Confederation Life Bldg., Toronto; J. L. Michaud, Esq., District Engineer, Merchants' Bank Building, Montreal; G. G. Scovil, Esq., Superintendent of Dredges, St. John, N.B.; and G. M. Graham, Esq., Superintendent of Dredges, New Glasgow, N.S. R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—The call for tenders for the construction of a wharf and for dredging basin at Sarnia, Ont., has been cancelled. R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—Sealed tenders for improving lower extreme to Lock No. 15, will be received until April 26th, 1912, addressed to L. K. Jones, Secretary Department of Railways and Canals, Ottawa. Plans, etc., at the office of the Chief Engineer of the Department of Railways and Canals, Ottawa, and at the office of the Resident Engineer of the Ontario-St. Lawrence Canals, Ottawa.

Ottawa, Ont.—Tenders for alterations to interior fittings, post office, Guelph, Ont., will be received at the office of R. C. Desrochers, Secretary, Department of Public Works, Ottawa, until April 17th, 1912. Plans, etc., can be seen on application to Mr. R. McLeod, caretaker, public building, Guelph; Mr. T. A. Bastings, Clerk of Works, Postal Station F, Toronto; and at the Department of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received until April 22nd, 1912, for interior fittings, Post Office and Customs, Essex, Ont. Plans, etc., with Mr. J. Laing, Clerk of Works, Essex; Mr. T. A. Hastings, Clerk of Works, Postal Station F, Toronto, and office of R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

Penticton, B.C.—Tenders will be received until April 18th, 1912, for excavation, backfilling for, and making about seven miles of concrete pipe 18 inches diameter, including furnishing and hauling of materials; and hauling and laying of about two miles of 10-inch and 12-inch high pressure steel pipe, having partly flanged and partly ball and spigot joints. (See advt. in Canadian Engineer).

Regina, Sask.—Sealed tenders for electrical apparatus and supplies will be received by the City Commissioners, City of Regina, until noon of April 20th, 1912, for Sections 1 to 5, and until noon of May 15th, 1912, on Sections 6 to 9. (See advertisement in Canadian Engineer.)

Saskatoon, Sask.—Tenders will be received for all trades up to 20th April, 1912, for the erection of a residence and garage on Spadina Crescent for Chas. R. Hill, Esq. Plans and specifications at the office of Messrs. Thompson & Crockart, architects and civil engineers, Masonic Temple, Saskatoon.

Stratford, Ont.—Tenders will be received until April 15th, 1912, for mechanical filters, 8-ft. diameter by 20-ft. long, with all pipes, roses and fixtures. Full particulars may be obtained from W. H. Trethewey, Stratford, Ont.

Stratford, Ont.—Tenders will be received until April 22nd, 1912, for approximately 32,000 sq. yards of pavements. Specifications, etc., may be obtained on application to M. Ferguson, City Engineer. (See advt. in Canadian Engineer).

St. Norbet, Man.—Tenders will be received until April 23rd, 1912, for draining and grading of approximately 14 miles of road as follows:—8 miles on St. Mary's Road; 6 miles on Pembina Highway. All information may be had on application to the Municipal Engineer, D. R. Baribault, 607 Builders' Exchange Bldg., Winnipeg, Man. G. T. Landry, secretary-treasurer, for Ritchot, St. Norbert, Man.

Toronto, Ont.—Tenders will be received up to noon of Tuesday, April 23rd, 1912, for the construction of concrete abutments and concrete floors for the following bridges: Malton Bridge, North Woodbridge Bridge, and Cockburn's Bridge. Plans, etc., at the office of Frank Barber, Civil Engineer, 57 Adelaide Street E., Toronto. (See advt. in Canadian Engineer).

Toronto, Ont.—Tenders for the supply of one concrete batch mixer will be received by the Chairman, Board of Control, City Hall, Toronto, up to noon of April 17th, 1912. (See advertisement in Canadian Engineer).

Toronto, Ont.—Tenders will be received until April 23rd, 1912, for the construction of Sections Nos. 10 and 11, High Level Interceptor. G. R. Geary (Mayor), Chairman, Board of Control, City Hall, Toronto. (See advt. in Canadian Engineer).

