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GRADE ELIMINATION AND BRIDGES.

By HENRY GRATTAN TYRRELL.

The subject of track elevation in the United States received but little attention until the year 1888, when the House of Representatives of Massachusetts appointed a commission to investigate and report on the subject of separation of grades for steam railroads and highways. The recommendations of the legislature were that grade crossings be eliminated, and that the expense of such work be borne

65% by the railroad companies
25% " " State.
10% " " local town or city.

In the two or three years following, the subject of grade elimination in Chicago was seriously considered, and in 1892 as a preparation for the approaching World's Fair in Jackson Park, Chicago, the Illinois Central Railroad undertook the raising of their tracks from Hyde Park to 72nd Street, Woodlawn, as in this district their tracks cross the principal avenues leading to the Fair Grounds.

In the same year a measure was introduced into the Chicago city council requiring a general raising of all the railroad grades entering the city. The population of Chicago was then about a million and a quarter, and there were 1,600 miles of track within the city limits, with 2,000 to 3,000 level crossings, over which upwards of 1,800 trains passed daily. The ordinance affected about thirty railroad companies, and required the elevation of 150 miles in line and the construction of 700 to 800 subways. So important an ordinance necessitating the expenditure of $75,000,000 or more, met with very serious opposition, and modifications were made requiring that parts only be elevated immediately, and the whole work spread over a period of years. A superintendent of track elevation was appointed, and portions of the work were soon commenced. The Chicago and Northwestern Railroad was one of those affected, and in the next few years portions of their various branches were raised, including about four miles of line on the Milwaukee branch between Diversey Boulevard and Balmoral Avenue, which was elevated in 1897. At a number of crossings in Chicago where the track is elevated on banks from 8 to 12 feet high, the streets beneath the tracks have been lowered from 4 to 6 feet, and graded back to the regular street lines. In Chicago and Evanston, it is impractical to depress the grades below the lake level, as provision for pumping would be necessary.

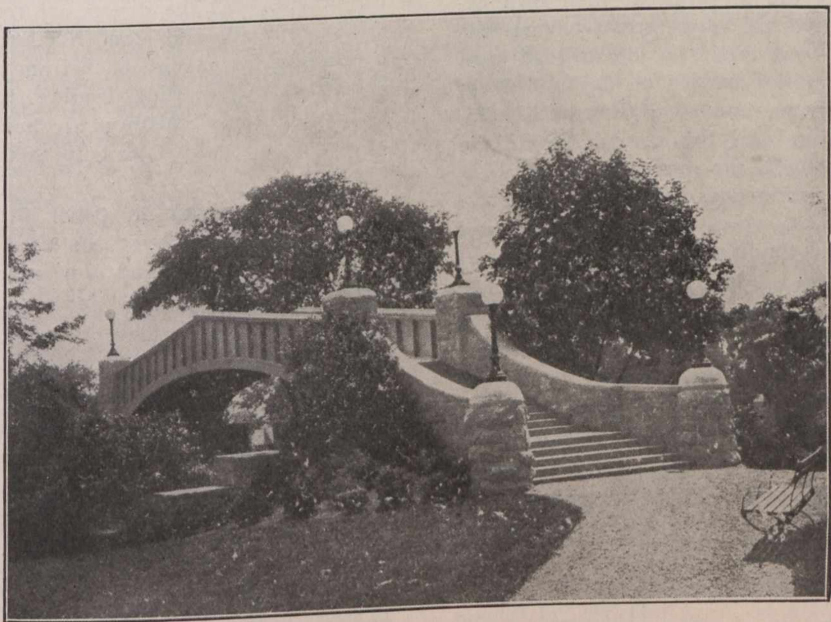

Fig. 1.—Forest Park Entrance, St. Louis.

This is an overhead bridge crossing when railway is depressed. It has a clear span of 50 feet, and spans two lines of track.

