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The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

BRANTFORD WATERWORKS

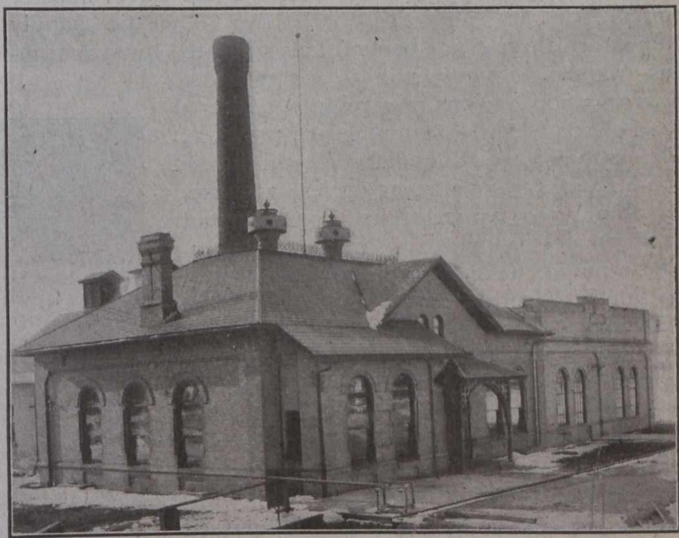
ILLUSTRATED DESCRIPTION OF A TYPICAL ONTARIO WATERWORKS PLANT—DETAILS OF EQUIPMENT.

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

BRANTFORD, Ont., derives its supply of water from an infiltration area of about 170 acres in extent, lying within and near a horse-shoe bend in the Grand River. There are intakes in the river and water is raised therefrom and discharged into the distributing pipes leading to the infiltration area. The city owns about 300 acres of land. The water is collected by two sets of lines. The first consists of two 15-inch perforated earthenware pipes about 1,700 feet long and the second consists of two 18-inch perforated tile pipes 1,200 feet long. The perforations are one-eighth inch wide and two inches long, and extend two-thirds round the pipes—the solid part being at the invert. The first lines discharge into the old pump well, which is 15 feet in diameter and 23 feet deep, and the second lines are connected to the new pump well, which is 25 feet in diameter and 29 feet deep. The hydraulic canal conveying water to Messrs. Slingby's works, passes the front of the pump-house and is slightly higher than the pump-house floor. This canal is about 100 feet wide and 8 feet deep and is controlled by gates. It is connected to the Grand River about a mile up-stream from the pump-house, where a dam with flashboards has been built across the riverbed to impound water and to increase the head. The city intakes are about a quarter of a mile below the dam.

Construction Work on Collection Gallery.

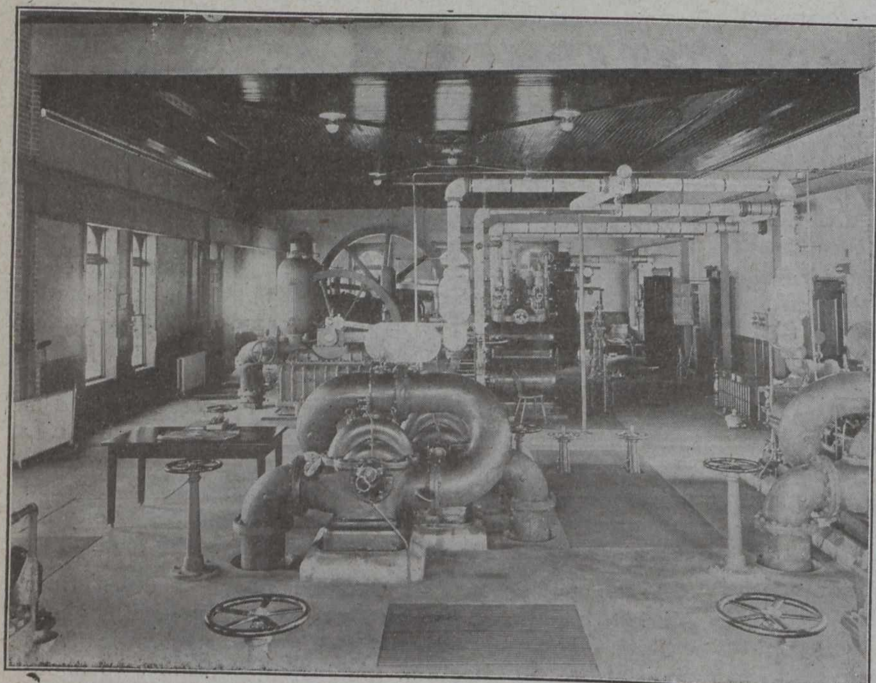
The pump-house is situated about 2 miles from Market Square and the difference in surface level is about 23 feet. The daily quantity of water pumped varies from about 1,670,000 Imperial gallons in December to about 4,250,000 gallons in March. The average daily consumption is about 2,610,000 gallons, and as the population is about 26,000 the average quantity per head is 100 gallons per day.



Pumping Station.

The pumping plant consists of: One Holly double-expansion, Corliss gear, steam-driven pump, 18-inch and 36-inch cylinders, installed in 1900. The suction is 24 inches in diameter and the delivery 20 inches. This pump with steam at 85 lbs. per square inch is rated to deliver 5,000,000 gallons per day under 80 pounds station domestic water pressure. One Worthington 1,670,000-gallon-per-day direct acting double expansion steam pump, installed in 1889, and one Gaskill 1,670,000-gallon-per-day double expansion steam-driven pump 12-inch and 24-inch cylinders, 12-inch suction and 16-inch delivery, installed in 1889. These pumps draw water from the old pump well which is situated under the pump-house floor, and are ordinarily used as emergency pumps.

There is also a new installation of pumps in an extension of the pump-house. These consist of two De Laval domestic supply pumps and two De Laval booster pumps for fire purposes. The two domestic supply pumps are three-stage centrifugals operated by synchronous motors. These pumps are rated to deliver 3,360 gallons per minute under a head of 200 feet when running at 750 r.p.m. The motors are Canadian Westinghouse 250-h.p. at 4,000 volts, 25 cycles, 3 phase, 29 amp., 750 r.p.m. The direct current exciters are 6-kw., 125 volts, 48 amp. These pumps have connections to a 16-inch suction line from the new well and 12-inch deliveries. Each booster pump consists of two De Laval single-stage centrifugals worked in series at 1,250 r.p.m. connected to a De Laval steam turbine by a reduction gear. The domestic supply pump delivers water into an 18-inch header at about 85 lbs. pressure, but in case of fire this connection is shut and the water is passed through an intermediate header to the booster pumps to increase the pressure to about 120 lbs. per square inch, returned to the main header and thence to the city through various connections ranging from 10 inches to 20 inches in diameter. These pumps were supplied by the Turbine Equipment Company, Toronto, and have been in operation for a few months.



View of Engine Room.

The steam is supplied by any two of three John Inglis & Co.'s return tubular boilers, each 16 feet long 72 inches diameter. The fires are banked and the steam pressure is maintained at 100 pounds. The feed-water passes through a 125-h.p. Hoppes feed-water purifier to reduce the temporary hardness of the water.

The De Laval steam turbines are connected to C. H. Wheeler's surface condensers and provided with a Mullan's air pump. The older engines are fitted with jet condensers.

The venturi meter is a M type, 9-inch throat, with an 18-inch inlet and a 20-inch outlet.

The pump-house is heated by Webster's vacuum-steam heating plant.

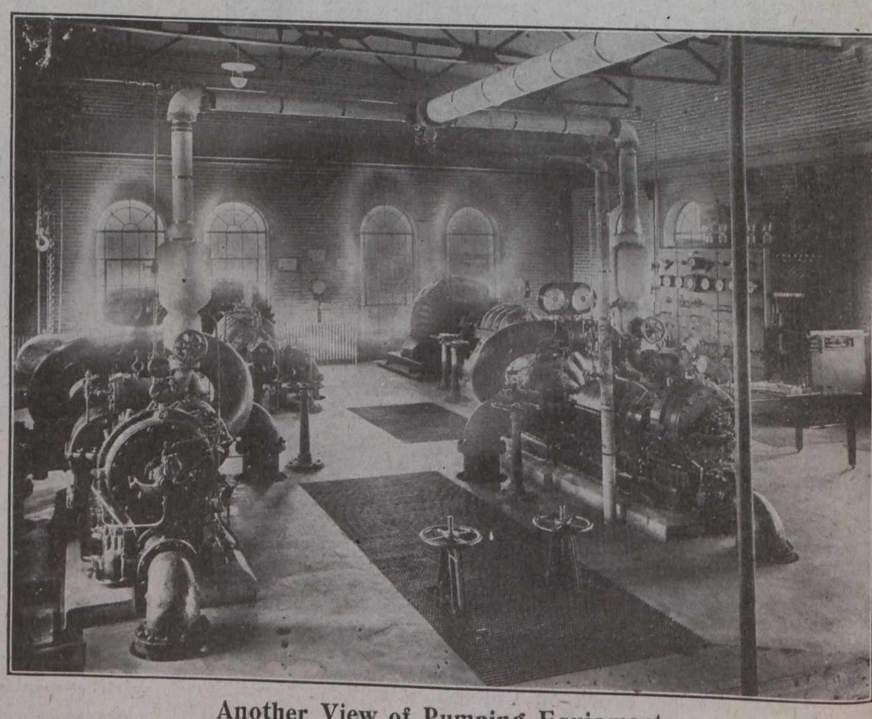
There is an overhead travelling crane with a runway extending the whole length of the pump-house.

A new screen-house, 32 feet by 40 feet is now being built near the river intake where an electrically driven submerged pump will lift the water about 10 feet into the distributing mains to feed the infiltration area. At present the water is raised 25 feet by a temporary pumping outfit and is discharged into the distributing system.

There is a 1,500,000-gallon open trapezoidal reservoir in the lower part of the infiltration area and near the pump-house to receive the excess yield of the infiltration galleries.

A small slow sand filter has been constructed adjoining the canal to treat water taken therefrom. This filter is 20 feet by 40 feet and 9 feet deep with 3 feet of sand. The water, after passing through the filter, is allowed to percolate into the ground to saturate the infiltration area and then recollected by the galleries and conveyed to the pump wells.

During 1915 about 952,800,000 Imperial gallons of water were pumped against a head of about 200 feet. The cost of fuel and energy was $11,538.30, which is equivalent to $12.15 per million gallons and 6.08 cents per million foot-gallons—that is, one million gallons raised one foot high.



Another View of Pumping Equipment.

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FREEZING OF WATER IN SUBAQUEOUS MAINS LAID IN SALT WATER AND IN MAINS AND SERVICES LAID ON LAND.*

By William Whitlock Brush.

THE transformation of water from the liquid to the solid state, known as ice, as a result of the abstraction of heat from the water, is a process familiar to all, but the exact conditions under which such transformation takes place are not so generally known. This withdrawal of heat may be by means of radiation, conduction or convection, the transfer of heat being accomplished by any one of these agencies operating singly or in combination.

Fresh water increases in density as the temperature is lowered, until a maximum is reached at 39° F. There is then a gradual reduction in density to the temperature of 32°, when the liquid changes to the solid form, known as ice, with a specific gravity of 0.89. It is this transformation that is particularly interesting to waterworks men, and some of the more important features of such transformation will be briefly discussed. The temperature of water is remarkably constant while ice is forming or melting. The temperature of the air may be many degrees below zero, but the temperature of fresh water, even though it be in a rapid running stream, will not be more than 0.01 below 32° F. Again, as long as there is ice in the water the temperature will only be a similarly small fraction of a degree above 32° F., even though the temperature of the air be many degrees above the freezing point. A mixture of ice and water forms the most constant temperature known to physicists.

It is popularly believed that running water may be lowered to a temperature of several degrees F. below the freezing point before ice will be formed. This is an error. Absolutely still water may be cooled to approximately 10° F. below the freezing point without ice forming, but as soon as there is the slightest agitation of the water an immediate formation of ice takes place and continues until the heat released by the change from water to ice warms the remaining portion of the water to the freezing point. The latent heat of water at the freezing point is large, amounting to 80 calories per gram, or sufficient to raise 143 pounds of water 1° F. for every pound of water changed to ice.

Ice is divided into three kinds, based upon the manner in which it forms, *i.e.*, surface ice, frazil ice and anchor ice.

Surface ice is the common form which appears on the surface of the water when the temperature of the water is cooled to the freezing point. It appears first near the shore and gradually extends out as the deeper water is cooled, the entire surface being eventually covered after the temperature of air remains below the freezing point for a sufficient period to cool the entire surface water to just below 32° F. After the ice is formed, the thickness increases, mainly through the conduction of heat from the water through the ice, it being necessary to conduct not alone the heat in the water but also the latent heat previously in the water, which is released as the water changes to ice. As the conductivity of ice is low, being only one thirty-second of that of iron, this process is relatively slow and the thicker the ice sheet the slower the increase in depth of ice.

*Abstract of paper read before the 4 States Section of the American Waterworks Association.

Frazil ice is the form which appears in running water when the temperature of the water falls below 32° F. and where an ice sheet cannot form due to the agitation of the water. It forms at the surface and may be made up of flat plates, if the surface is not greatly agitated, but more frequently is in the form of minute needle crystals which join together and form a bulky mass, floating lower in the water than the ordinary surface ice.

Anchor ice is ice which is found attached or anchored to the bottom of a river or a stream, and results from the cooling of the material at the bottom of the river by radiation, and the resultant freezing of the water which comes in contact with the surfaces, which have been cooled below the freezing point. It will only occur under a clear sky and where there is nothing to interfere with the process of radiation. As dark objects radiate heat more rapidly than light-colored ones, anchor ice will form more rapidly on a dark stone than on a light one. It will not be formed under a bridge where radiation is interfered with, nor under ice, which also prevents radiation. When the sun's rays strike the masses of ice, earth and stone, they are absorbed and frequently the whole mass will become loosened and float to the surface. Large rocks are thus raised and carried down stream with the ice.

These three forms of ice are all of interest to the waterworks engineer, not alone as affecting the problems to be met at the source of supply, when such source may be a reservoir or stream, but also in the distribution of water, as will be shown later.