Toronto, Ont.—Plans and specifications for large additions to the plant of the Goldie & McCulloch Co., Limited, Galt, Ont., are being prepared by T. Pringle & Son, Limited, Industrial Engineers, Continental Life Building, Toronto.

Toronto, Ont.—Tenders will be received by the Chairman, Board of Control, City Hall, up to noon of April 23rd, 1912, for the construction of Storm Overflow Sewer, Main Garrison Creek, Section No. 1. Specifications, etc., at the office of the City Engineer, Toronto. (See advt. in Canadian Engineer).

Vancouver, B.C.—Tenders will be received until May 2nd, 1912, for the following fire apparatus; One auto gasoline pumping engine; two auto hose wagons; one combination chemical engine and equipment for each car. Specifications may be seen at the office of Wm. McQueen, City Clerk, City Hall, Vancouver, B.C.

Winnipeg, Man.—Tenders are to be called at once for four miles of pavement by the Municipality of Assiniboia, Man. It will extend from the city limits, Portage Avenue to St. Charles. F. Ness, Clerk, Kirkfield Park, Winnipeg.

Winnipeg, Man.—Tenders for construction materials and supplies for the year 1912 will be received at the office of the Chairman of the Manitoba Government Telephone Commission, up to noon, April 22nd, 1912. Form of tender, specifications, etc., may be obtained from W. M. Houston, Supply Agent, McDermot & Charlotte Sts., Winnipeg.

Winnipeg, Man.—Tenders will be received up to noon of April 18th, 1912, for supply of labor and materials required for the erection of an electrical substation at Garson Quarries near Tyndall, Man. Plans, etc., at the office of the City Light and Power Department, 54 King St. M. Peterson, Secretary, Board of Control Office, Winnipeg.

Winnipeg, Man.—Tenders will be received by the Chairman, Board of Control, until April 16th, 1912, for supply of 1,250-⅞-inch diameter x 4-⅞-inch Tobin Bronze Bolts. Specifications, etc., at the office of the City Engineer, 223 James Avenue. M. Peterson, Secretary, Board of Control Office, Winnipeg.

Winnipeg, Man.—Tenders will be received up to noon of April 16th, 1912, for all trades except plumbing, heating and electric wiring required in the erection of a fireproof garage building on Henry Avenue, Winnipeg, for the Manitoba Government Telephone Commission. Plans, etc., at the office of the architect in the Telephone Building, at the corner of Charlotte St., and McDermont. F. C. Patterson, Chairman of Commission.

Winnipeg, Man.—Tenders for the erection and completion (except plumbing, heating and ventilation) of the new West End School Building, Yorkton, Sask., will be received by the Secretary-Treasurer of the Yorkton School Board, up to noon of April 22nd, 1912. Plans and specifications may be seen at the Winnipeg or Yorkton office of the Architect, J. Pender West, 607-9 Somerset Block, Winnipeg, and 9 Dunlop Block, Yorkton.

Winnipeg, Man.—Tenders for the supply of one or two electric trucks will be received at the offices of M. Peterson, Secretary, Board of Control Office, Winnipeg, Man., up to noon of April 17th, 1912.

CONTRACTS AWARDED.

British Columbia.—The B.C. Electric Railway Company has awarded a contract of 24 passenger cars to the St. Louis Car Company, of St. Louis. The cost of the new rolling stock with electrical equipment will be about $250,000.

Calgary, Alta.—The municipal council have awarded the following contracts for street paving:—

Curb and gutter, Crown Paving Company, 44c. per lineal foot.

Catch basin, Frank Fahrenbach and Company, $14.85.

McGibbon Bros., all sidewalks in ward one, west of the Elbow River, and north of the main line of the C.P.R., at 9¾c. per sq. foot, and all in ward two at 9⅞c. per sq. foot.

Frank Fahrenbach and Company, all sidewalks in ward three and ward one, east of the Elbow River, between the Bow River and the main line of the C.P.R. at 9c. per sq. foot. C. M. Payne, all sidewalks in ward four at 9c. per sq. foot.

Calgary, Alta.—The contract for the supply of one 2,500-K.w. steam turbine with Vickers generator for the city of Calgary municipal electric light and power plant has been awarded to Messrs. Laurie & Lamb, for $42,750, and for switchboards and apparatus, to Messrs. P. S. McLaren, Ltd., for $6,640.40.