Evanston Work.— The method of track elevation used in Evanston is similar to that in Chicago, the country being all flat, and the grades insignificant. The city of Evanston, a residential suburb with a population of 25,000, lies directly north of Chicago, and the boundaries of the two municipalities meet. Two branches of the Chicago and Northwestern Railroad pass through the city, connecting with Milwaukee. In the morning and evening, during the hours of greatest travel, suburban trains run at intervals of three to ten minutes apart, averaging twelve per hour. Adjoining the steam railroad, are double tracks of the Northwestern Elevated Railroad, which is likewise elevated on an earth embankment, and where trains make stops at frequent intervals.

Grade removal was greatly needed, not only to avoid accidents, but also to make possible the running of faster trains between Evanston and Chicago. At some of the crossings several persons had been killed, and the fire risk was also increased by the level grades, because where trains are numerous fire engines might be delayed by them, and a few minutes' delay at the beginning of a fire might result in increased fire loss. Gates and flagmen are a partial protection but do not insure safety, as any provision depending on human watchfulness is sure, sooner or later, to prove disastrous.

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The general plan of track elevation in Evanston consisted in placing the steam railroad on an earth embankment, using retaining walls where the width of the railroad land was not sufficient for side slopes. At the street crossings, the bank was supported by abutments and the tracks carried over the streets on bridges, having three lines of columns in the streets, two at the curbs and one in the middle, dividing the street into right and left driveways. Travel was first diverted on a temporary track at one side of the permanent line, and pile trestles were then built on the permanent location over the streets and a sufficient distance at each side of the street to allow space for building the permanent abutments. In several places where the streets are fairly close together, the trestles were made continuous.

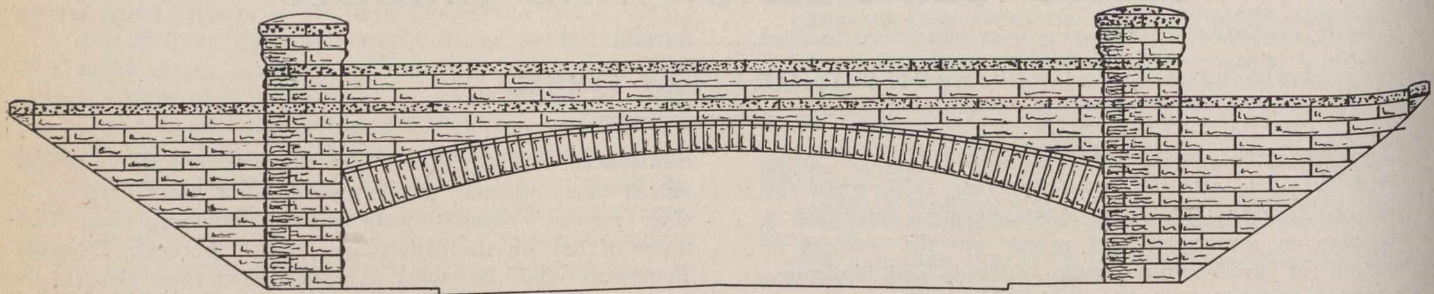


Fig. 2.—Main Street Crossing, Springfield, Mass.

The railroad companies did all work at their own expense, unassisted by the city, and where street paving was removed for foundations, it was relaid by the railroad company. The driving of piles was carried on day and night with drop hammer pile drivers, and some Naysmith hammers making blows at intervals of two seconds. On the Melrose branch, only a part of the street crossings are bridged at present, the remaining ones where travel is light, being filled with earth banks, which can be removed and bridges substituted when the condition of travel demands it.

Much caution was needed in driving piles at the street crossings to avoid injuring the city sewers and water mains. When sufficient pile trestle work was built, sand filling was brought in by train and the bank made. The temporary side tracks were then removed and all travel turned over the bank and trestle. At several of the streets, when building abutment foundations, so much water was encountered that sheet piling was necessary. Two-inch tongue and grooved plank was used for this purpose and water pumped out of the excavations with hand pumps. Oak piles were driven in the excavations and were cut off three or four feet below street grade with hand saws.