It is generally considered that ice is a poorer conductor than water. This belief is probably founded upon the very material protection which ice or snow gives against frost penetration. Such protection is mainly due to the resistance of ice and snow to the transmission of the heat waves of radiation. Clear water offers little resistance to the radiation of heat, but is a very poor conductor of heat. Due to the difference in density of water at different temperatures, water will transmit heat through convection, or the movement of the molecules, much more rapidly than will ice, by conduction. The molecules of ice are unable to move freely, and transmission of heat through ice, by convection, is therefore negligible.

Pressure lowers the temperature at which water changes to ice, but its effect is very slight, thus, a pressure of 1 pound per square inch will lower the freezing point 0.009° F. Assuming the normal pressure in a water main to be 40 pounds per square inch, the lowering of the freezing point by such pressure would amount to less than 0.04° F.

The introduction of certain chemicals into the water lowers the freezing point. The most common chemical found is salt, and all are familiar with the lowering of the freezing point caused by the presence of salt. The volume of salt determines the temperature at which the ice forms, the salt being thrown out by the crystallization of the water, so that ice formed in salt water is fresh. The ordinary sea water will freeze at about 27° F. and the temperature of the water is therefore well below the freezing point of fresh water. As the percentage of salt in the water decreases, the freezing point rises, but this freezing point is probably below 30° F. in the tidal waters surrounding our sea-board cities.

Formation of Ice in Water Mains.—The formation of ice in water mains is dependent upon the temperature of the water in the main and the velocity of current, the pressure being of negligible effect, as has previously been shown. It is probable that the water as drawn from a reservoir or stream is seldom below 33° F., as the formation of ice and the density of the water generally prevent the cooling of the water below this temperature. If the water in passing through the main is not reduced in temperature to below 32° F. there will be no danger of freezing. If it is reduced below 32° F. ice will begin to form, the ice forming a coating on the inside of the pipe, due to the high conductivity of the iron. As the ice film thickens, the transmission of the heat of the water to the surrounding earth and thence to the air is greatly retarded, the conductivity of ice being such a small fraction of the conductivity of the iron. If the velocity in the main is reduced through a lowering of the rate of draft, the water in the main is more readily cooled, and the rate of ice formation correspondingly increases. This ice formation may be properly classified as surface ice. It is probable that in a main where the velocity is high, the water is cooled slightly below the freezing point and a form of frazil ice created. Such ice might eventually clog the main, stopping the flow, and the whole mass of water in the main quickly change to solid ice. In the report of the committee of the New England Waterworks Association on the depth at which mains should be laid to prevent freezing, submitted in 1909, reference is made to slush ice forming in a main laid in a salt marsh at New Brunswick, New Jersey. The velocity in this main was high and frazil ice probably formed. A stoppage in flow may also occur after a thaw, due to the loosening of the film of ice which has formed during the cold spell, and which may break up and flow through the water until it reaches a point in the main where the ice may not have broken loose and where the floating ice will become packed in such a manner as to completely stop the flow. While this might account for the stoppage of flow in mains, especially in house services, after a thaw, which is an experience not uncommon to waterworks superintendents, there is a record of an actual reduction in temperature of soil below 32° F. following a thaw, and such reduction would be ample reason for the freezing up of water mains coincident with a thaw.

Prevention of Formation of Ice in Subaqueous Mains.—Where a main is laid in salt water it is common practice to lay the main without any earth cover. The iron is therefore exposed directly to the salt water, which is usually in motion, and heat may be rapidly abstracted from the water in the main through the three agencies of transmission, *i.e.*, radiation, conduction and convection. Radiation is active in clear water and especially so from the black pipe. The iron is also an excellent medium for conduction, with the heat being absorbed from the surface of the iron by the water flowing over the pipe. Convection will readily do its part within the pipe. The temperature of the salt water, during a period of severe cold, may be lowered several degrees below the freezing point and under such conditions ice will form in the water main and the main will be completely clogged, unless the rate of flow is sufficient to maintain the temperature at the discharge end of the main, at or above 32° F. If a main is laid in a body of fresh water, there is little danger of freezing, except at the point where the main enters the water, as the temperature of the water will be above 32° F. and a covering of surface ice will prevent excessive radiation. If the main is laid in the bottom of a rapidly flowing fresh water stream, it is possible that through radiation and the cooling of the water in the stream, ice might form in the main, but it is improbable that such ice would be of sufficient thickness to interfere with the delivery of water through such main.

Frost Penetration on Land.—The committee of the New England Waterworks Association, which reported in 1909 on freezing of water mains, stated in their report that they had received 90 replies from 320 circulars sent out to waterworks engineers and superintendents, 53 communities had had trouble with freezing of mains, 50 per cent. of the freezing had occurred at dead ends, and in all cases there had been little or no velocity. In all but three cases the mains were smaller than 10 inches in diameter, and only seven as large as 8 inches in diameter. In every case the ground was frozen below the axis of the pipe. Forty per cent. of pipe was laid in clay, 48.6 per cent. in gravel, 5.7 per cent. in sand and 5.7 per cent. in rock. The depth of penetration of frost was found to be 1 foot greater in the streets than in the fields, and 1 foot 5 inches deeper in gravel than in clay, the depth in sand being about midway between the depth in clay and in gravel. The ice was found at times in concentric rings in pipe as large as 24 inches in diameter, and no stoppage of the pipe had occurred. The ice formation was not always solid, but sometimes in the form of slush. The depth of frost penetration varied materially. The committee called attention to a belief or tradition that existed in the minds of many plumbers and water works superintendents, that most stoppages occurred during a thaw, following a period of severe cold weather, it being suggested that this might be caused by evaporation from the surface during the early stages of the thaw, producing additional refrigeration or reduction of temperature at the depth of a water main sufficient to cause freezing. The committee comment that the reports received did not support this theory. In the discussion of the report an instance was cited where a pipe was laid in the late fall in rock cut, and the backfilling was composed of frozen earth and rock, giving a very porous filling. A comparatively slight current was maintained in the pipe. In the early spring, on a day when it was warm enough so that it was comfortable to be about in shirt sleeves, the pipe stopped up. It was left until the following morning, when it was found that the pipe was again clear.

Mr. Jesse O. Shipman, division engineer, public service commission, New York City, states that, where services are run through bays in the subway, where, in general, the distance from the surface of the ground to the service is about 4 feet, with 6 inches of earth below the service and 12 inches of concrete forming the roof of the subway, trouble from the service clogging with ice usually occurs a day or so after a thaw, following a severe cold spell, has set in.

The writer endeavored to find records of ground temperature but was able to locate only those of Profs. H. L. Callendar and C. H. McLeod, of McGill University, Montreal, Canada, and recorded in the proceedings of the Royal Society of Canada for the years 1895, 1896 and 1897.

These experiments were started in 1894 by Professor Callendar and he was later assisted by Professor McLeod. The location selected for the experiment was level ground in a garden where there was turf and loose light-brown sand to a depth of 8 feet 6 inches. Below this sand was stiff blue clay to a depth of 30 feet from the surface. Water was found in the sand for some distance above the clay but the sand was nearly dry to a depth of 5 feet.

A trench 3 feet wide and 9 feet deep was dug, with one face vertical. Into this face horizontal holes were bored for nearly 3 feet, using a one-half inch rod. Electrical resistance thermometers, consisting of a carefully insulated coil of platinum wire about 3 inches long and protected by an external tube of glass or copper, were inserted in these holes and connected to the indicating apparatus by insulated leads of convenient length. The holes were bored at depths of 1, 4, 10, 20, 40, 66 and 108 inches. In the earlier periods readings were taken daily at 12 noon, but later a continuous recording apparatus was installed. An abstract of the snow conditions and temperature recorded are given herewith.

This record shows very clearly the material effect of snow on the depth of frost penetration and the slight cover probably required when snow is always present early in the winter. The record of the thermometer buried at a depth of 10 inches, which showed in April, 1895, a drop of 0.2 to 0.3° below 32°, which was the temperature at the beginning of the thaw, is very interesting. This shows that a lowering of the ground temperature below 32° F. may results from a thaw. The following notes are copied from the text:—

Winter 1894-1895.

Depth of thermometer.	Period temperature was below 32° F.	Minimum temperature.	Snow conditions.
Air	Dec. 20 to March 29	—10° F. in Feb.	10 inches snow Dec. 28 which increased to 21 inches by Feb. 1, 33 inches by Feb. 7. Began to melt in March. Final melting of snow between April 7 and 14.
1 inch	Nov. 25 to April 14	27° F. in Dec., just before snow fall	
4 inches	Nov. 28 to April 14	28° F. in Dec., just before snow fall	
10 inches	Dec. 16 to April 14	31½° F. in Dec., just before snow fall	
20 inches	0	33° F. Dec. 14, melting snow	
40 inches	0	35½° F. April 20, melting snow	
66 inches	0	38° F. April 21, melting snow	
108 inches	0	41½° F. April 22, melting snow.	

Winter 1895-1896.

Depth of thermometer.	Period temperature was below 32° F.	Minimum temperature.	Snow conditions.
Air	Nov. 20 till Apr. 10 except for short rises	—15° F. Feb. 18	Practically no snow till Jan. 24. The winter is remarkable for lateness of heavy snow fall and for the rapidity of its disappearance.
1 inch	Dec. 2 to April 20	27° F. Jan. 22, before snow fell	
4 inches	Slightly shorter period than for 1 in.	28° F. Jan. 22, before snow fell	
10 inches	Dec. 22 to April 20	30° F. Jan. 22, before snow fell	Light snow fell in Nov. and Dec., disappeared. Heavy snow fall commenced Jan. 24 and increased to maximum of about 30 inches in March. Snow disappeared about April 12.
20 inches	0	32½° F. Jan. 23	
40 inches	0	34¼° F. April 15, melting snow	
66 inches	0	38° F. April 20, melting snow	
108 inches	0	41° F. April 25, melting snow	

The final thawing of the ground took place at a depth of 10 inches on April 19th. The 10-inch thermometer which had remained within less than 0.1° F. for about two months previously, showed a depression of 0.3 when the thaw reached it, probably due to lowering melting point by dissolved salts. . . . . The percolation of water caused a slight simultaneous fall in the two thermometers next below.

Winter 1896-1897.

Depth of thermometer.	Period temperature was below 32° F.	Minimum temperature.	Snow conditions.
Air	Nov. 15 to March 20	Mean temperature air Dec. 23, 5° F.	No snow during early part winter; frost penetrated much deeper into soil than during two years previous; thawing of ground after disappearance of snow was lengthy operation; 20 days were required. Temperature at 20 inches did not rise above freezing till May 1.
1 inch	Nov. 23 to April 3	10° F. Jan. 20	
4 inches	Dec. 1 to April 10	12° F. Jan. 20	
10 inches	Dec. 15 to April 18	19° F. Jan. 20	
20 inches	Jan. 5 to April 25	27° F. Jan. 20	
40 inches	Nearly reaches 32° F. during Mar. and April.	33° F. March and April.	
66 inches	0	36° F. April 22, melting snow	
108 inches	0	39° F. May 2, melting snow.	First fall of snow quite light Dec. 5. Practically no snow till Jan. 20. About 20 inches snow on ground from Jan. 20 to Feb. 20. About Feb. 20 snow increased gradually and uniformly to about 28 inches by March 1. Snow disappears about Apr. 2 or 3.

This record obtained in a carefully conducted experiment is confirmation of the possibility of a thaw causing the freezing of water pipes. The rapid lowering of ground temperature by cold water percolating through the ground was strikingly shown several times during the period covered by the records. While percolating waters may lower the temperature, the presence of moisture reduces the likelihood of services freezing, for the following reasons:—

(*a*) The freezing of the water releases latent heat which is transmitted to the ground.

(*b*) The frozen ground is a poor conductor of heat.

(*c*) Water is a poor conductor of heat, and when it is held in the ground by the action of capillarity, it cannot readily conduct heat by convection, as it would if it were free to move.

Prevention of Formation of Ice in Mains and Services.—Where frost penetration has extended to, and possibly beyond, the level at which a water main or service has been installed, the water in the main or service will freeze unless the temperature of the water in such main is kept at or above 32° F. This can only be accomplished by having such quantity of water pass through the main that the rate of abstraction of heat will not be sufficiently rapid to cause the temperaure of the water to fall below 32°

As has been pointed out, in the supply from the Croton River, the temperature of the water, even during a very cold spell, is found to be about 34°. As long as there is sufficient water passing through the mains to prevent this temperature being reduced by more than 2°, *i.e.*, to 32° F., there will be no danger of freezing of water in the mains. By testing the temperature of the water as it is drawn from a hydrant, it can be determined whether there is or is not likelihood of the main freezing. No rule can be formulated which would answer the question as to whether a main will freeze under given conditions. A protecting covering is certainly a great aid in reducing the danger of freezing, and snow on the ground is an almost sure preventive.

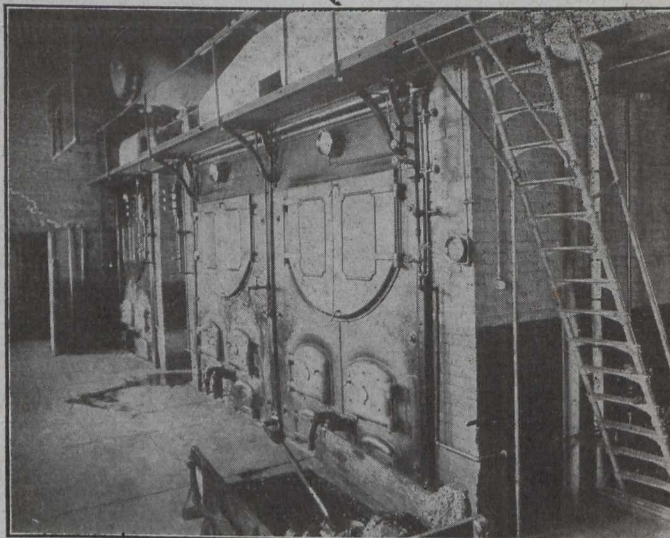
Thawing Ice in Mains and Services.—The problem of thawing out frozen mains and services has been greatly simplified through the utilization of the electric current at low tension. While it was found that this method was not of much value when applied to a main laid in water, where the heat generated through the passage of the electric current would be rapidly dissipated by the flowing current of water, the condition where the pipe is covered with soil is entirely different and much more favorable to the thawing of the main. As the electric current passes through the metal, the heat generated will thaw both the ice which is formed within the main and the ice which is formed in the soil outside of the main. The transmission of this heat to the surrounding earth and thence to the surface is very slow and a comparatively small amount of current is required to make the necessary change from ice to water. It is not necessary to describe the actual application of electricity to the mains as this has been set forth in detail many times.