Calgary, Alta.—The City Council have passed recommendations of the City Commissioners for the awards of the paving contracts as follows: A contract for 100,000 yards of bitulithic pavement will be awarded to the Canadian Mineral Rubber Company at $2.50 per yard; 100,000 yards of sheet asphalt to the Calgary Paving Company at $2.05 per yard; 70,000 yards of asphaltic concrete to the Crown Paving Company at $2.12 per yard; 50,000 yards of bitulithic to the Bitulithic and Contracting, Ltd., at $2.85 per yard, and 25,000 yards of granitoid to the Alberta Granitoid Company.

Galt, Ont.—The contract for the erection of the new Y.M.C.A. building has been awarded to the lowest tenderer, Mr. A. E. Faulkner, of Brantford, the price being $45,242.50.

Kingston, Ont.—Dormitory, R. M. C.; contractor, Michael Sullivan, of Kingston.

Montreal, Que.—John Millen & Son, Limited, of Montreal, have been awarded the contract for chain drives, aggregating 200-h.p., for the big addition to the Grand Trunk Pacific Grain Elevator at West Fort William, which is being erected by John S. Metcalfe & Co., the well-known Grain Elevator Engineers. The chain drive selected is the famous Coventry Noiseless.

Niagara Falls, Ont.—Nine bids were received for the construction work of the 75,000 sq. yards of pavement, but the tenders were not opened. Bids were returned and the matter was deferred for 60 days. W. J. Seymour, City Clerk.

North Bay, Ont.—Additions to Land Titles Office Building; Messrs. Robert Wallace & Son, contractors for building addition; the Cochrane Hardware, Ltd., for heating, plumbing and wiring.

North Toronto, Ont.—Mr. C. E. Lewis, of Toronto, has received the contract for the erection of a concrete bridge on Albertus Avenue, for which he will receive the sum of $1,923.

Ottawa, Ont.—Two 150 cu. yd. capacity steel hopper scows; the Brown Machine Co., Ltd., of New Glasgow, N.B.

Ottawa, Ont.—Mr. Geo. Ambridge has been awarded the contract for the building for the Dominion Wire Cloth and Manufacturing Company, to be erected in Mechanicsville.

Regina, Sask.—"Contract Number 1," for excavating the trench, laying concrete pipes, and backfilling Seventh Avenue from Albert Street to Toronto Street, was awarded to Wilson, Townsend and Saunders, of Moose Jaw, whose figure was $18,312.38. This company's tender was also accepted for similar work from Fourteenth Avenue out to the septic tank. Here the tender was for $17,538.94. The other tenderers in both cases were Robert J. Leckey and the Parsons Construction Company. Wilson, Townsend and Company were awarded a $24,893 contract for the construction of two filter beds, one stand-by tank and pipe lines. For blocks for false floors in the filter beds, the tender of Freeland Brothers, at $4,693, was accepted. The contract for the steel roof over the filter beds went to the Western Steel and Supply Company, at $8,400.

Saskatoon, Sask.—The new sedimentation basin for the municipality will soon be completed. It is to give settling facilities to 700,000 gallons of water additional to the present supply.

Saksatoon, Sask.—Labor on sanitary sewers and water construction; Prices were all unit prices; Contract divided into three sections as follows: Section 1 to Messrs. Flanagan & Murphy, Dauphin, Man. Section 2 to Messrs. Robinson & Foster, Spokane, Washington; Section 3 to Mr. A. R. Campbell, Saskatoon.

Saskatoon, Sask.—Labor on storm sewers; Saskatoon Construction & Engineering Co., 36-inch storm sewer.

Vancouver, B.C.—The City Council have awarded the contract for the construction of the big concrete Balaclava Street sewer main, which will form a trunk in the Greater Vancouver sewerage scheme, to Palmer Brothers & Henning, giving that firm the preference over Romano, Pinto & Co. The tenders submitted to the board of works were:—Palmer Brothers & Henning, $89,071; Romano, Pinto & Co., $89,105.90. The Graff Construction Company tendered at about $2 lower than Palmer Brothers & Henning. These three were much lower than the other half dozen contractors who also figured.