Concrete was used almost exclusively for abutments and retaining walls, side walls being used only where the width of right-of-way is insufficient to hold earth slopes. Low walls are used in some cases near the toe of slope where enough land width was not available. High retaining walls are paneled on the face, but lower ones are plain, excepting for the presence of a coping. Vertical joints are left at distances of 15 feet apart for expansion. Little or no effort was made to remove form marks from the abutment faces, and these are very evident. Walls and abutments are of the solid gravity type, with backs stepped rather than sloped, and waterproofed with a coating of tar or asphaltum, which in many cases is not proving effective. Three lines of old rails are imbedded in the concrete, and at places where new walls are joined to old ones, a dovetailed joint is provided which not only permits expansion, but holds the two adjoining parts together.

Where the Northwestern Elevated Railroad adjoins the steam road, columns in the street correspond with those for the steam railroad bridges. The foundation in the centre of the street consists of a continuous wall pointed at the ends to serve as wheel guards, and standing a foot or two above the street level. On these walls are reinforced concrete columns, two under each line of track, with eight bars in each column, the four corner bars being larger than the others. At the depots are retaining walls between the steam railroad and the Northwestern Elevated Railroad, continuing far enough back from the street to form inclined driveways 24 feet wide, leading from the street up to the elevated grade. Stairways are built into the abutment faces at the depots, which lead up to the elevated platforms and shelters.

Grade Elevation in Other Cities.—Various methods of grade elimination have been used in other cities, differing considerably in cost and appearance. All of these may be divided into two general classes,

(a) Those where the track is depressed,

(b) Those where the track is elevated.

The Boston and Albany Railroad through the Newtons, Mass., adopted a plan of depressing the railroad tracks and carrying the streets over on ornamental bridges. There is no doubt that this arrangement produces the most satisfactory results as far as the aesthetic effect is concerned, for the trains are then below the general level of the ground and there is no unsightly bank to obstruct the view, and divide the city into two parts. At Newton, in the vicinity of the depots, the side slopes are sodded and planted with flowering shrubs, which serve not only as ornaments in summer, but also to unite the soil and prevent the banks from sliding.

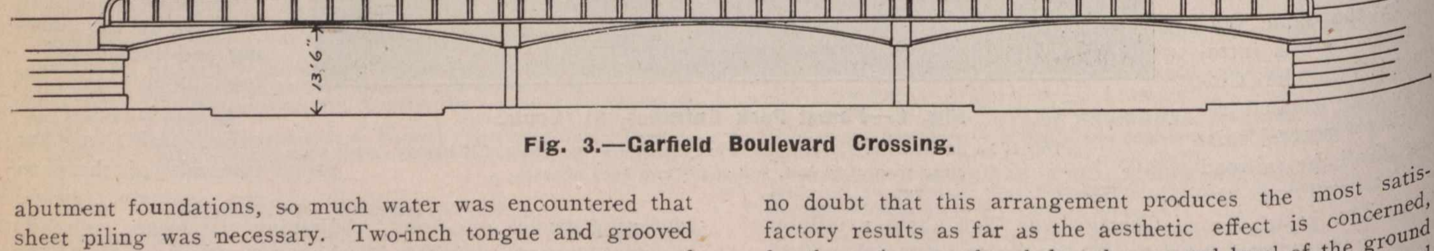


Fig. 3.—Garfield Boulevard Crossing.

Adjoining Forest Park, St. Louis, the Wabash Railroad adopted the plan of elevating the tracks on a bank of earth 15 feet in height. A view of this elevation at the main part entrance is shown in Fig. 1. The bridge over the main drive is quite a satisfactory solution of the problem as far as that feature is concerned, but the high embankment remains as a disfigurement to the otherwise beautiful surround-ings. Such a bank forms an obstruction to the view of a beautiful park vista, that might be a permanent source of pleasure. The railroad bank may be hidden with trees or shrubs and its unsightliness concealed, but if conditions would permit, a better way would be to depress the tracks and leave a clear and unobstructed view.

The city of Springfield, Mass., has a railroad bank running across the city, but some of the street crossings have been made quite attractive, like the one shown in Figure 2.

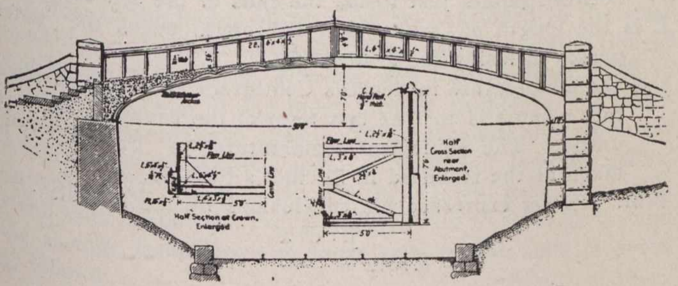


Fig. 4.—Foot Bridge, Madison, Wis.