The writer found in his investigation of this subject that a study of the formation of ice in streams has greatly aided him in obtaining a clearer conception of the conditions under which ice is liable to be formed in mains, and on this subject he has drawn freely from the "Treatise on Ice Formation," by Howard T. Barnes, Associate Professor of Physics, McGill University, Montreal, who has made extensive experiments and observations on ice formation in the St. Lawrence River and elsewhere.

BRANTFORD WATERWORKS.

(*Continued from page 24.*)

The water commissioners for 1916 are: Mr. John Fair, C.E., chairman; Mr. A. G. Montgomery, Mr. J. W. Rowlby, K.C. (Mayor), Mr. Fred. W. Frank, secretary; Mr. Thomas Lamb, superintendent; Mr. David L. Webster, chief engineer.



Boiler Room, Brantford Waterworks.

BRITISH FIRM OUTBIDS UNITED STATES FIRMS.

There was great surprise a few days ago when it was announced by Secretary Daniels of the United States Navy that Hadfields, Limited, of Sheffield, England, was the lowest bidder on contracts for 16-inch and 14-inch armour-piercing naval projectiles. Not only were their bids $146 lower per shell on the 14-inch shells and $237 lower on the larger ones than the lowest American bids, but they offered to deliver the order in eleven months and sixteen months respectively, while the best the American firms could do was 22 and 24 months. Hadfields became a serious competitor for naval contracts in 1912, when they underbid the American firms on 14-inch shells by a considerable margin.

Commenting on the wide disparity between the English bid and the American proffers, Secretary of the Navy Daniels said he thought it singular that American firms with their tremendous facilities were unable to compete either as to price or time of delivery with the English manufacturer.

The report of the German steel syndicate regarding shipments of steel for the fiscal year 1915-1916 states that of the total shipments 87 per cent. were for home consumption, as against 81 per cent. the preceding year. The total steel production of Germany for the same period is given as 14,700,000 tons, as compared with 11,700,000 tons the preceding year.

Dutch shipyards have been informed by the German authorities that they will be put on the German black list if they repair Norwegian vessels, whether the work is carried out with German material or not. For Danish and Swedish vessels special permission has to be obtained. In the case of vessels being built in Holland of German materials, permission for export has to be obtained, and no such permission will be available for vessels built for Norwegian account.

THE ENGINEERING SOCIETY—ITS PAST, PRESENT AND FUTURE ACTIVITIES.*

By Ernest McCullough.

A LITTLE over a century ago the men engaged in works of civil construction organized a society and called it a society of civil engineers. The right to assume the title of engineer was contested by the only men to that time recognized as engineers, that is, the men engaged in military engineering work, and it became necessary to define a civil engineer when the society finally applied for a royal charter. The result was the incorporation in 1828 of the Royal Institution of Civil Engineers of Great Britain, civil engineering in the charter being defined as "the art of directing the great sources of power in Nature for the use and convenience of man."

For a number of years in the first half of the last century it was common to read on title-pages of books the term "Mechanical Civil Engineer," "Mining Civil Engineer," etc., the inference being that in those days all men not military engineers were civil enginers. The development in the manufacture of power brought about by improvements in the steam engine and the vast increase in railway building finally resulted in the distinct professions of Mechanical Engineering and Mining Engineering, and later Electrical Engineering. Now the civil engineer is said in a late report of a committee of the Institution of Civil Engineers to have almost disappeared in the original meaning of the term. The men known as civil engineers are engaged in many special lines of work, so the multiplicity of specialties and the multiplying number of special societies is something requiring notice. Before the civil engineer was known as such there were road builders, bridge builders, canal builders, colliery viewers (engineers), surveyors and builders. The fundamental education in all branches being the same, the development of industry has had the effect of recreating the old sub-divisions, more highly trained perhaps, but conditions now are as they were before the engineer evolved as an entity.

The time has come when the engineering society should pause and consider if it is doing necessary work. The earlier societies performed a valued service. They brought together men having similar interests; where the older men read papers and discussed papers which were intended purely for instructional purposes, most of the engineers being trained by apprenticeship. There existed few schools and there was a demand for trained men. Young men picked up their knowledge as best they might in the offices of eminent practitioners, and at the society meetings met other men of experience. Thus they obtained the broad view of their business so necessary for future success. The educational value of the meetings was so great that a professional spirit developed and was fostered.

The technical, or engineering societies, have not developed with the work of the engineer. They still consider themselves as institutions organized solely for educational purposes. This is the way they are conducted, but the majority of the members know many societies exist rather as an evidence of the standing of the members than for their declared purposes. The modern technical journal is doing more real educational work than any society, no matter how large or how important it may be. The pages of the weekly and monthly papers bring to us news from the front fresh, and in a way which the more formal papers of a society cannot. Our society proceedings are become encyclopedias, which are consulted less frequently than are the pages of the journals maintained purely for profit.

Some societies are beginning to realize that something is lacking in the old methods, and this is shown by the growth of social activities. That there is a real demand for this side of the training of a technical man is proven by the societies which feature the social side.

May it not be asked if the central idea of the original technical societies was not the young man? Granting that he was the reason for the inception of such societies, we can ask ourselves if we have been for some time treating him fairly. Are we now taking proper notice of him and the increased difficulties attendant upon his endeavors to secure a foothold in his chosen work with the increase of competition following upon the great development of the engineering school and the popularity of technical training to-day?

The young man feels he has not been paid the proper attention. There is a well-founded idea that engineering societies have for many years past been mutual admiration societies of successful men, and used for furthering of insidious advertising by men qualified to take full advantage of the position their membership brings them. The discussions at the meetings are too frequently inadequate, and real criticism is seldom developed when the author of the paper is of commanding eminence. Some men even use the society to which they belong for exploiting patented processes and materials.

The third method, namely, the affording of patent and legal advice, needs to be approached with care. The society should have an attorney who can help members who have trouble in collecting pay,—that is, members who fall into the hands of unscrupulous employers. There are many such. There was organized a couple of years ago a society of authors to protect individuals against the rapacity of certain dishonest publishers. It is said to have been very successful. Medical men have such means for collecting bad accounts and to protect them against blackmail, for a number of physicians and surgeons are annually attacked by former patients who know a man will often pay large sums rather than get undesirable notoriety. This side of the medical societies is so well taken care of that few accounts of such attacks ever get into the public press. It is understood that lawyers and ministers of the gospel have similar legal protectors, and some of us believe our colleagues, the architects, have a few societies in which the business side of the profession is properly cared for. Engineers should similarly protect themselves against attacks on character and attempted extortion or robbery. Just what the new association intends to do in the matter of patent advice I do not know, and supposedly the members have only a vague idea, but that there is some good reason for including this item we cannot doubt.

The fourth method is concerned with legislation for the technical man. The people of the United States have gone mad on the subject of legislation. They apparently wish to preserve the individuality so long a characteristic of Americans, combined with the socialistic condition which is the inevitable result of the passing of a large number of regulatory laws. It is not for us to object and stand too much on dignity. We must recognize the fact that a condition and not an hypothesis confronts us. The legal profession would not have the standing it enjoys were it not for the very thorough way in which the lawyer

*Journal of the Western Society of Engineers.

has intrenched himself legally. The medical profession did not enjoy the high standing it now has until legally it was protected from the men who otherwise would bring the profession into disrepute. The architects are working hard to obtain legislation to make architecture a closed profession, beginning with the passage of the license law for architects in Illinois in 1897. Now many of the States have similar laws, the greater number of which were passed the present year. Engineers, myself among the number, were opposed to legislation to license engineers, but conditions in the State of Illinois became so intolerable on account of the monopoly given to architects that we obtained this year the passage of a law to license structural engineers.

We attempted to have the lien law amended to protect engineers, for at the present time they are not protected. Architects are so protected, their society seeing to this item some years ago. The fight, however, for the license law was so strenuous that the lien law was not fought for hard enough, but we hope it will be looked after in the next session of the legislature. The next piece of legislation to be attended to is one fixing the status of sanitary engineers or the plumbers will get ahead and obtain control of the design and construction of sanitary work. A bill in the interests of the plumbers was prepared to be presented to the legislature at the session just closed which would have given plumbers a practical control of matters properly belonging to sanitary engineers. Not for the purpose of making a closed profession of sanitary engineering, but to prevent injustice to such engineers because of legislation which may be secured by men in other lines of work it will no doubt be necessary to have examinations and licenses for them.

However, a better way will be to secure a law requiring the registration of professional engineers with an examining board qualified to examine men in different specialties so that the word "engineer" will possess a dignity comparable with the titles of the other learned and honorable professions, which stand high in the esteem of the public. Not only must the modern engineering society see that legislation is secured to protect and elevate the engineering profession, but it must also carefully look after proposed legislation to the end that no laws will get on the statute books which work harm to the people of the state. That is, as citizens, we must protect fellow-citizens whose lack of knowledge of technical affairs leaves them at the mercy of special interests.

The fifth method is proper publicity. What is it? Proper publicity depends upon changing ideas and advances in civilization. That is, methods of publicity in one generation which are perfectly proper may be improper in a succeeding generation. The advertising methods of the live, wideawake business man may be considered coarse and unbecoming for the professional man. They are usually so considered. Is this idea a survival of a generation past? Is it, as many young men claim, a fetish worshipped by professional men for the purpose of helping older men maintain their pre-eminence and hold the young man back The question must be answered individually just now, for the engineer, no matter how decently he may conduct his business, is frequently partly a professional man and partly a business man. When he is employed in a confidential manner and given a fee he is a professional man. When he is on a regular payroll he is a technical employee. When he assumes the direction of work he may be said to be a business man. Throughout his life the technically educated man, the engineer, is at times a professional man, a technical employee and a business man. He must do some publicity work, and societies should not be hidebound in what is to be considered proper means of publicity to be employed by individual members. It should be enough for the societies if the members remain decent and bring no discredit on the work of the technical men.

The societies heretofore have concerned themselves with the publicity work of individuals. What is now a crying need is publicity work of a proper sort by the societies for the benefit of the membership, and, incidentally, of the technically educated men not members of any societies. Through proper publicity work all technical men not members will want to become members. Incidentally, the work of technical men will be so placed before the public that there will be an increase of good material in the ranks. Proper publicity should have the effect of sifting out desirable men from those not so desirable. It is due to improper publicity work that we have complaints to-day that there are too many unfit men now enrolled as engineers. These men, no matter how unsuited they may be to the work of the engineer, have a place somewhere in this world where they can fit in, and it should be a part of the duty of the engineering society of the future to find the hole into which these misshapen pegs may fit.

WINNIPEG AQUEDUCT CONTRACT PROTESTED.

Ten contracting firms who unsuccessfully tendered upon the construction of nine and a half miles of reinforced concrete pipe for the Greater Winnipeg Water District, threatened to obtain an injunction restraining the Board from letting the formal contract to the Winnipeg Aqueduct Construction Co., and as a result the Board have agreed not to let the contract before investigating the whole matter. The contractors allege that the engineer called for tenders upon his own specifications, permitting each contractor, however, to tender upon alternative designs. Only two contractors tendered upon their own alternative designs and the contract was awarded to the Winnipeg Aqueduct Construction Co. upon a "lock-joint" design. This company is said to have tendered jointly with the Canadian Lock Joint Pipe Co., of Regina, Sask.

Some of the other contractors allege that they had been told by the chief engineer of the water board not to figure on a lock-joint pipe, but it is stated that the conversation was misunderstood. In explaining to the Board his preference for the lock-joint tender, the chief engineer is reported as having stated that the lock-joint pipe is preferable to any other and also cheaper than the specifications that he had originated. His only reason for not having specified lock-joint pipe in his own specifications was that there would not have been any competition, as the manufacturers of the lock-joint pipe hold all the patents on this type of construction. His own design, while inferior, brought in the element of competition.

The Winnipeg Aqueduct Construction Co. were not the lowest tenderers on the engineer's design.

The complaints are to be put in writing and all the tenderers are invited to be present at the next regular meeting of the Board. The Tom Sharpe Construction Co., one of the unsuccessful tenderers, allege that they were furnished with inaccurate specifications, and that their tender cannot be rightly compared with other tenders on account of their having been furnished with incomplete plans.

FUNDAMENTAL CONSIDERATIONS IN THE MAKING OF PLATS.*

The general principles to be followed in developing a proper street plan have been laid down by Professor Unwin as follows:—

Having settled the purpose of the different areas, determined the general character of growth and the approximate direction desirable for main and subsidiary highways, the town planner finds himself with the following component parts out of which to make his design, namely: The main centre-point, or climax, dominating the whole; the secondary centres in definite proportion and relation to it; and the main highways linking them up; the whole giving the bones or main framework of the design.

Within the space defined by this framework, having special relation to the secondary centres and proportion to the primary highways, we have the network of secondary highways; while within the areas which these leave, for the purpose almost solely of giving access to the buildings we have the minor roadways or drives, which should be in relation to any subsidiary centre-point, and both in relation and proportion to the framework of secondary highways. No system cuts up the land into more awkward corners or more thoroughly destroys the street facades than that which consists of a framework of diagonal highways laid upon a rigid gridiron system of minor roads, and from no system do such unsatisfactory road junctions result. In town planning it is essential to avoid being carried away by the mere pattern of lines on paper. Order, definiteness of design there must be, but there must first be grasped an understanding of the points where order is important and will tell, and of those where it matters little.