Vancouver, B.C.—The contract for concrete work in connection with the proposed new piers of the Great Northern Railway on Burrard Inlet has been awarded to Messrs. Cummings & Kiehel, of Seattle. It will involve the expenditure of $125,000. Messrs. H. Chase & Co., Seattle, have the contract for pile driving. The dredging contract has not yet been let. The entire improvement will cost over $400,000.

Victoria, B.C.—The municipal council of Oak Bay have awarded the contract for the construction of a trunk sewer to Messrs. Naylor Bros., of Huddersfield, England; their price being $119,260.75. The other tenders were:—Robert McLean & Company, $138,400; Hugh McDonald, $145,359.45; Victoria Machinery Company, $153,545.90; Jeffry & Burton, $156,076.25; Jas. McDonald & Company, $168,267.

Victoria, B.C.—The municipal council of Oak Bay have awarded the contract for a supply of water pipe to Messrs. Robert McLaren & Sons, of Glasgow, through the Messrs. Forsyth & Co., who represent this firm. Their figures were $28,701.21 (including $690.50) for specials. Other firms tendered as follows:—Messrs. Evans, Coleman & Evans, $28,861.60 (including $675.70 for specials); Victoria Machinery Company, $29,203.07; W. J. Winterburn, $31,271 (including $567 for specials); Canada Foundry Co., $31,423.50 (including $675 for specials); Robertson Godson Co., $36,867.95; Hutchison Bros., $784 for specials.

Winnipeg, Man.—The Carter Halls Aldinger Company have been awarded the contract for the erection of large garage for the Detroit Electric Automobile Co. The cost of this work is estimated at $50,000.

RAILWAYS—STEAM AND ELECTRIC.

Province of British Columbia.—The Canadian Northern Pacific Railway are planning to extend their lines toward the north. A report states that tenders for this work will be called within six weeks.

Humber River, Ont.—The new concrete pier of the Grand Trunk Railway bridge crossing this river withstood the severe test satisfactorily when the river ice broke up.

Niagara Falls, Ont.—A report states that the management of the Canadian Northern Railway are considering the construction of a railway bridge across the Niagara River in order to gain an entrance to New York State.

Winnipeg, Man.—Plans for the new Canadian Pacific Railway yards at Winnipeg, include new shops, round-houses and bridges across the Red River. Two thousand men are employed on construction.

LIGHT, HEAT AND POWER.

Province of British Columbia.—The C.P.R. is constructing a large dam on Bull River, near Cranbrook. Electrical power will be supplied to towns in the Crow's Nest as far east as Hosmer and west to Cranbrook, Moyie and Fort Steele. The company is also erecting a sawmill there.

Moose Jaw, Sask.—The municipal commissioners have received a large number of replies to their tender for the power house extension. It is reported that the proposition for an oil operated plant will not be considered to any great length.

Port Stanley, Ont.—The Hydro-Electric rates for this town have been fixed as follows:—4c. per square foot and 5c. per kilowatt for actual current used; 12c. per kilowatt for the first 30 hours, and 5c. for time additional as a commercial current consumption basis. These rates are about 25 per cent. less than the charges on the former system.

Tyndall, Man.—The Municipal Light and Power Department of Winnipeg, Man., are about to erect a substation at Carson Quarries near Tyndall. M. Peterson, Secretary,

Board of Control, will receive tenders for the erection of the building until April 18th next.

Vancouver, B.C.—The estimates of city electrician Woodroofe for new lighting standards totals $235,000. The court of revision will report on the matter.

GARBAGE, SEWAGE AND WATER.

Edmonton, Alta.—The commission reporting on a water supply have made the following recommendations:—That an additional 6,000,000 gallon low lift pump, and an additional 6,000,000 gallon service pump be installed. Installation of gauges to determine run off and rain fall at Pigeon Lake. Take water from two sources only, Saskatchewan River and Pigeon Lake. That a further investigation be taken up.

Galt, Ont.—The municipal water board are preparing to install a synchronous motor in the pumping plant. The machine will operate on the mains of the hydro-electric commission. Specifications are prepared for a one-and-a-half million gallon pump for the above. Mr. E. O. Fuce is the town engineer.

Regina, Sask.—The municipality will sink three wells with a view of increasing the water supply.

Weston, Ont.—The ratepayers will vote and decide whether they will expend the sum of $40,000 on a new sewerage system. The system will be a trunk line emptying into a filtration plant near the Humber River.