The railroad is carried over Main Street on a stone arch, artistically designed with towers at either end and stone belt courses of different colors. The necessary head room underneath makes the use of an arch difficult in some cases, and when used, it must necessarily be a flat arch. The bridge at Springfield is so low at the springs that there is a sense of insufficient head room when walking on the sidewalk beneath the bridge. The extreme flatness of the arch also produces a feeling of insecurity and lack of strength which injures it aesthetically, for strength should, if possible, be emphasized in all bridges. Apart from the flatness of the arch, the general effect is quite satisfactory.

At Brockton, Mass., there are a number of ornamental overhead crossings, carrying lines of railroad over the

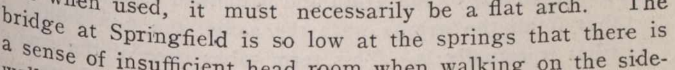


Fig. 5.—Park Bridge at Madison, N.J.

streets. These are built somewhat similar to that at Springfield, with stone arches, but at Brockton the long blank wing walls are unsightly and more prominent than the bridges themselves.

Garfield Boulevard, Chicago, is crossed by a set of railroad tracks which are supported by through plate girder bridges, shown in Figure 3. As the boulevard is quite wide, the bridge has three spans, and an effort has been made to relieve the straight overhead lines by using flat arches beneath the girders.

Other cities have treated the subject of grade crossing elimination in various ways, but generally either by track elevation or depression, as any great change in street grades is usually impracticable.

A plan used by the writer for grade elimination is shown in Figures 4 and 5. This bridge is in the park at Madison, N.J., and carries a foot walk over a double line of railway, which in this case is depressed instead of being elevated on an embankment. Similar treatment can be applied to street or highway bridges over railroad cuttings, either by lowering the railway or by grading up the street approaches instead of using steps, as in the illustration.

THE FLOW OF WATER THROUGH A POROUS MEDIUM.

By L. R. Balch.

The flow of water through a filter medium is a question of important practical application upon which our knowledge is so imperfect that a great deal of further investigating in the laboratory is required. The final object of such experimental research is to determine what factors influence the variation in results under various conditions, and what the effects of those factors are. In conducting the experimental investigations, the principal, and also the most difficult, thing is so to design the apparatus and conduct the tests that these various factors either be eliminated or be determined in effect. A large amount of work and a great deal of study is required before this can be accomplished. It often happens that, though an investigation promises to be comparatively simple, the additions and revisions found necessary as the work advances cause it to become quite complicated before satisfactory results are obtained.

Through the work done on this subject by Mr. Allan Hazen for the Massachusetts State Board of Health, and by Prof. C. S. Slichter, of the University of Wisconsin, a fair knowledge is had of the conditions influencing the flow of water through a soil column and of their effects. A number of conditions which have a very great effect on the rate of flow are quite difficult to determine, making the experimental work a matter of great care and thoroughness. The conditions which influence the rate of flow as shown by previous experiments will be taken up somewhat in detail.

The hydraulic gradient or difference in pressure from point to point, measured in the direction of flow, is the primary cause of the flow of liquid, and the greater the gradient, the greater will be the flow. The value of the hydraulic gradient is measured by means of gage tubes, similar to the piezometer tubes familiar to those acquainted with experimental hydraulics.

The porosity or amount of void space in the porous material has a great influence on the rate of flow, which varies directly with the porosity. In experimenting with a mass of spherical shot, Prof. Slichter found that a number of values for the porosity could be obtained with the same material, depending upon the arrangement or manner of packing. The minimum value was found to be 25.95 per cent. of the whole space occupied. The great effect of the porosity on the flow may be shown by a tabulation given by Prof. Slichter in Water Supply and Irrigation Paper No. 67, published by the United States Geological Survey. From this it appears that if the porosity of the same sample of sand is changed from 30 per cent. to 37 per cent., other conditions remaining the same, the flow in the latter case will be twice that in the former.