These principles may perhaps be restated as follows: In every city there is a central business area to and from which the greatest amount of traffic flows. There are, in addition to this central area, subsidiary centres of activity, either business, social, educational or residence. Each of these subsidiary centres should be connected by direct routes having easy gradients with the central portion of the city. It is not necessary, in fact it is not even desirable, that these routes should be straight, but they should be conditioned by the topography and by existing improvements. The subsidiary centres should also have direct means of communication with each other. After these main lines of travel have been laid down, secondary lines may be developed also in conformity with topographical and other conditions. This will leave, then, certain areas of larger or smaller extent to be subdivided into tracts by means of purely local streets. Now it is not at all important—in fact, it is extremely undesirable—that these local streets should all follow the main points of the compass. The systematic division of our country into townships and sections has been a great convenience in many respects, but it is carrying the influence of the section line entirely too far to make it—as has been done so universally throughout the western state—the basis of all street planning work. Each tract of land into which the primary and secondary system of streets divides should be platted solely with a view to its own special requirements, with such orientation of blocks and arrangement of streets as will serve to develop to the best advantages its own individual peculiarities. It is by no means important that these local streets should be continuous, in fact it add very much to the beauty and detract nothing from the utility of the district if these streets are not continuous, but are so arranged as to furnish desirable building sites, closing the vista at convenient points. By following this plan the sharply angular lots involved in the diagonal street laid across the rectangular street plan will be very largely avoided. Each tract will have a character and an attractiveness of its own and the city will be free from the curse of dull uniformity.

The platting of any district should, of course, be varied to meet the topographical conditions. In some cases, for instance, we have steep hillsides. The folly of platting such hillsides in the regulation way into blocks consisting of two tiers of lots separated by an alley or sometimes by no alley at all, is apparent. In grading the streets laid out in this manner there will necessarily be heavy cuts on one side and heavy fills on the other. The cost of grading is therefore enhanced, as is also the cost of adjusting the property to private use. In such cases it is very much better if narrower and more frequent streets should be platted, so adjusted as to give reasonably good gradients and easy access to the property; these streets to be separated by a single tier of lots. These lots might be a little longer than the ordinary lot. The property then has the advantage of permitting all of the residences to be so situated that they have an outlook away from the hill instead of having half of them face into the hill. Furthermore, they will have access both from the rear and in front, which is a great convenience under these conditions. Where the ground is more uniform the ordinary plan of platting may be followed, but even here the exercise of a little ingenuity will yield very desirable results. It is not at all necessary that even on flat lands all blocks and lots should have uniform dimensions. This was the case in New York City, the lots all being 20 to 25 by 100 ft., and if you wish to build a church or a factory, a house or an office building, you have no choice as to dimensions except to take as many lots as may give the needed frontage.

Authority, therefore, should be vested in the city to regulate not only the size and location of streets dedicated to public use, but the size of the lots themselves. We are all familiar with the fact that the farther the lots are situated from the centre of the city and the cheaper the land the smaller the lot becomes. Public interest and convenience require that there should be public control over this feature of platting.

Then, too, it has sometimes been the custom when plats fail to receive the approval of city authorities that the owner proceeds to sell the lots off by metes and bounds descriptions, without regard to the public interest. The law should provide a certain subdivision of a section or a minimum size and prohibit the sale of smaller tracts unless a proper plat had previously been duly prepared and filed for record. In the making of any plat it must be borne in mind constantly that the present use of the property may—undoubtedly will in many instances—be greatly modified as time goes on. In so far as possible such future use should be anticipated and the plat adapted to such changing use as nearly as may be. This changing use of property, due, of course, to the fact that a city is a living, growing organism and not a dead piece of mechanism, constitutes one of the chief difficulties of city planning. The erection of garden cities, with every detail ordered before hand, seeks to eliminate this difficulty by fixing the maximum limits of the future city. It is better from this point of view to build a new city than to permit the old one to grow beyond its boundaries.

It is important that alleys should be required in all blocks platted on reasonably level ground. Such alleys will have a use even when the property is used solely for residence purposes, in that they permit the construction of garages in the rear of the property. Later on, as the

*Abstracted from a paper by Arthur H. Dimock, presented at the 7th Annual Convention of the League of Washington Municipalities.

use of the property becomes more intensive and as it becomes occupied by large buildings, these alleys become more and more useful for the service of such buildings, relieving the street from the more objectionable and unsightly necessities of such service, such as for instance, the collection of garbage.

In all modern street planning, we must necessarily take into consideration the immense change in traffic conditions which is taking place. The motor bus is rapidly replacing the street car. The number of passengers carried by street cars in London in 1914 showed practically no increase over those carried in 1911. For the same period, however, passengers carried by motor buses showed an increase of about 60 per cent. It is true, of course, that London is not so adaquately supplied with street cars as some American cities. However, the great convenience and flexibility of motor bus transportation will inevitably increase its use in our cities regardless of the facilities afforded by street car systems. The effect of this development upon the street system should be carefully considered by municipal engineers. When this traffic is properly controlled by the municipality—and it is as much the function of the municipality to supply adequate means of transportation as it is to provide an abundant supply of water or electric energy—it may be that the tendency to congestion of travel on certain streets will be reduced because it will be possible to occupy more streets with lines of bus transportation than it was possible to occupy with street cars. This will have a tendency to scatter this traffic and to utilize more fully the street system. On the other hand the great increase of motor-driven vehicles has led to an enormous increase in street traffic. The streets in any city which a few years ago were suburban in their character now carry heavy traffic. There are some thoroughfares towards which, on account of their location, traffic tends to flow in vast quantity. The planning of streets so to care for this increasing traffic will probably call for increasing widths, not only of the main thoroughfares but of many secondary streets as well. The Royal Commission on London Traffic recommended that the principal arterial highways be 140 ft. in width and that the streets be graded down to a minimum of 40 ft. In my judgment, no street should be less than 60 ft. in width except where situated on steep sidehills or where it will manifestly have nothing more than purely local use. The question as to the width of a street opens up, of course, an interesting and essential feature in city platting.

It is now recognized that the greatest municipal mistake of the 19th century was the failure to control the development of suburban areas. One of the marked features of the last century was the tremendous growth of cities—a growth fostered and made possible by modern developments and methods of transportation and intercommunication. There is little doubt that this remarkable growth will continue for many years to come. The modern city is beginning to lose its squalor and unattractiveness and is becoming the most healthy and most desirable spot on earth in which to live. For this and many other reasons, the continued rapid growth of cities is assured. The development of cities, however, will not be confined to the great centres of population. All cities at all favorably situated will continue to grow. It is important, therefore, that not only our larger cities, but that the smaller communities shall embrace every opportunity to lay our systematically and with foresight as may be possible the territory which they will some day occupy. All of our cities and towns will from time to time extend their boundaries and add new territory. This territory will usually be already platted and its future fixed. Too often this platting will have been done without reference to the needs of the future city and without any consultation whatever with the city authorities. Now, in order to secure the proper development of this suburban territory—that is to say, of areas outside the present official boundaries of our towns and cities—it is essential that the control of the platting and laying out thereof be vested in some authority in which the city would have, if not the paramount, at least an equal, voice. In providing for this control of the development of suburban areas, it will frequently happen that other municipalities are included in the district tributary to some growing city. It will be necessary, of course, to consider the rights and privileges of such municipalities. We should not, however, lose sight for one moment of the fact that the public interest and convenience of the whole community and not of any part thereof should be the controlling factor in these decisions. The law might require, for instance, that cities should have the power to create a zone outside of the existing boundaries, in which zone they should have a voice in the development and platting of the streets. All plats within this zone prior to approval by the legislative body vested with this authority should bear the approval of a commission composed of the county engineer, the city engineer and possibly a state officer, say, for instance, the professor of municipal engineering at the state university. Or the law might provide that plats within such district or zone should not become effective until approved by some state officer, as for instance the State Commissioner of Public Lands. Or possibly this approval by a state official might not be required except in cases of inability to agree between the county and city authorities. Another method would be the creation of town planning commissions with power to lay out all such lands and to require all plats to conform thereto. These suggestions are purely tentative, but I am sure that the problem is one of great importance to all of our cities, both great and small.

Another power which the city should have is that of compulsory replatting. In many of our cities areas were platted many years ago when the country was covered with thick timber or sage-brush and no one except a few prophetic souls realized that it would one day be covered with a dense population. These plats were often laid out entirely on paper in accordance with the controlling section lines. No regard was paid to hills or valleys or any other features of topography. They were laid out in many instances by real estate promoters interested solely in securing the greatest possible number of lots per acre. The real estate promoter of the type so familiar to our western cities has been the curse of modern city development.

It is reported that a four years' programme of harbor development is being undertaken at Aomori, Japan, including two detached breakwaters, two moles and a quay. The works are estimated to cost about $775,000.

According to statistics published by the Spanish Consejo de Minera 439,835 tons of pig-iron and 387,314 tons of manufactured forms of iron and steel were produced in Spain in 1915, as against 382,044 and about 330,000 tons respectively in the previous year.

During the last fiscal year San Francisco has constructed more pavement under public assessment than during any other like period of the city's history. The total area paved was 472,253 sq. yds. The average costs for various types were as follows:—Asphalt, $1.91; bituminous rock, $2.14; basalt rock, $3.42; vitrified brick, $3.35.

EXPORTATION OF ELECTRICITY—AN INTERNATIONAL PROBLEM

RELATION OF A POSSIBLE COAL EMBARGO BY UNITED STATES TO A CURTAILMENT OR STOPPAGE OF CANADA'S ELECTRIC POWER—AN INSTRUCTIVE STATEMENT OF AN IMPORTANT MATTER.

By ARTHUR V. WHITE.
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THE people of Canada, and especially of Ontario, should understand and fully realize the extent to which they are dependent upon others for their coal supply, and understand also their increasingly great dependence upon hydro-electric power as well as its relationship to coal.

Both the United States and Canada, as well as many of the European countries, are now experiencing a shortage of coal supply with consequent increases in price. The present, therefore, is an opportune time to review the Niagara power situation. In the course of this survey we shall consider a number of statements† made by various authorities.

In November, 1916, the District Attorney in charge of the investigation held at Buffalo respecting the coal situation, asked one of the witnesses:—

> "If the Canadians put an embargo on power when there is a power shortage, should we not put an embargo on their getting coal when there is a shortage **here?**"

In 1891, Mr. E. B. Borron, in making his report to the Ontario government on the lakes and rivers, water and water powers of the Province of Ontario, drew special attention to the fact that Ontario has no true coal. Mr. Borron stated:—

> "Thus it will be seen that in respect of fuel and consequently of steam power, Ontario occupies on this continent a very unfavorable, one might say, unenviable, position, as compared with the maritime provinces and British Columbia, and with many, if not most, parts of the United States, and still worse as compared with England, Belgium and other great manufacturing countries in Europe."

That the time may come when the United States may deem it expedient to reserve her supply of coal for her own use, is not impossible. Dr. George Otis Smith, Director of the United States Geological Survey, commenting upon the world's supply of coal, and with particular reference to the reserves in his own country, states:—

> "This glance at the world's reserves of coal shows plainly not only that the United States leads all other countries in production, our annual output being nearly 40 per cent. of the total, but also that it possesses the greatest reserves. Yet in respect to no mineral is there greater need to emphasize the folly of exporting the raw material. Let us keep our coal at home, and with it manufacture whatever the world needs."

Dr. Smith advises: "Let us keep our coal at home and with it manufacture whatever the world needs." Is it without significance that such a policy should even be suggested?

Examples are not wanting to show that when countries have recognized the fact that certain of their natural resources were essential to their national welfare, policies have been adopted designed to stop or curtail the exportation of such natural commodities.

Consider, for example, the phosphate rocks so valuable as agricultural fertilizer. A few years ago when the United States government perceived that they would require the products of their own phosphate beds, the phosphate lands of the west were formally withdrawn from private entry, thus retaining **these deposits** of fundamental importance to the future of the nation, as its property. Commenting upon the phosphate situation, President Van Hise, of the University of Wisconsin, stated:—

> "Indeed, by the **statesmen** of foreign civilized nations, exportation of **phosphates** would be regarded as unthinkable folly."

and, to use his own words, he urged for the United States:

> "that there should be a law which prohibits **absolutely** the exportation of a single pound of phosphate rock."

However, it is not necessary to go outside of Canada to find advocates of this doctrine. It has been stated time and again that the growing industrial and other needs of Canada require that there no longer be exportation of Canada's electrical energy to the United States, without acceptable *quid pro quo.* This policy of Canada's retaining her electrical energy for her own use, is that which stimulates one like the District Attorney to ask the very pertinent question above quoted:—

> "If the Canadians put an embargo on power when there is a power shortage, *should we not put an embargo on their getting coal* when there is a shortage **here?**"

As we have just seen from a foregoing quotation, Dr. Smith goes even further and definitely counsels, "*let us keep our coal at home and with it manufacture whatever the world needs.*"

Ontario and Canada may yet require *every unit of electrical energy* just as much as the United States may yet require *every pound of phosphate rock,* or may find it expedient to retain *every pound of coal.*

In an article dealing with the *Exportation of Electricity,** the writer in 1910, made the following statement, which is equally true to-day: "Certainly the people of Ontario and Canada are in better circumstances to maintain a supply of heat and power if their water powers, including their full share of international water powers, are reserved to themselves and not permitted to be exported, except upon terms and conditions which will conserve absolutely the present and future interests of the citizens of Canada. Not only would the water powers of Canada provide, to a certain extent, a substitute for the coal supply of the United States as a means of furnishing light and heat and power, but control of these water powers would secure a basis upon which negotiations for coal could be conducted in a possible day of need. Canada would be in a position to exchange, if need be, part of her electric energy for part of the coal supply of the United States. It is obvious, however, that if the United States interests should control both the coal and the

†For purposes of emphasis portions of the statements are here printed in special type.

*The Exportation of Electricity. By Arthur V. White, in *The University Magazine,* of October, 1910.

water powers, the situation of Canada would become exceedingly grave."

In the present condition of world affairs no demonstration is needed of the truth of the statement that the keen competition of large commercial interests too frequently constitutes a most serious menace to the peace of nations. There have been times when, on account of commercial rivalry, international relationships have become so strained that exercise of a nation's force of arms has been enlisted on behalf of the demands of large private or corporate interests.