BUILDINGS AND INDUSTRIAL WORKS.

Province of Alberta.—The Canadian Pacific Railway are preparing to proceed with considerable concrete work in connection with the irrigation scheme in this province. Mr. A. S. Dawson, chief engineer at Calgary, is in possession of the details.

Brantford, Ont.—A report states that the American Radiator Company will erect an important addition to their plant. The extension will be about 750 feet in length.

Province of British Columbia.—Mr. George Collins, of the Seal Cove Fish and Cold Storage Company at Prince Rupert has announced the rough details of a new cannery near Prince Rupert. It will cost about $300,000.

Fort William, Ont.—The Northern Navigation Company will construct a new steamer. The work will be done in the yards of the Western Drydock Company, who have secured the contract. It will be 425 feet long, 55 feet beam, and cost about $750,000.

Fort William, Ont. — The management of the Western Drydock Company will enlarge their present plant by the addition of two buildings. A new machine shop 270 by 100 and a blacksmith shop of smaller dimensions are included in the plans.

Granby Bay, B.C.—The management of the Granby Consolidated Mining and Smelting Company are considering the details of a new plant to cost $1,000,000. It is reported that the new work will start in May. Mr. F. M. Sylvester is the general manager of this company and the head office is at Trail, B.C.

Guelph, Ont.—A report states that the Guelph Carpet Mills will erect a new warehouse. It will be three storeys 60 by 60. Messrs. Tanner, T. Colwill & Tanner are the architects for the new structure.

Lethbridge, Alta.—The Board of Trade have announced that a large hotel will be erected in this city. The cost will be about $300,000. Messrs Paul Fader and J. F. Davis of Calgary, are interested in the project.

Montreal, P.Q.—A ten-story office structure will be erected on the corner of Notre Dame and St. Peter Streets. Mr. John Findlay is interested in the matter.

Niagara Falls, Ont.—The management of the Sanitary Can Company are planning to construct extensive additions to their present plant. The work includes considerable concrete and steel work.

Owen Sound, Ont.—This municipality will construct a new school at an estimated cost of $35,000.

Ottawa, Ont.—Mr. C. J. Booth will erect a seven story office building in this city. Work will start on the structure about the first of May next. Mr. Albert Ewart, has prepared the plans.

Port Stanley, Ont.—The members of the congregation of Christ Church are considering the erection of a new rectory. Messrs. Thomas Meek, M. Hyndman and H. Ellison comprise the committee that will report on the matter.

Port Colborne, Ont.—The Buffalo Union Furnace Company of New York, will erect a plant at this place for the manufacture of pig-iron.

Quebec, P.Q.—The Government will call tenders at an early date for the construction of a graving dock in this city. The tenders are to be in the hands of the proper officials by May 20th.

Quebec, P.Q. — The Federal Government have called tenders for the construction of the new drydocks at this point. Tenders close on July 2nd next. The successful bidder will receive 3½ per cent. subsidy for thirty-five years on $5,000,000. The dimensions of the drydocks will be 1,150 feet long, 137 feet wide, and 37 feet deep.

Regina, Sask.—A company has been formed to drill for natural gas, and will be known as the Western Gas & Oil Company. Mr. G. F. Baxter, of Pense, Sask., is the president of the new company. They will be equipped for a depth of 2,000 feet at present, and will increase this should occasion demand.

Regina, Sask.—The management of the Cockshutt Plow Company have let the contract for the erection of a new factory in this city. It will consist of three stories and a basement constructed on the property owned by the company in Block 77 with a frontage of 150 feet on Broad Street, and 100 feet on Fifth Avenue. The plans include two large-sized heavy capacity freight elevators. The total cost is estimated in the neighborhood of $120,000.

Saskatoon, Sask.—The work of enlarging the Empire Hotel has been commenced. Mr. Herbert Lancaster is in charge of the work and Mr. Sutton is interested in the business of the hotel. The work will add forty-four additional rooms to the building.

Saskatoon, Sask.—Mr. J. C. Drinkle will erect two large stores and office buildings in this city during the next few months.

Saskatoon, Sask. — Messrs. Thompson, Daniel & Colthurst are preparing plans for the construction of a new hotel for this city. The materials of construction will be concrete and brick with stone dressing. The building will be 100 by 130 and cost about $150,000. Mr. James Barry is the proprietor.