There are several methods which may ordinarily be used to determine the porosity of a sample of sand. Probably the

*From the Wisconsin Engineer.

most successful method is that used by Messrs. Cenfield and Urbutt, which is described in their thesis for the degree of Bachelor of Science in 1909. This method, by which repeated trials gave substantially the same results, is to fill the testing receptacle with thoroughly dry sand by allowing it to flow through a tube maintained at a constant height above the sand surface in the receptacle. Water is added through a pipe connected to the bottom of the apparatus from the outside. This method of filing the voids drives out the air as the water rises. A difference of two per cent. by weight was found in the amount of sand necessary to fill the apparatus in various determinations by packing the sand in any other way than by the tube method. This method has a disadvantage in that the tanks used in the flow experiments are not packed in the same way and the consequence is that the correct value for porosity to use in the computation of results is not known.

Probably the most satisfactory way would be to measure the void space in the sand when in place in the flow apparatus. This would be open to criticism, since the value obtained could not be checked, and in case the determination was incorrect, the results would be unreliable.

The larger the size of the separate pores, the greater will be the flow through the porous material. The value of this factor depends upon the "effective size" of the soil grain in the sample The flow through the interstices of an ordinary sand bed is similar to the flow through capillary tubes and is proportional to the first power of the head causing the flow. When the grains become about three millimeters or larger in diameter, the condition for free flow obtains and the flow varies in accordance with $\sqrt{2gh}$.

The method of determining the effective size will be briefly taken up in a discussion of Hazen's Formula.

The rate of flow varies directly with the temperature. This is because of the effect of temperature on the viscosity of water. An idea of the effect of change in temperature on the flow may be had from the fact that a change from 50 degrees to 60 degrees Fahrenheit will produce a change of about sixteen per cent. in the flow.

It has been found that the shape of soil particles is an influencing factor, though it is impossible to express it in the flow formulas. It is plain that sand grains that are round, flat, rough or smooth will have varying effects on the results even though the effective size is the same for each kind. Cleanliness, chemical composition and distribution of sizes in the sample also have greater or less effects upon the flow, but are exceedingly difficult to express. The distribution of sizes is shown by the "uniformity coefficient" used in selecting the value for C in Hazen's formula.

There are two accepted formulas for the flow of water through soil, one by Allen Hazen, resulting from his work at the Lawrence Experiment Station, and one by Prof. Slichter, resulting from his investigations of the flow of underground water.

The former is generally used by American engineers in their designs and has become standard. This formula is

$$V^2 = c\, d \frac{h}{L} (0.70 + 0.03t)$$

V is velocity of flow in meters per day.

C is a constant depending for its value upon the shape, cleanliness, chemical composition and distribution of sizes of grain. In practice its value is assumed by comparison of the results of mechanical analysis of the given sand with those of a sand which has been tested.

d is the effective size of soil grain. It is the diameter in millimeters of a sphere whose volume is equal to the volume of that soil grain of such size that 10 per cent. of the grains in the sample are smaller. The size of grain is found by thoroughly shaking the sample through a set of sieves and finding that size which just will not pass each sieve. The results are platted and the effective size taken from the diagram. The size than which 60 per cent. of the sample is smaller divided by the effective size is termed the "uniformity coefficient," the comparative value of which is considered in selecting the proper value for C.

h is the loss of head or the head causing the flow measured between points just inside the ends of the soil column.

L is the length of sand column through which the water passes in losing the head h.

t is the temperature in degrees Centigrade. It may be noted that when t is 10° the last term of the equation becomes unity. The equivalent temperature, 50° Fahrenheit, is taken as the standard in Slichter's formula.

Prof. Slichter expressed his conclusions by the formula:—

$$Q = 0.2012 \frac{h\, d^2\, a}{L\, w\, k}$$

Q is the volume flow in cubic feet per minute.

$\frac{h}{L}$ is the hydraulic gradient and has the same value as is used in Hazen's formula.

d is the mean size of soil grain and is defined as that size such that if all the grains were the same, the flow would be what it actually is. This term takes care of the size of voids, the cleanliness, chemical composition, shape and distribution of sizes in the sample.