Some years ago when the relations of the United States with Canada were under discussion before the "Select Committee on Relations with Canada, of the United States Senate," Mr. Joseph Nimmo, Jr., addressed the committee with respect to the possibility of Canada dealing with her transportation facilities in such a manner as would adversely affect interests in the United States using Canadian transportation, and stated that:—

> "In the entire range of our Canadian relationship, from Halifax to Vancouver, the United States holds an overpowering advantage over Canada, and at every point. The suspension of the transit trade would be of comparatively small disadvantage to the United States, whereas it would be utterly disastrous to Canada. . . . It is high time for the people of this country to appreciate the fact that their national government holds a preponderance of commercial power on this continent as absolute as the preponderance of its military power, and to demand that those who are charged with the affairs of government shall adopt such measures as shall prevent any interference by a foreign power with the course of the development of our domestic or foreign commerce."

In its official **Opinion** rendered comparatively recently, the Public Service Commission of the State of New York referred to the possibility of Canada taking back electrical energy which had been utilized in building up United States industries, as follows:—

> "We have nothing before us but the suggestion that the Dominion of Canada may, at some future time, forbid this exportation. This commission must assume that international relations affecting so important a subject as the means of continuing great industries which have grown up in reliance upon the use of this imported power, and, as well, the interests of the Canadian producing companies themselves, have become fixed and subject only to such changes as will fully protect the great commercial and industrial interests and rights now served by this power brought from Canada. The time has long since passed when governments proceed ruthlessly from pure national rashness or anger to destroy the settled accepted commercial relations and formally vested rights of persons and corporations."

In connection with the exportation of electricity, Canada certainly does not desire to assist in creating any circumstances which would even tend to invite a possible carrying out of any such policy as is suggested by the language in the **Opinion** delivered by the Public Service Commission of the State of New York, or in the Address, just quoted, as delivered at Washington before the Select Committee of the Senate on Relations with Canada. Such policies are foreign to the aims and aspirations of the peoples both of the United States and of Canada.

From the foregoing statements, it will be perceived that there is an increased demand in the United States for electrical energy. Let us note more specifically how keenly United States interests desire to possess larger quantities of electrical energy for use in the upbuilding of industries and communities.

The following testimony will demonstrate the views thus entertained. Lieutenant-Colonel J. C. Sanford, reporting on January 6th, 1913, upon the subject of Niagara power, to the chief of engineers, United States army, states:—

> "There is no question but that Niagara power will soon be utilized to the fullest extent allowed by governmental restrictions. *If advantage of the power generated in Canada cannot be had on the American side, manufacturers will be attracted to Canada* by this cheap power, and the industries of this country will suffer accordingly. The effect of present restrictions on the importation of power is becoming noticeable. . . . Manufacturers at present contracting for additional Niagara power, must locate, and are locating in Canada. It, therefore, seems advisable to permit immediately the importation of Niagara power to the fullest extent permissible under the law, and, other things being equal, to grant permission for its importation to the company or companies which will make the earliest use of such power."

The former secretary of war, Hon. Henry L. Stimson, before the Committee on Foreign Affairs, recently stated that:—

> "The investigation which has been made by the engineers indicates that Canada, if we do not take it, will use the entire amount that the treaty permits in a very brief time, so that whatever effect any restrictions on importations would have, would not protect the Falls for more than a very brief period, and *it*

> *would result in giving to Canada, very possibly, a large number of industries which otherwise would be established on this side of the Falls."*

When Representative Chas. B. Smith was speaking on behalf of his bill, he submitted, before the Committee on Foreign Affairs, a letter from a leading citizen of Buffalo, in which it is stated:—

> "Every restriction on the importation of Canadian power should be at once removed. Electrical power is a *raw material and should be free."*

The Sub-committee on Niagara Falls Power, appointed by the Committee on Foreign Affairs, in its report on one of the Cline bills, states that it had been urged for its attention:—

> "That the Canadian companies were rapidly increasing their sales and would very soon take the full amount of water they were entitled to and the United States ought to get what power it was able to **now."**

and they add:—

> "If the advancement in the development of power on the Canadian side increases for another year or so—and it is not apparent to the committee that it will not—then the *committee concluded that it was proper to take as large an amount as it could get for consumption in the villages, cities, factories and homes along* **our** *border."*

Representative Chas. B. Smith, of the state of New York, in conversation, stated to me that he favored no restriction on the importation of electricity, because if it was good for the United States to have this commodity he thought it was advisable to get as much as possible, and permit it to come into the country without any restriction. This view of Mr. Smith was amply reflected in certain bills of his which provide for no restriction.

In the state of New York there is a ready market for additional electric energy. The **Opinion,** delivered on February 12th, 1914, by the Public Service Commission of the State of New York, records that:—

> "There is a large shortage of electric power in western New York, with a strong demand for greater supply which is not being met by existing companies. . . . We are using all the power made on the New York side, and all that has been brought from Canada, and *the demand for more power in western New York is insistent and being urged with great force."*

It is also stated that Niagara Falls power produced in the United States is so far from supplying the needs of portions of the state of New York, that if the importation of power were prohibited it "would plainly amount to a great public calamity."

When the demands in the United States for more electrical energy are such as those set forth by the foregoing quotations, it is not strange that public organizations and other interests have been prompted to urge action on the part of the Federal government of the United States to relieve this situation.

Various organizations, such as the Water Power Investigating Committee of the New York State Legislature, the Hydro-Electric Association of Buffalo and other places, the special committee of the Committee on Foreign Affairs of the United States House of Representatives, the United States War Department and others, have been studying the problem with a view to at least alleviating the present circumstances.

In the United States, the problem at Niagara is recognized as a national one, and of late special emphasis has been given to the fact that no federal policy of "war-preparedness" can successfully be carried out without increasing the producing capacities of plants at Niagara, which plants are either manufacturing munitions of war, or materials and commodities which are essential to the production of war munitions.

In Canada, efforts put forth, by the Hydro-Electric Power Commission of Ontario*, by the Commission of Conservation, Ottawa,* by the Unions of various Municipalities, by Boards of Trade, and other organizations, have resulted in the conservation for Canada of a large amount of electrical energy which doubtless would not otherwise have been utilized. The activities of the Hydro-Electric Power Commission have very materially increased the consumption of Canadian electricity.

It is not possible within the confines of the present article to do more than briefly indicate some of the chief factors which enter into this problem of the exportation of electricity. Before concluding, however, it will be profitable very briefly to explain a few matters respecting which the public at large, including a large portion of the public press, is in comparative ignorance.

With the factors which we are about to mention held in mind—and not otherwise—one will be able, intelligently, to interpret the course of future discussion or legislation respecting **power development** at Niagara.

For many years the supply of Niagara waters for power purposes was regarded by the public as practically inexhaustible. Companies in the United States, however, had obtained power concessions which, if put into operation, would have drained Niagara dry. The United States federal government recognized the danger of this situation.

The International Waterways Commission, consisting of members appointed by the United States and by Canada, had originated in 1902, following a recommendation in "The Rivers and Harbours Act" of the United States. In 1905 this commission was requested to report upon the general conditions obtaining at Niagara Falls, with the request that there be co-operation between both countries to the end that proper and adequate steps be taken to prevent further depletion of the Niagara waters.

This commission conducted its investigation, co-operatively with the United States War Department and subsequently made its report. Certain recommendations with respect to the preservation of Niagara and the amount of water to be diverted on the United States side, were enacted into law by *The Burton Act*. This commission having completed its work, disbanded about a year ago.

The Burton Act of June 29, 1906, was "For the Control and Regulation of the Waters of the Niagara River, for the Preservation of Niagara Falls, and for Other Purposes." It was regarded chiefly as a temporary measure. It limited the diversion of water on the United States side to a rate not exceeding 15,600 cubic feet per second; and under special permits the *importation* of electrical energy from Canada into the United States, could be had to an aggregate amount of 160,000 horse-power The Burton Act continued in force until 1913, when it lapsed by limitation.

Closely following the passage of the *Burton Act*, the government of Canada, on April 27, 1907, passed **an Act to Regulate the Exportation of Electric Power and Certain Liquids and Gases.** "The Fluid Exportation Act," as it is called, among other features, provides for the taking out each year, of a license permitting the *exportation* of electricity to the United States; and for a possible export tax not exceeding $10 per horse-power per year.

Thus the *Burton Act*—a United States measure—regulated the *importation* into the United States, while the Canadian measure, *the Fluid Exportation Act*, regulated the *exportation* from Canada.

*Consult the *Annual Reports* of these Commissions.

The passage of the Burton Act was furthered through the influence of such organizations as the American Civic Association, the American Scenic and Historical Society, the Colonial Dames of America and others, assisted, also, by efforts of Canadians.

The Burton Act recommended the opening of negotiations between the President of the United States and the Government of Great Britain, for the purpose of regulating and controlling the waters of the Niagara River and its tributaries. Negotiations were opened, and in due course, the **Boundary Waters Treaty** was signed at Washington on the 11th of January, 1909, and ratified on May 5th, 1910. The Burton Act and the Treaty, for a time, were coexistent and the Act was effective until its expiration.

This *Boundary Waters Treaty* specifies nothing with respect to the importation or exportation of electricity, but it provides for a diversion of "not exceeding in the aggregate a daily diversion at the rate of 20,000 cubic feet of water per second for the United States" and of 36,000 cubic feet per second for Canada.

Until quite recently the United States War Department, which exercises federal jurisdiction over Niagara power matters, had not issued permits for more than 15,600 cubic feet of water per second, although it has had the right to issue permits up to the treaty quantity of 20,000. A statement was made in December, 1916, that, on account of the great power shortage, the Secretary of War had decided to release, by permit, the unappropriated water up to the 20,000 cubic feet per second.

The province of Ontario has allotted about 30,000 cubic feet of water per second to provide for the full installations of the existing power companies at Niagara. The balance of about 6,000 cubic feet per second, is to be utilized by the proposed Chippawa development, which, it has been stated, is to be made by the municipalities of Ontario through the agency of the Hydro-Electric Power Commission.

At the present time there is installed on the Canadian side a nominal plant capacity of about 425,000 horse-power, and on the United States side about 260,000 horse-power.

In the United States, federal jurisdiction over Niagara, by virtue of its being regarded a navigable stream, is exercised by the War Department. The Secretary of War issues the permits to the different companies utilizing the water, and the Corps of United States Engineers are entrusted with the enforcing of the various regulations.

In Canada, the control of the waters of Niagara for power purposes is under the jurisdiction of the province of Ontario. The exportation of electricity is under the control of the federal government. The Department of the Interior, Ottawa, issues the annual licenses and, through the agency of its Gas and Electricity Inspection Branch, provides certain supervision of the operations of the power companies.

The licenses issued a year ago by the Department, provided for the following export quantities: Electrical Development Company, 35,000 kw.; Ontario Power Company, 45,000 kw.; Canadian Niagara Power Company, 55,000 kw.; a total of 135,000 kilowatts, or approximately 181,000 horse-power. It is probable that these quantities will be materially reduced in the next licenses issued.

The carrying out of the terms of the Boundary Waters Treaty, as well as adjudication upon certain matters of dispute between the two countries arising out of the use of boundary waters, is now vested in the **International Joint Commission,** which tribunal, in many respects, corresponds to the former International Waterways Commission. Its functions and powers, however, as set forth by the Treaty and more fully defined by Rules of Procedure, are broader. Thus, the means of adjusting differences between the two countries are available through the instrumentality of this Joint Commission, and the Boundary Waters Treaty. The Treaty is based upon the **Doctrine of Equal Benefits.** Each country is entitled to receive its full share of the benefits derivable from the use of one-half of the waters which would naturally flow in the Niagara River. If each country receives the share to which it is entitled there can be no just ground for contention or dissatisfaction.

Having, now, knowledge of the various factors already discussed, including the International Waterways Commission, the Burton Act, the Fluid Exportation Act, the Boundary Waters Treaty, the International Joint Commission and of the functions exercised by the Secretary of War, Washington, by the Department of Inland Revenue, Ottawa, and by the Province of Ontario, with its Hydro-Electric Power Commission, and other organizations, one is in a position to give intelligent understanding to events which may arise in connection with this very important subject—the Exportation of Electricity.

SHIPBUILDING ACTIVITY IN SWEDEN.

The Grängesberg-Oxelösund Traffic Company, which controls most of the Swedish iron ore export, has now placed definite orders with the Gothenburg New Shipyard Company for eighteen steamers, of which ten are to be of 7,500 tons and eight of 5,000 tons. The Transatlantic Steamer Company has ordered two cargo boats from the Lindholmen yard, each of 7,900 tons. The same company has also bought the second 3,000-ton boat being built at the same yard for account of the Rex Company. This is the sixth steamer of this type which the Transatlantic Company has secured, the first, the "Boren," having been delivered in April of this year; the last will probably be delivered in less than a year from that date. This makes six boats of 3.150 tons each delivered to the same company within a twelvemonth, which means a record in Swedish shipbuilding.

It is estimated that there are about 350 cities in the United States that are under the control of commissions, while about 20 have adopted the system of control by city manager.

New York's dual system of rapid transit lines includes the most expensive railroad in the world. This is the so-called Centre St. Loop, the cost of which to the city to June 30th, 1915, as figured by Chief Engineer Craven, of the Public Service Commission, was $16,080,964.09. This is at the rate of $10,843,536.13 per mile of subway and $3,050,837.43 per mile of track.

The Public Service Commission for the Second District of New York has settled a problem which has been vexing it and the gas corporations in its jurisdictions for several years by making an order fixing heat units instead of candle-power as the standard of value for coal gas. Hereafter gas must average 585 B.Th.U. per cubic foot instead of 16, 18 or 20 candle-power as heretofore.

Sulphate of aluminum is needed by Argentina for clarifying its water supply. It was formerly imported from Germany, but it is now difficult to obtain anywhere. American firms are quoting $120 to $185 a ton for it, and the estimated needs for 1917 for the country are placed at 8,000 tons. As a result of a protest to the Government by the Argentina Public Health works, a plant to manufacture the compound from native kaolin has been authorized at a cost of $188,000.

THE EFFECT OF SUDDEN ENLARGEMENT UPON THE FLOW OF WATER IN PIPES.*

By T. J. Rodhouse.

THE experiments presented in this paper have been conducted for the purpose of determining the effect of sudden enlargement of section upon the flow of water in pipes. The distribution of velocities in various sections near the expansion has received special investigation. A comparison between the effects of sudden enlargement and of contraction has been made, and the observed loss of head due to expansion has been compared with the theoretical loss.