Stanley Springs, Ont.—The plant of the western Brewing Company at this point will be enlarged by an addition to cost about $500,000. The head offices of this concern are in Winnipeg, Man.

St. Catharines, Ont.—The Canadian Bank of Commerce will erect a suitable branch office in this city during the coming summer.

St. John, N.B.—Messrs. Ames-Holden-McCready Co., Ltd., are about to erect a large warehouse in this city. It is to be of brick, five stories in height, 31-ft. x 100-ft.

Toronto, Ont.—The management of the Canadian Northern Railway announce their intention of erecting a ten-story office building on the site of the present offices of the company, Toronto and King Streets.

Vancouver, B.C.—Mr. A. A. Davidson is erecting an apartment house in this city at a cost of $150,000.

Vancouver, B.C.—A report states that the Dominion Government will erect a large terminal elevator at Burrard Inlet during the next year.

Victoria, B.C.—Mrs. S. J. Curry and Rev. T. E. Holling are interested in a project for the erection of a new church.

Victoria, B.C.—The Provincial Government have prepared plans and are about to call for tenders for the erection of a new court house, lock-up, and constables' quarters, at Arrowhead, and constables' quarters at Yale, B.C.

Welland, Ont.—The management of the Welland Machine and Foundry Company will erect a new foundry, a paint shop and storehouse and will install one or more travelling cranes.

Winnipeg, Man.—The Detroit Electric Automobile Company will erect a fine garage for their cars in this city. Solid reinforced concrete will be used throughout, and the 60-foot front will be particularly handsome. It is designed to be the most thoroughly fireproof building in Winnipeg.

BRIDGES, ROADS AND PAVEMENTS.

Alton, Ont.—A large steel bridge near this town was badly damaged by the recent floods. The bridge was three years old.

Calgary, Alta.—The commissioners have recommended to the council that the following tenders for street paving be accepted: 70,000 yds. asphaltic concrete to the Crown Paving Company at $2.12, and when required by the engineer to coat same with squeegee at the price of 10c. extra; 100,000 yards sheet asphalt to the Calgary Paving Company at $2.05; 100,000 yards to the Canadian Mineral Rubber Company at $2.50; 50,000 yards of bitulithic pavement to the Bitulithic Contracting Company at $2.85; 25,000 granitoid to the Alberta Granitoid Company at $2.65.

Calgary, Alta.—The municipal commissioners have recommended that the following tenders for street paving be accepted:—70,000 yards asphaltic concrete, Crown Paving Company, $2.12, with squeegee coat, 10c. yard extra, $2.22; 100,000 yards street asphalt, Calgary Paving Company, $2.05; 100,000 yards Canadian mineral rubber, $2.50; 50,000 yards bitulithic, Bitulithic Paving Company, $2.85; 25,000 yards granitoid, Alberta Granitoid Company, $2.65. This covers work on last year's tender and work on Ninth Avenue East, from Twelfth Street East and Second Street East, from Eighteenth Avenue to Victoria Bridge.

County of Essex, Ont.—A movement calling for the construction of a memorial driveway along the river front has been started. Mr. Charles Montreuil, warden of this county, was elected president of the association discussing the project.

Ottawa, Ont.—The Ottawa Improvement Commission will construct a driveway at a cost of $10,000, and will convert an old cemetery into a park at a cost of $14,700.

Province of Saskatchewan.—The provincial government of this province have appointed a board for the purpose of administrating the affairs of the provincial highways, etc. A method will be worked out whereby the municipal authorities will aid the provincial officers in this work. Mr. A. J. McPherson, Regina, will, in all probability, be the chairman of the new board.

Toronto, Ont.—The City Engineer has recommended that the following pavements be proceeded with:—

Pelham Street, block pavement	$9,795
Dufferin Street, block pavement	11,022
Sherbourne Street, asphalt surface	14,484
Wyndham Street, bitulithic	4,604
Crescent Road, Roc-mac (reconstruction)	10,368

Vancouver, B.C.—Paving recommendations as local improvements, calling for a total expenditure of $532,652, of which the city's share would be $136,696, have been submitted by the City Engineer to the Board of Works.