W is a number called the viscocity coefficient which depends upon the temperature for its value. It is defined as that force necessary to maintain unit difference in velocity between two strata of water unit distances apart.

K is a constant depending upon the porosity for its value. Tables of values of both K and W are given in the water supply paper previously mentioned.

Experiments which have been made show the necessity for observing certain principles in conducting investigations of the flow through sand.

Water used in the tests should be treated with some agent such as formaldehyde to prevent the growth of organic life, and should be filtered through charcoal before using. It has been found that water treated in this manner answers the purpose about as well as distilled water. The water should not be used in the tests a second time. In passing through the sand the water may dissolve material which affects its viscosity.

The temperature of the influent water should not be different than that of the effluent by more than one-half degree. In varying the temperature, the experiments should not be conducted at a temperature much above about 65° F. until a satisfactory amount of data has been taken at the lower temperatures. The reason for this is that the heated water seems to cause an entirely new arrangement of the material. The increase in temperature of runs should be made in small increments to discover the critical temperature if such exists.

SHIP-RAISING AT SARNIA.

The Steel Trust is using a novel method to raise the Joliet at Sarnia. It was found impossible for the divers to work on account of the current, so another boat will be sunk directly in front of the Joliet, which will break the current and enable the damage on the Joliet to be repaired. It is expected the scheme will be successful and the boat removed in a short time.

PROTECTING PIPE LINES AGAINST ALKALI.

The matter of the proper method of protection for pipe-lines when alkali is present is a very important one to the engineer. Many of the water supplies for our Western towns and cities must be conveyed through many miles of pipe, and adequate protection is a necessity. Mr. C. P. Bowie makes the following comment on the subject in the May issue of Western Engineering.

Most of the larger oil pools so far developed in the state of California lie in the arid districts. In the construction of pipe-lines through these districts, and leading from them to the sea-coast, one of the most serious problems the engineer has to solve is the question of an adequate protection for the pipe against alkaline soils. In the San Joaquin valley, through which the majority of these lines pass, the total alkali salts in the soils range from 0.05 up to 5 per cent., and the average composition of these salts in the soils is about as follows.

	Per cent.
Potassium sulphate	11.28
Sodium sulphate	19.48
Magnesium sulphate	2.89
Sodium chloride	23.03
Sodium carbonate	40.96
Sodium phosphate	2.08
Sodium nitrate	0.28
	100.00

In many places the percentages of chlorides and sulphates are much higher than shown. In such soils, steel pipes 5/16-inch in thickness, altho gh originally protected with three coats of asphaltum paint, have corroded so badly that pit-holes have developed, extending entirely through the pipe in three years' time. If the life of a pumping system be taken as 20 years, and the cost of the pipe installed in the system as 40 per cent. of the total first cost, it is obvious that a protective coating which will triple or even double the life of the pipe through bad territory, becomes an important factor.

Working along these lines, a number of coverings have been brought forward. Various kinds of asphaltum paint have been used, but, so far at least, without any marked degree of success. Crude oil has also been applied by covering the pipe after it has been lowered into the ditch to a depth of six inches or more with the oil, and then immediately filing in the ditch with earth. This method is only partly successful for the reason that if the soil is at all sandy the oil soaks into it, and in time almost entirely disappears from the vicinity of the pipe, leaving the metal quite as badly exposed to the alkali as before the application. Quick-setting bituminous enamels, which can be put on in a layer ⅛ to ¼-inch thick, bid fair to give results. However, up to the present, these have one serious drawback, in that they cannot be successfully applied to a moist pipe or to a pipe having a lower temperature than 60°F., because the enamel, although it is put on at a temperature of approximately 200°F., is chilled so rapidly that it hardens before it can be spread. The action of the mop with which it is applied is merely to roll it into a myriad of balls or globules which do not stick to the pipe at all but fall to the ground. This not only causes a great waste of material, but is apt to leave many small portions of the pipe, especially on the under side, wholly unprotected even though several coats of enamel are put on. This difficulty can be largely overcome by applying the enamel in warm dry weather only, or to pipes through which warm oil is being pumped. There are no lines in this state which have been covered by this process and allowed to remain in the ground for any great length of time. One line passing through slightly alkaline territory, which was covered in this manner about two years ago, was found to be in excellent condition upon a recent examination.