The Apparatus.—The apparatus used in carrying on these experiments is a part of the equipment used for experimental purposes in the Hydraulic Laboratory of Cornell University.

Pipes.—The investigations herein presented were limited to the two cases of the effect of sudden enlargement from pipes of one inch and one and one-half inches in diameter to one whose diameter is 2.096 inches. The three sizes consisted of straight, smooth, seamless-drawn brass tubing.

The drawing, Fig. 1, shows somewhat in detail the connections and their positions. The pipe-line was horizontal, and the two pipes of different diameters were carefully aligned so that their axes were coincident. The pipes had been carefully calibrated in previous experiments, and were noted to be clean during the investigations herein described.

Water Supply.—The water supply was drawn from a tank in the attic of the building and at an elevation of about 47 feet above the pipe line. The inlet to the supply tank was controlled by a valve regulated by a float and consequently a very uniform head could be obtained for all velocities up to about five feet per second in the two-inch pipe.

Weighing Tanks and Scales.—The discharge from the pipe was through a diverting funnel into a large weighing tank of about 2,500 pounds capacity. The weighing scales were tested and found to be accurate. The error of the scale is less than 1/10 of one per cent., so small as to be neglected without in any way impairing the value of the results.

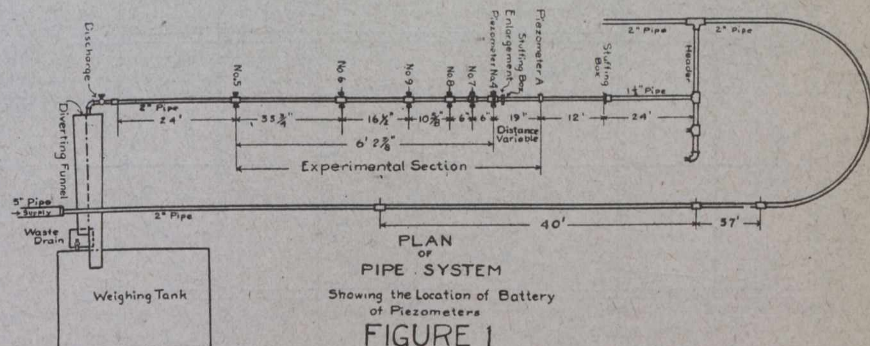
The Diverting Apparatus.—The diverting funnel leading from the discharge end of the pipe line to the weighing tank was made of galvanized iron with a vertical diaphragm dividing it into two parts, one side leading to a waste drain and the other to the weighing tank. The funnel was suspended by a wire from the ceiling, so as to swing freely, and the time required for thus diverting the jet to or from the weighing tank was less than one-half second. The time periods of weighing were taken with an ordinary watch whose daily variation was only a few seconds from standard time. The duration of a weighing period was from three to five minutes.

The water used was drawn from the regular supply to the University from the new filter plant, was clean and ranged in temperature from 40 degrees Fahr. at the beginning of the experiments, March 1, 1904, to 69 degrees Fahr. at the close, July 15, 1904.

*Abstracted from paper in Cornell Civil Engineer.

Pitot Tubes.—The Pitot tube consisted of a straight, cylindrical German silver tube 1/16 inch diameter and projecting 2 3/32 inches from the end of a larger brass tube of 5/16 inch external diameter by 7/32 inch internal diameter, having hose connections and a setting arm or pointer for indicating accurately the position of the impact opening when placed in the pipe. The tube had only the single impact opening 1/32 inch diameter located 0.04 inch from the end with its axis intersecting at right angles the axis of the tube. The static pressure was taken at the piezometer at the wall of the pipe in the same plane with the tube. The pressures from the impact opening and the static piezometer were conducted to the triple differential gauge through one-fourth inch heavy cotton-insertion rubber tubing.

Guiding Frame.—An attachment invented by Prof. G. S. Williams for facilitating the setting of the tube was used. It consists of a brass frame whose base fits snugly over the stuffing box and is securely clamped there by three set screws. The frame is slotted on each side for guiding the central tube which receives the main stem of the Pitot tube, holding it in place by a large thumb screw. This central tube is threaded its full length and passes through a thumbnut set in the upper end of the frame. By turning the thumbnut the tube can be quickly and accurately set and firmly held at any desired position in the traverse. The author attributes the uniformity of



PLAN OF PIPE SYSTEM
Showing the Location of Battery of Piezometers
FIGURE 1

readings in practically all of these traverses largely to this accurate means of controlling the positions of the impact point. The impact opening was circular, 1/32 inch in diameter, and in making a traverse the opening was kept pointing directly up-stream, its axis always parallel to the axis of the pipe.

Gauges.—The gauges used were differential in type and consisted of a double and a triple gauge. The graduations were double centimeters subdivided into tenths, so that the third place could be estimated with a fair degree of accuracy, within about one or two-tenths, equivalent to a reading closer than 0.001 of a foot. The vertical glass tubes, about 5/16 inch internal diameter, were connected at their tops so that air remained entrapped when the water rose in them, and the difference in pressure could be read upon the scale between them. The triple gauge enabled the reading of the difference of pressure between two points along the pipe and between each of these and the impact point of the tube simultaneously.

A Traverse.—*Number of Points.*—A traverse consisted in setting the impact point of the Pitot tube at seventeen consecutive positions along the diameter of the pipe and observing the gauge readings for those positions. The positions were so chosen as to be on the circumferences of eight concentric rings dividing the internal section of the pipe into eight equal areas. This method of division was made in order to facilitate the computation of the mean observed velocities at any given section.

In traverses at the different positions along the pipe the tube was inserted at various angles with the vertical in the plane perpendicular to the axis of the pipe. As no indication of unsymmetrical distribution of velocities was observed, these angles were not recorded.

Reading the Gauge.—At every position of the tube in a traverse the columns of the gauge were read simultaneously three times at intervals of from 20 to 30 seconds. Before beginning the readings at any point from two to three minutes were allowed for the gauge to settle. In case the second reading differed greatly from the first in any given position, the first was rejected and more time allowed for the gauge to come to rest. This happened only a very few times throughout the entire series of traverses.

The differences of the means of the three readings in each column were taken as giving the correct observed differences of head.

Tube at Centre of Pipe.—At the end of the traverse, which was made continuous across the pipe, the tube was

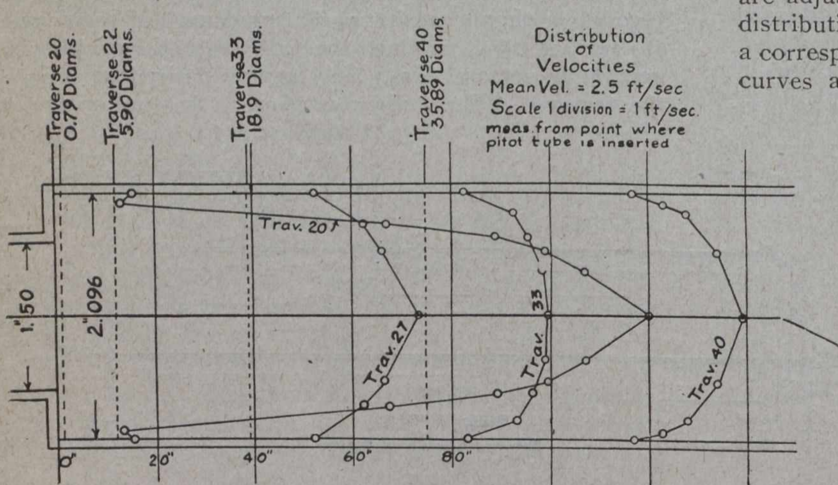


Fig. 2.

brought back to centre and the gauge readings observed as at the beginning of the traverse. This then gave three observations in each traverse with the tube on centre, at the beginning, middle and end. The mean of these three observations was taken at the true reading at the centre during the traverse.

Weighing the Water.—Weights were taken at the middle and end of each traverse as at the beginning, so that three weights were taken for every traverse. The mean of the three weights was considered as the true one from which the mean velocity in the pipe could be determined.

Time.—The time occupied for a complete traverse was about one and one-half hours.

Hydraulic Gradient.—Gradient lines have been plotted showing the observed difference of head between the different positions along the pipe below expansion for a distance of 36 diameters, Fig. 3. These curves are for velocities of one, two, three and four feet per second. The datum level or origin is the pressure at the point of expansion, and in the smaller pipe immediately above the plane of enlargement, and designated in the drawing by "E."

It will be seen that the pressure drops suddenly upon entering the large pipe, remains nearly constant for the short distance of 0.86 diameters, then begins to rise rapidly for a distance of about six diameters (12 inches). From this point the pressure begins to fall and the gradients have a slope slightly exceeding that under normal conditions, but gradually decreasing in rate of descent until at about 36 diameters below the expansion they approach very nearly the hydraulic slope of normal flow for these velocities in two-inch pipe.

It is interesting to study these curves of hydraulic slope in connection with the curves of distribution of velocities taken at the various points below the enlargement. The pressure is seen to rise most rapidly in the region where the eddies occur. There seems to be a rise in the gradient line corresponding to the amount of distortion in the curves of velocity distribution due to combined eddy formation and a retardation of the mean velocity. As the jet passes from the smaller to the larger pipe the velocity curves show first a maximum distribution at the walls and here it is that the rate of rise in the gradient is a maximum. The jet issuing from the smaller pipe is rapidly expanding with a consequent decrease in mean velocity. Farther down the pipe the velocity curves are adjusting themselves rapidly toward a more uniform distribution and in consequence the gradient line takes on a corresponding downward slope. Finally, as the velocity curves assume the form of normal distribution the hydraulic slope approaches the gradient of normal conditions of flow.

Readjustment of Velocity Distribution.—A curve of the ratios of $\frac{V_m}{V_c}$ for the various positions below enlargements was plotted in order to determine, if possible, at what position below the expansion the flow becomes normal. It is interesting to note that the conditions of velocity distribution adjust themselves to the form of normal flow in straight pipe at approximately the same distance below the disturbance in the case of sudden enlargement as in that of contraction, in the neighborhood of 35 to 40 diameters below the enlargement.

Loss of Head Due to Sudden Enlargement.—The theoretical loss of head due to sudden enlargement of section may be expressed by the equation, $H_b = \left(\frac{A_c}{A_1} - 1\right)\frac{V_2^2}{2g}$ known as Borda's formula. A_2 and A_1 are the areas of the larger and smaller pipes, V_2 is the mean velocity in feet per second in the larger pipe, $g = 32.2$, and h the loss of head in feet.

The *observed* loss of head due to sudden enlargement of section may be expressed by the aid of Bernoulli's Theorem for steady flow between any two positions in a level line as follows: $h_1 + \frac{V_1^2}{2g} = h_2 + \frac{V_2^2}{2g} + H_f + H_e$, where $h_1 + \frac{V_1^2}{2g}$ is the total effective head, the sum of the pressure and velocity heads, at any definite point in the up-stream section, $h_2 + \frac{V_2^2}{2g}$ the total effective head at any point in the down-stream section, H_f the frictional loss between the two points, and H_e the loss, indirectly observed, due to sudden enlargement.

Since $h_1 - h_2$ may be observed, the expression may be written, $h_1 - h_2 + \frac{V_2^2 - V_1^2}{2g} - H_f = H_e$, where H_e

may be considered as the *observed* loss due to the enlargement, providing H_f, the loss due to friction, be considered as known and equal to the loss for straight pipe with undisturbed flow.

H_f cannot otherwise be separated from H_e for the reason that the conditions of which H_e is a result are modifying the flow in such a way as to affect the frictional coefficient, H_f. It seems better then, to charge up to the left-hand member of the equation the term H_f, assigning to it the usual values for frictional loss in straight pipe at the various observed velocities, thus leaving the right-hand member of the equation, H_e, as the total result of the effects due to the enlargement, and of finally comparing this result with the theoretical loss expressed in Borda's formula.

to obey this law perhaps on account of conditions which might be considered as producing a water-cone of gradual instead of sudden enlargement.

The writer prefers the latter theory as a possible explanation rather than the former, for it is difficult to imagine any reduction in frictional resistance less than that for straight pipe in the region of these greatly disturbed conditions.

The position of Piezometer 5, 6 feet below the enlargement, was selected as the down-stream point for observation, and Piezometer A as the up-stream point (see Fig. 1) in order that all the losses due to the disturbance might be included. The velocity curves of distribution as shown by the Pitot tube observations indicate that

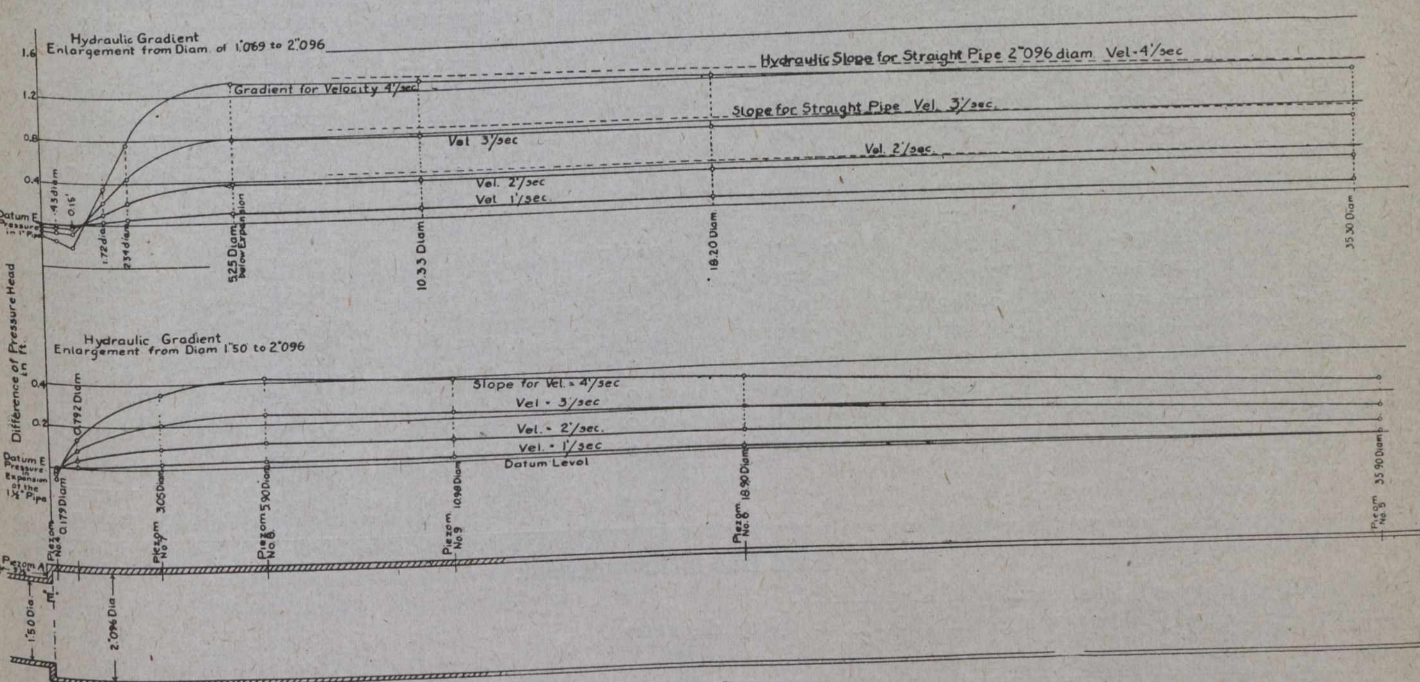


Fig. 3.