County of York, Ont.—The pavement of the Lake Shore Road from the Humber River to Mimico will be of Dolarway and not of tar macadam as previously announced. Messrs. J. H. McKnight Construction Company, Ltd., will do the paving. The offices of this company are at 152 Bay Street, Toronto.

FIRES.

Deseronto, Ont.—The plant of the Standard Iron Company was damaged by fire to the extent of $50,000.

Hamilton, Ont.—The Hamilton Facing Mills were damaged by fire to the extent of $10,000.

New Toronto, Ont.—The Brown Copper & Brass Rolling Mills were destroyed by fire on Sunday, April 7th. The loss is estimated at $125,000.

Vancouver, B.C.—Fire damaged the Foster building on Hastings Street to the extent of $232,000. This sum includes the damage to the contents, which was distributed among retail stores occupying the lower portions of the building.

CURRENT NEWS.

Brantford, Ont.—During the ravages of the overflowing of the river, a large gas main was carried away which necessitated the shutting off of the gas throughout the city.

Calgary, Alta.—The management of the Builders' Exchange have been instructed by the members to request the Canadian Northern and the Grand Trunk Pacific Railways to give all contracting work to the local contractors when those roads enter the city of Calgary. They claim that as they do considerable freighting outside contractors should be excluded from railway work in this vicinity.

Collingwood, Ont.—The Collingwood Shipbuilding Company will construct a canal and lake steamer for Keystone Transportation Company at Montreal. The new vessel will be employed in the grain and coal carrying trade between Lake Erie and Montreal. It will be 258 feet long by 42.6 feet beam, 20 feet depth, 800 horse-power engines, and have a speed of ten miles an hour. The capacity will be 2,400 short tons, or 80,000 bushels of wheat, and the cost will be approximately $140,000.

Fort William, Ont.—Arrangements are under way for the installation of a fire alarm system in this city. The citizens voted in favor of spending $12,000 on fire alarms, and tenders will be received at the city hall up to April 15th.

Niagara Peninsula, Ont.—The Dominion Government will call tenders for the construction of the new Welland Canal at an early date.

Toronto, Ont.—The Dominion Government have made a grant of $218,517 for improvements to the harbor of this city.

PATENTS.

The following is a list of patents recently issued from the Canadian Patent Offices in Ottawa. This list is furnished by Messrs. Featherstonhaugh & Company, Royal Bank Building, Toronto:—

A. Hough, explosives; N. E. Lister, flangers for railways; W. McCloskey, mop wringers; H. E. Niblett, building blocks; J. J. Carrigan, wagon brakes; C. R. Cote, electric medical apparatus; M. L. Dansereau, weak measures and distributers; J. D. Hoffman, machines for making cement shingles and the like from plastic materials; C. J. Hickling, starters for explosive engines; J. L. Marcil, street indicators; G. Maude, cattle stanchions; A. A. Mowry, set works for sawmill carriages; M. M. Passy, cream removers for milk bottles; A. Perrault, egg whips; A. H. Reid, concrete; H. C. Shipman, games; A. C. Thompson, fitting spring for mattresses and the like; L. A. Whyte, containers.

The following is a list of patents recently issued through the agency of Messrs. Ridout & Maybee, Manning Chambers, Toronto, from whom further particulars may be obtained:

Canada:—Nathaniel & Gideon Beam, thresher; Charles Maples, cloches for French garden culture; J. C. Doust, clothes-line reel.

United States:—W. F. Scott, reinforced concrete; A. Nonnington & H. G. Ackers, production of calcium of cyanamide: The Massey-Harris Company, Limited, lever mechanism.

The following is a list of patents recently issued through the patent office of Herbert J. S. Denison, Star Building, 18 King Street, West, Toronto, from whom further particulars may be obtained.

C. J. Bothwell, adding machines; Jas. Payer, hat fastener; J. C. Royce, separable electrical connection; H. B. Croker, printing presses; C. L. Williams, sleeper or ground for walls; W. N. Nicholls and A. W. Carmichael, cleat for roofing; M. J. Haney, concrete block structures; A. Roebuck, snow plow; H. C. Hogarth, filter; J. H. K. McCollum, internal combustion engine; H. R. Winter, necktie; T. G. McGonigle, rotary engine; J. D. Hoffman, cement shingle machine; S. F. Leslie, coupling device; Geo. Maude, cattle stanchion; B. F. Johnston, gang plow; F. W. Lanchester, high speed reciprocating engines; M. J. Haney, package handling appliance; Geo. Borgfeldt & Co., sheaf of wheat.