If the first member of the equation, $h_1 - h_2 + \frac{V_1^2 - V_2^2}{2g} - H_f = H_e$, be considered as the indicated loss of head between any two points, then the expression may be written $h_1 - h_2 + \frac{V_1^2 - V_2^2}{2g} - H_f = K \cdot \left(\frac{A_2}{A_1} - 1\right)^2 \frac{V_2^2}{2g}$, where K is a coefficient to be applied to Borda's formula.

The accompanying tables have been prepared in which the last column of ratios gives the value of K. The tables show a slightly less loss of head thus indirectly observed than the computed theoretical loss due to enlargement as expressed by Borda's formula. This discrepancy may be due to one or two causes or perhaps a part due to each. Either the frictional loss expressed in the term H_f is less than occurs in the case of straight pipe with undisturbed flow, due perhaps to the high central velocity of the jet as it enters the larger pipe and continues in this condition for some distance before spreading out and obtaining its full pressure and frictional effect on the wall of the pipe, or else the loss in the impact of the particles in the expanding jet due to the enlargement of the pipe-section does not follow exactly the law for sudden enlargement as expressed in Borda's formula, $\left(\frac{A_2}{A_1} - 1\right)^2 \frac{V^2}{2g}$ failing

most of the disturbance has been eliminated in this distance.

A correction might be applied for the effects due to the piezometers themselves in the battery just below the enlargement. That there is a slight excess loss of head due to the battery was found by Messrs. Utz and Ellis in their experiments upon the Effects of Contraction in which they used the same battery of piezometers. However, this slight loss of head, if applied as a correction, does not relieve the conditions above, but rather augments the discrepancy. The excess loss due to the presence of the piezometers is very small, and was obtained by placing the battery of piezometers, No. 5 to No. 7, in a line of straight pipe of the same diameter as that of the battery, thus eliminating all other disturbances than those due to the piezometers themselves. The distance from piezometer No. 7 to No. 5 is 5.75 feet. The formula for the total loss of head in this section as determined by Messrs. Utz and Ellis was $h = 0.268\, V^{1.75}$ in feet per 100. The excess loss of head due to the battery length then is found to be .001, .005, .016, and .026 feet for the respective velocities of 1, 2, 3 and 4 feet per second. Applying these corrections to the column in the tables, H_e, the loss due to the enlargement is further decreased and the coefficient K in the last column consequently decreased. This affects the coefficient K due to the enlargement to such a small amount, however, that it is thought better to leave the values as they are given in the tables, and to consider the losses as due solely to sudden enlargement.

Upon examination of the curves of Hydraulic Gradient, as shown on Fig. 3, it is evident that the observations for loss of head due to the enlargement must include a length of at least 35 diameters of the larger pipe on the down-stream side. Since the effect of the disturbances dies out so gradually it appears that a length of 50 diameters might better be chosen in order to insure that all of the loss due to the enlargement be included in the observations.

The mean value of the coefficient K in the case of enlargement of pipe from one inch to two inches diameter is found from the results given in Table I. to be 0.967.

In the case of enlargement from 1½ inches to 2 inches diameter the value of K obtained from the table is approximately 0.98.

Had the excess frictional loss of head due to the presence of the piezometers previously referred to been applied these values of the co-efficient K would have been slightly reduced by an amount in no case exceeding one and one-half per cent.

Loss of Head Due to Enlargement.

Pipe enlarged from 1.069 inches to 2.096 inches diameter.
Length of section below enlargement, 6.16 ft. 35.3 diameters.

TABLE I.

V_2 mean velocity by weight in 2" pipe. Ft. per sec.	$h_1 - h_2$ observed loss of head in section (E—5). Feet.	$\frac{V_1^2 - V_2^2}{2g}$ loss of velocity head. Feet.	$\frac{V_1^2 - V_2^2}{2g} + (h_1 - h_2)$ total loss of head in section (E—5). Feet.	H_f loss of head straight pipe length 6.16'. Feet.	H_e loss due to enlargement (4) — (5) Feet.	H_b $\left(\frac{A_2}{A_1} - 1\right)^2 \frac{V_2^2}{2g}$ Borda's formula for loss due enlargement. Feet.	K Coefficient $= \frac{H_e}{H_b}$
3.419	—0.908	2.500	1.592	0.147	1.445	1.469	0.985
3.375	—0.903	2.420	1.517	0.143	1.374	1.435	0.958
3.325	—0.820	2.360	1.540	0.139	1.401	1.400	1.000
3.175	—0.583	2.155	1.372	0.129	1.243	1.270	0.978
3.072	—0.731	2.021	1.290	0.121	1.169	1.189	0.984
2.708	—0.575	1.575	1.000	0.098	0.902	9.924	0.978
2.427	—0.465	1.264	0.799	0.080	0.719	0.742	0.969
2.053	—0.335	0.908	0.573	0.060	0.513	0.530	0.970
2.029	—0.329	0.885	0.556	0.059	0.497	0.519	0.958
1.700	—0.229	0.620	0.319	0.043	0.348	0.364	0.957
1.584	—0.198	0.552	0.354	0.040	0.314	0.316	0.994
1.397	—0.154	0.424	0.270	0.031	0.239	0.245	0.976
0.903	—0.064	0.175	0.111	0.015	0.096	0.103	0.933
0.758	—0.016	0.124	0.108	0.011	0.097	0.107	0.910
						Mean	0.967

Loss of Head Due to Enlargement.

Pipe enlarged from 1½ ins. to 2.096 ins. diameter.
Length of section below enlargement 6.27 ft. 35.9 diameters.

TABLE II.

V_2 mean velocity by weight in 2" pipe. Ft. per sec.	$h_1 - h_2$ observed loss of head in section (E—5). Feet.	$\frac{V_1^2 - V_2^2}{2g}$ loss of velocity head. Feet.	$\frac{V_1^2 - V_1^2}{2g} + (h_1 - h_2)$ total loss of head in section (E—5). Feet.	H_f loss of head straight pipe length 6.16'. Feet.	H_e loss due to enlargement (4) — (5) Feet.	H_b $\left(\frac{A_2}{A_1} - 1\right)^2 \frac{V_2^2}{2g}$ Borda's formula for loss due enlargement. Feet.	K Coefficient $= \frac{H_e}{H_b}$
3.881	—0.275	0.666	0.391	0.175	0.216	0.216	1.000
3.722	—0.257	0.613	0.356	0.158	0.198	0.199	0.995
3.247	—0.184	0.465	0.281	0.131	0.150	0.151	0.993
2.640	—0.125	0.307	0.182	0.087	0.095	0.099	0.960
2.214	—0.083	0.215	0.132	0.065	0.067	0.070	0.958
2.099	—0.079	0.193	0.114	0.058	0.056	0.063	0.890*
1.690	—0.049	0.125	0.076	0.041	0.035	0.041	0.854*
1.572	—0.048	0.109	0.061	0.035	0.026	0.035	0.744*
1.253	—0.024	0.069	0.045	0.023	0.022	0.022	1.000
0.970	—0.014	0.047	0.033	0.016	0.017	0.013	——*
0.802	—0.008	0.028	0.020	0.011	0.009	0.009	1.090
						Mean	0.987

*Rejected.

Conclusions.—The final results obtained in this investigation may be briefly summarized as follows:—

1. The Pitot tube measures with a fair degree of accuracy, always within two or three per cent. and more frequently within one per cent., the velocities of flow in a pipe where the resultant motion of the water throughout

the entire cross-section at the point where the tube is inserted is a forward motion, and where the distribution of velocities is symmetrical about the axis of the pipe.

2. The Pitot tube is a means by which eddies or whirls caused by obstructions in the pipe may be detected, but it will not measure with any degree of accuracy the discharge of a pipe when inserted in the immediate region of such eddies.

3. The rating coefficient of discharge of the Pitot tube for normal conditions can not be applied in the case of abnormal conditions produced by sudden enlargement where eddies exist, but immediately below the region of eddies the rating coefficient of discharge may be applied with a fair degree of accuracy.

4. The eddies produced by sudden enlargement of section extend for the short distance of only about two or three diameters below the enlargement.

5. The disturbance caused by sudden enlargement of section produces abnormal conditions in the distribution of velocities which continue down the pipe for a distance of about 35 diameters.

6. The ratio of the mean velocity to the velocity at the centre, $\frac{V_m}{V_c}$, increases in value, in the case of sudden enlargement, from a minimum near the point of enlargement to a maximum at a point about 11 diameters downstream, after which it begins to gradually decrease, approaching the value of the ratio for flow in straight pipe at a distance of 35 diameters below enlargement.

7. The loss of head due to sudden enlargement may be expressed by the equation, $H_b = K\left(\frac{A_2}{A_1} - 1\right)^2 \frac{V^2}{2g}$ a constant times the theoretical loss by Borda's formula, and in making the observations for the total loss due to this disturbance, a distance of at least 35 diameters of the down-stream section, below the enlargement must be included.

The value of the coefficient K is very nearly the same in the two cases of enlargement herein investigated, and is approximately 0.97.

8. The Pitot tube reversed, i.e., the impact-point turned down-stream, gives a negative pressure-head, which reduced to velocity, negative, gives a value whose ratio with the velocity in the up-stream direction is fairly constant for any given form of tube. But the relative values of the down-stream readings to the up-stream readings for different forms of tubes vary greatly. The maximum negative pressure or suction action at the impact-point of the Pitot tube occurs when the direction of the axis of the opening is approximately perpendicular to the direction of flow.

MINERALS OF NEW BRUNSWICK.

The minerals of New Brunswick, developed and undeveloped, cover a considerable range. They include an antimony deposit at Lake George, which has recently been taken over by the Northern Antimony Smelting Company with a capitalization of $2,000,000; bituminous coal deposits (estimated to contain fifteen million tons); iron, gypsum, oil shales, manganese, graphite, tungsten, molybdenite, copper, lead, zinc, galena, barytes, infusorial earth, black, grey and red granites, freestone, sandstones and other minerals, which offer a very attractive field for investment. A discovery of a rich bed of galena ore was recently made at Maple Grove, York County, by W. H. Griffin, a provincial game guide. Two veins of 22 feet and 12 feet respectively have been uncovered. Ontario parties have secured an option of the mine.

SOME ADVANTAGES OF REFINED COAL TAR FOR ROAD CONSTRUCTION AND MAINTENANCE.*

By Philip P. Sharples,
of the Barrett Company, New York.

THE success of simply surface treatments over waterbound macadam in resisting modern state highway traffic has led in the last few years to a reversion to the macadam type to meet the needs of the lesser traffic roads. Its ease of construction and its adaptability to repairs, widening and reconstruction, commend themselves to the thinking engineer.

The choice of bituminous materials for protecting the surface lies between those which form distinct mats and those which are thin enough to enter into the surface of the roadway and form an integral part of it.

As mat-forming protectors, both asphalts and tars are available, refined to suitable consistencies. They must, however, be handled with extreme care to avoid the formation of a movable mat which ruts and rolls under traffic.

Excellent examples of this form of mat surface long in use are to be seen in the vicinity of Boston. A section of the Newton Boulevard opposite the Brae Burn Club has never been re-treated since the original three-quarters of a gallon of refined tar to the square yard was given in 1906. As the road receives heavy auto traffic, several thousand cars per day, it probably represents as low an upkeep cost for a road kept in perfect condition as any in the United States. The traffic is, however, wholly automobile and the road and its surface as perfect as could be presented for this form of treatment.

The Massachusetts State Highway at West Lynn and the Metropolitan Parkway through Everett and Revere are other examples dating from 1907 and 1906 of the success of this treatment under favorable road and traffic conditions.

The employment of bituminous material applied cold to the macadam surface has to a large extent taken the place of the hot applications. The ease and cheapness of application and the less skill required in their use have been responsible for the wider extension of cold applications.

The refined tars used for cold application have much more penetrating power than any of the other bituminous materials of an equal viscosity. This penetration makes them particularly valuable where it is important to avoid the formation of a distinct mat owing to traffic conditions which would disrupt a mat if formed. It also makes them of the greater value in treating bituminous macadam of every type. The refined tar finds its way into the surface and has a healing effect even on a distinctly disintegrating road.

The amount of bituminous material required will usually vary from ¼ gallon per square yard for re-treatments to ¾ of a gallon per square yard for new absorptive roads. The most favorable results on a first treatment can be obtained by supplying sufficient bituminous material to cause a slight excess to remain on the surface after it has been allowed to dry in for an hour or so. Usually better results are obtained on new work by applying in two treatments at an interval of two to six hours.

The kind of cover to be used depends largely on the local material available. With the refined tars, success may be obtained with a large variety of materials from three-quarter inch stone chips, through the gravels to a

*Abstract of paper read before American Association of State Highway Officials, December 6th, 1916.

fine, though sharp, sand. Materials containing clay are barred as its presence tends to cause disruption of the surface through the emulsifying properties of clay and water on bitumens.