TRADE INQUIRIES.

The following were among the inquiries relating to Canadian trade received at the office of the High Commission for Canada, 17 Victoria Street, London, S.W., during the week ending March 25th, 1912:—

A Birmingham firm manufacturing plate and wire springs and similar steel goods, school and machinery accessories, etc., including all kinds of small bent plate and wire goods, twists, bows, etc., to pattern or drawing, are desirous of introducing their goods to the Canadian market.

A correspondent in South Wales has a market for white oak staves, and would like to hear from Canadian exporters.

A correspondent at Frankfort-on-Main reports a large market in Germany for Canadian corundum, and would like to hear from miners and exporters in the Dominion.

A Scottish firm of rubber tyre manufacturers make inquiry for the names of Canadian manufacturers of rubber.

From the branch for City Trade Inquiries, 73 Basinghall Street, E.C.:—

A firm of importers in Genoa, Italy, invite offers from Canadian shippers of lard, tallow, greases and soap fats generally. They would also like to hear from producers of dried codfish and provisions.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.

16177—March 25—Approving location of G.T.R. station to be erected at Houston, Coast District, B.C.

16178—March 25—Approving location of Kettle Valley Ry. from mileage 43.92 to 55, northwest of Midway, B.C.

16179—March 26—Approving location of three G.T.P. Stations situated in Coast District. B.C. (No name).

16180—March 28—Directing C.N.R. to put its main line running tracks in Saskatoon yard in good shape and condition before June 1st, 1912, pending completion of work train not to exceed six miles per hour.

16181—March 28—Authorizing Lachine Jacques-Cartier & Maisonneuve (G.T.R.) Railway Co. to cross certain streets in Montreal, Que., by overhead crossings, subways and level crossings.

16182—March 25—Rescinding Order 16122 of March 14th, 1912, and slightly amending Order 16095 March 7th, 1912, re C.N.R. Taking Lands town of Trenton, Ont.

16183—March 28—Rescinding Order 13060 of February 21st, 1911, and approving by-law of M.C.R. authorizing C. F. Daly, V.P., L. W. Landman, G.P.A., W. C. Rowley, G.F.A., and J. L. O'Brien, Chief of Tariff Bureau, to prepare and issue tariffs of tolls, etc.

16184—March 4—Rescinding Order 15938 of Febuary 6th, 1912, in so far as it authorizes construction of railway across Rachel Street, Lachine, Jacques-Cartier & Maissoneuve Ry.

16185—March 26—Directing G.T.R. to within 90 days from date of this Order install electric bell at crossing just east of Clarkson Station, Ont., 20 per cent. from Railway Grade Crossing Fund.

16186—March 26—Authorizing Province of Saskatchewan to construct highway across C.N.R. in S.W. ¼ Section 30, Twp. 47, R. 26, W. 2 M.

16187—March 27—Relieving C.P.R. from further protection at 1st highway south of St. Vincent Rd. mileage 91, near town of Owen Sound, Ontario.

16188—March 28—16189—March 26—Authorizing C.P.R. to construct three spurs from main line in S.W. ¼ of Section 28, Twp. 23, R. 29, W. 4 M., into and through Blocks Nos. 24, 25, and 30, and Block B. in subdivision of S.E. ¼ of Section 28, Twp. 23, R. 29, W. 4 M. And spur for the Calgary Brewing and Malting Co., at Coleman, Alberta.

16190—March 28—Rescinding Order 15683 of December 23rd, 1911, and recommending to the Governor-in-Council for approval rules of regulations of G.T.R. operating department.

16191—March 27—Authorizing G.T.P.B.L.Co. to cross with its Regina-Moose Jaw Branch the Moose Jaw Northwest Branch of the C.P.R. by undergrade crossing at Moose Jaw, Sask.

CAISSON SICKNESS.

A French authority has recently made public a report on his investigations into the above disease and has come to the conclusion that the distressing effects of the malady are due to the fact that when air is compressed the oxygen factor is reduced to four-fifths of the proportions that it held before compression.