The cost of these surface treatments vary with freights and localities, but the contract prices in Maryland, showing a total cost of between 6 and 7 cents per yard, give a good idea of the cost of doing work carried out on a large scale with power trucks in the best possible manner using stone chips for cover.

The point where it becomes desirable from an economic and engineering standpoint to build a bituminous macadam instead of a plain macadam with a surface treatment is not easy of determination. Theoretically, the decision should rest on the ability of the road to resist internal wear. The surface coatings, if kept intact, preserve the road from wear from the top but they do not prevent wear within the road itself. This internal wear has long been understood in England but has been given little study in this country.

If the loads on a macadam road increase beyond the ability of the structural strength of the road to bear them, the stone move on each other and internal disintegration takes place. With soft stone and heavy loads, a road will quickly wear out from within even though the surface is protected by treatment.

Any approach to the point where this wear becomes a serious menace to the life of the road would indicate the advisability of introducing a bitumen into the structure of the road to prevent interstitial wear.

The bitumen may be introduced either by the mixing method or by the penetration method. The less expense of the penetration method, the ease of handling the bitumen, especially if refined tar is used, the less skilled workmen required, and its peculiar adaptability to state highway conditions would warrant its wider adoption. Theoretically, the method is not perfect; practically, under ordinary conditions, it meets every requirement.

The difficulties which engineers have had with the penetration method have arisen less through the faults of the bitumens applied than through neglect of some of the fundamental tenets of macadam road construction. That is the reason that the greatest success of the penetration work has been achieved in New England and especially in Massachusetts where macadam road work has been practised in an understanding way for a generation. Some credit should also be given to a knowledge of tars in road work for the New England tar and gravel sidewalk has made the use of tar for road purposes familiar to every New England road man.

Bituminous macadam roads require, even more than plain macadam, strict attention to drainage both underground and surface. It is folly to construct a bituminous macadam without strict attention to drainage.

The base course will vary with soil and load conditions from four to eight or even ten inches. The deeper bases must be laid in layers as it is difficult to roll more than 4 inches of loose stone and consolidate it. The base course should be built like a one-course macadam rolled dry and then filled with stone screenings or gravel. The filler has the double purpose of making the base more solid and of preventing the bitumen from draining away from the top course where it belongs into the base where it is not needed.

The stone for the bituminous course, which is usually 2½ inches rolled, must be carefully selected to get clean stone, in fact much of the success of the pavement depends on the cleanliness of the stone, its proper sizing, and its proper rolling.

The size of the stone and the method of putting the top together depend much on the softness of the stone, its form of fracture, and its action under the roller. As a general rule, a soft stone should be of larger size, even up to 3 inches, than hard trap rocks. With the hard rocks, it is often necessary to add smaller sizes of clean stone in order to form a proper surface for the reception of the bitumen.

The course must be rolled enough to key the stone together and obtain structural strength, but extreme care must be exercised, especially with soft stone, not to roll it so much that the surface is closed against the entrance of bitumen. Work with asphalts and work in cold weather require a more open top than work in hot weather. In fact, care must be taken in extremely hot weather not to let the bitumen run through to the top of the base course, leaving the top course deficient in bitumen at the surface.

The amount of bitumen is, roughly, one gallon for each inch in depth of rolled stone but this quantity should include the seal coat. Usually, one and one-half to one and three-quarter gallons are used in the first coat and one-half to three-quarters of a gallon in the seal coat, for a 2½-inch top.

The bitumen is applied best by pressure apparatus of some kind. A very simple one adaptable to refined tars delivered in tank cars has been devised, using steam pressure from a road roller on the refined tar in a tank wagon and forcing it out under pressure through a single spraying nozzle. The success of the method depends on the man at the nozzle but it is not difficult to train a man to do good work, and a little extra bonus usually keeps him on the job.

After the first coat of bitumen, clean three-quarter-inch stone are cast over the surface to chink the voids. The road is then thoroughly rolled and any excess of chinking stone removed by sweeping with push brooms.

The seal coat is applied in the same way and then clean peastone cast over the surface and rolled in.

If the stone is soft, the road is finished with clean peastone. If it is hard stone, especially on light traffic roads, it is best to follow the clean peastone with stone dust. The surface voids are in this way more completely filled.

The unique property of refined cold tar of sticking to cold stone makes it especially valuable in penetration work. The hot spray striking a cold surface sticks and even a slight amount of moisture does not prevent adhesion. Coupled with this, the coal tar bitumen has strong cohesion so that even though coated surfaces be disturbed, the pieces upon being brought together reunite.

These rather striking properties allow considerable latitude in penetration work and it is not impossible, if due care is used, to build good pavements even in freezing weather.

The possibility of building macadam roads with stone not previously considered available should also be kept in mind. The cementitous qualities of a rock so necessary in waterbound macadam may be neglected, and really successful roads may be built out of flint, quartzite and granite of very low cementing values.

Some soft rocks are also made available, especially where not subjected to much rainfall. Roads built of the soft adobe rock in the vicinity of San Antonio, Texas, and protected with refined tar have been markedly successful. Experiments at Phoenix, Arizona, with caliche gravel show equal promise.

The scope of road engineering is rapidly widening and the study of the possibilities of available local materials must always be a fruitful field to cultivate.

Editorial

DEPRECIATION.

Depreciation is a term for which there does not appear to be any universally accepted definition, although the importance of depreciation as a factor in the operating costs of any power plant, pumping plant and machinery and in buildings generally has always been recognized.

Is it too much to say that engineers and managers have in the past not recognized this factor sufficiently?

Failure to appreciate the inexorable law that apparatus of all kinds must come to the end of its useful life has resulted in the financing of economically unsound enterprises of all kinds and in the embarrassment of good enterprises through the distribution to stockholders of funds that should have been held in reserve for maintenance.

Difficulties arising from lack of funds with which to provide replacements are often responsible for poor service.

It is obvious that deterioration, visible or invisible, is going on continuously. Engineers, therefore, must not fail to note the distinction between depreciation and maintenance.

The length of useful life of any unit is determined by one or both of two factors: First, the inherent quality of most physical property to deteriorate owing to use and to the elements until it reaches such a condition that it is either impossible to keep it in satisfactory operative condition by repair or the cost for such repairs becomes so great that it would be more economical to replace it by a new one.

Second, the changes in the art whereby the character of the service required is so changed that it becomes obsolete.

The rate to be allowed for depreciation must be largely governed by local conditions and will vary according to the utility. Depreciation is a constant loss and should be reckoned with.

ESTIMATE vs. TENDER ON CIVIC WORK OPEN TO CONTRACT.

The practice of city engineering departments competing with contractors on public works is becoming more general and in a number of ways this is to be welcomed. It serves as a preventative against a possible agreement among contractors in the matter of prices or conditions of work. Another good effect is that it acts as a stimulus to the municipal engineering staff. When the onus is thus placed upon the staff of competing with outside concerns it tends to keep it more efficient and at the same time keeps the price of general construction work more nearly where it ought to be.

On the other hand, in not many cities in Canada is the engineering department so well organized as to be in a position to better carry out such work (with the exception of perhaps extensions to water mains, sewers, pavements, etc.) and at a lower cost than the responsible contractors who bid for it are in a position to do. Questions of plant, labor and experience are usually in favor of the contractor.

This raises the question as to the advisability of getting a tender from the city engineering department on work to which the above conditions apply. If it be the lowest it ought to be accepted under the competitive plan. If, on the other hand, the engineer's tender is to be merely used for the purposes of comparison is not the same object obtained by the submission of an estimate?

It is claimed by many that the municipal engineer has many opportunities for so distributing his charges as to make the ultimate cost of a particular piece of work amount to any figure he desires within reasonable limits.

There would appear to be many pieces of work concerning which an estimate would answer the same purpose as a competitive tender and leave to contractors the tendering for work which they are better equipped to carry out.

This would have the effect, however, of being less beneficial so far as stimulus to the engineering staff is concerned. However, an intelligent combination of the two would add to the efficiency of the city engineer's department without losing the advantage of being able to check contract prices, and without being as unfair to the contractor as engineers' bids occasionally have been.

AIDING THE PROFESSION.

During the past few months the status of the engineering profession has been very frequently discussed in scientific spheres. Not a few papers have been read before various technical societies on the subject and these have brought out much discussion as to how engineering might be aided to come more nearly into its own as a profession.

The engineer is the man who is expected to do things, and in most instances he does not disappoint. The thing accomplished, he is disposed to say little or nothing about it. This trait in him is to be commended, but may not always be the wisest procedure to follow. If this is persisted in it may well be doubted that the general public will ever have clear-cut ideas as to the real importance of the engineer in the community.

The fact that these questions are forcing themselves upon the membership of the profession is in itself a hopeful sign. It does really seem as if the desire to do more in the way of mutual assistance of one another in the engineering profession was gaining ground.

There are wonderful engineering possibilities in Canada and unlimited scope for the engineer. Problems are facing us as a people and will continue to face us in the solution of which the engineering profession will have a large part to play. It is fitting, therefore, that every member of the profession do his share in an effort to assist it to attain that position which it should rightly occupy.

ENGINEERS WILL OFFER SERVICES.

In our issue of last week under the heading "Engineers Will Offer Services," we reported an open meeting that had been held at the Engineers' Club, Toronto, of members of the local branches of the technical societies in that city. At that meeting a committee was appointed composed, in the main, of one member of each of the various technical organizations having members in Ontario.

This committee met on Tuesday evening, January 2, and discussed at length various lines of action that seemed to offer promise of real and useful results in the way of hastening our victory in the war. Professor J. C. McLennan, who is also a member of the recently appointed Industrial Research Advisory Council, outlined the work that body is planning and expressed the belief that the committee of engineers could work best through this Advisory Council, at least for the present. This plan commended itself to the committee and in all probability developments will follow along that line.

PROPOSED SPECIFICATIONS FOR HIGHWAY BRIDGES.

In our issue of December 21st, 1916, an article appeared under the above title. This dealt with the proposed recommendations of the Committee of the Canadian Society of Civil Engineers on Highway Bridge Specifications. As the article might be construed as outlining the final recommendations of the committee, we desire to correct that impression. The discussion, a report of which we published in the article in question, was precipitated by a paper which was prepared by Mr. P. L. Pratley and read by Mr. G. H. Duggan, which contained certain suggestions as to highway bridge design. These suggestions, however, may and may not be adopted by the committee. The draft of the specifications as proposed by the committee is still subject to revision, and is quite different from those embodied in our article of December 21st.

PERSONAL.

A. C. GARDEN has been elected chairman of the Hamilton Harbor Commission for 1917.

A. A. COLE, president of the Canadian Mining Institute, has been nominated for re-election.

A. INGRAM, superintendent of the electric light and water commission, Kincardine, Ont., has resigned.

ROBERT PARKER, a contractor of Windsor, Ont., has been appointed building inspector for that city.

D. M. MAWHINNEY, formerly with the Winnipeg, Selkirk and Lake Winnipeg Railway, has been appointed engineer for Rockwood municipality, with offices at Stonewall, Man.

Lieut. JAMES CAMERON ARMER, of the Commercial Press, Limited, Toronto, has been appointed recruiting officer for the Canadian Engineers in Military District No. 2, Toronto, vice Lieut. M. B. DUTHIE.

LAWRENCE T. MARTIN, a member of the firm of O'Brien & Martin, railway contractors, Renfrew, Ont., has been appointed commanding officer of the Railway Construction Battalion to be formed in Canada for service in France.

LORD COWDRAY, formerly Sir Westman Pearson, president of S. Pearson & Sons, Limited, contractors, London, England, has been appointed chairman of the Army and Navy Airplane Service Board, in succession to Lord Curzon.

W. W. BUTLER, heretofore senior vice-president of the Canadian Car & Foundry Co., Limited, Montreal, has been elected vice-president and managing director, and W. S. ATWOOD, heretofore chief engineer and general works manager, has been appointed operating manager.

Lieut. CUTHBERT P. COATSWORTH, son of his Honor Judge Emerson Coatsworth, Toronto, has been awarded the Military Cross. He is 22 years of age, and was a second year student at the School of Practical Science when he joined the 2nd Canadian Pioneer Battalion, with which he went overseas.

JOHN I. REID has been appointed superintendent of the Longue Pointe plant of the Canadian Steel Foundries, Limited, Montreal. He was formerly works manager of the American Steel Foundries' plant at Chester, Pa., and recently sales agent for the company at 30 Church Street, New York City.

Major LINDSAY MALCOLM, A.M.Can.Soc.C.E., of the Canadian Engineers, who at various times acted as city engineer at Guelph, Ont., in the absence of the regular engineer, and who went overseas in command of an engineering company from Queen's University, Kingston, received honorable mention in the latest dispatch of General Sir Douglas Haig.

Lieut. ROBERT L. DUNSMORE, of St. Thomas, Ont., who was wounded last July, has been awarded the Military Cross for bravery under fire. He is a civil engineer by profession, and a graduate of Queen's University, Kingston, Ont. He volunteered for active service four days after the declaration of war, and went overseas with an engineering unit in the Second Division. Since he has been at the front he has suffered from an attack of typhoid fever.

Lieut. C. AUSTIN BELL, son of Chas. H. Bell, 427 Sumach Street, Toronto, is reported to have been awarded the Military Cross for bravery in action. Lieut. Bell, who is 25 years of age, enlisted as a private in the Engineers, and won his commission on the field. He was twice wounded, once at Langemarck and once at Ypres. After convalescing in a Boulonge hospital he returned to the front. He is a graduate of the School of Practical Science and before enlisting was employed as a mines maintenance engineer with the Canadian Copper Co.

OBITUARY.

Lieut. CHARLES THURSTON BOWRING, of the Canadian Machine Gun Company, a member of the late firm of Bowring & Logan, electrical engineers, Winnipeg, was killed in action on December 29.

Lieut. GERALD GALT, a graduate of the School of Practical Science, Toronto, and who for many years prior to enlisting was a mining engineer in Chile, South America, is reported to have been instantly killed on Christmas night. Lieut. Galt went to the front early last year with the 3rd Tunnelling Corps. He was about 29 years of age.