The method of covering most extensively used, and perhaps the most successful one, is that employing especially prepared roofing papers. The papers commonly used are those made from ordinary deadening felt run through a mill in which the felt is plunged into a number of successive baths of hot asphaltum and rolled hot and under pressure after each successive bath until the fibres of the paper are thoroughly impregnated with the asphaltum. Just before entering the last set of rolls the paper is sprinkled with either mica or soapstone, which mineral, while it no doubt adds somewhat to resistance against the attack of chemicals, has for its principal function the quality of affording a means of keeping the paper from sticking in the roll in hot weather. Asbestos papers, prepared somewhat in a similar manner to the felt papers, have also been used in a number of places.

These papers are applied to the pipe by two methods, known locally as the "spiral warp" and "longitudinal lap." The spiral warp, which is in most cases the most efficient method, consists of applying the paper to the joints between collars by wrapping it around the pipe spirally. For this purpose, the paper is cut in the mill into rolls of the desired size, varying from 3 to 12 inches in width, and containing from 50 to 100 ft. in length as best suits the diameter of pipe to be covered. The pipe is covered immediately after being screwed together by the tong gang, and while still on skids over the ditch. It is coated with hot asphaltum and the wider strips wound on spirally before the asphaltum has had time to set. The crack which is left between each wrap of the wide strip is then coated with the hot asphaltum, and a batten, or 3-in. strip, wound on to cover it. The asphaltum used is a thin grade of the ordinary refined product, and is applied to the pipe at a temperature of about 200° F., and is of such a consistence that it will not set for about five minutes after application. If, due to climatic conditions or variance in the different shipments, the asphaltum sets too quickly, a so-called flux, which is simply a very thin grade of asphaltum, is added. It is usually the practice to ship one barrel of "flux" to the field for every 60 barrels of asphaltum. At the joints 3-in. strips stuck together with asphaltum are wound around the pipe on either side of the collar until a shoulder is built up flush with the outer circumference of the collar. The sleeve and shoulder thus built up are then coated with hot asphaltum, and the whole covered with a 12-in. strip of paper. Besides being stuck to the pipe with asphaltum, this last strip is bound on with wire, as are also the ends of the paper where it is wrapped spirally. If this is not done, the ends will curl up and allow dirt to get between the paper and the pipe after the pipe has been lowered into the ditch, and before the back-filling has been done.

The longitudinal lap system, which to the present time has been much more extensively used th n the system just described, consists (as the name implies) of wrapping the paper longitudinally around the pipe. The paper is delivered in the field rolls, about 6 in. wider than the circumference of the pipe to be covered, each roll containing approximately 72 lineal feet. Two men go ahead of the paper gang and measure up each joint of pipe between collars and cut the paper into the desired lengths.

In applying the paper to the pipe, undoubtedly the best method is first to coat the pipe with hot asphaltum as previously described; then to wrap the sheet of paper around the pipe and stick down the lap with hot asphaltum. This, however, is not often done when covering lines where the oil passing through is to be heated, the supposition being that the heat of the oil (usually about 130° F.) combined with the pressure of the earth on the pipe after it has been buried will be sufficient to soften whatever asphaltum there is in the paper and form the necessary bond between paper and pipe to keep the water out. Without question, this supposition is correct to a certain extent. The paper, especially where a heavy quality is used, will undoubtedly adhere to the pipe in most places where it comes in contact with the metal; but it is to be noted that roofing papers applied to a pipe, while still on skids above the ditch, and allowed to stand in the sun for a few hours, will stretch to such an extent that the contact will be found to be on the upper circumference only, there being often as much as one-quarter of an inch of space between the bottom of the pipe and the paper. It is a serious question if this same thing does not occur when the heat from the oil first reaches the paper, even though the pipe has been lowered into the ditch and covered up. The paper, of course, does not bag uniformly as in the case above ground, but the surplus is taken up in wrinkles, and these wrinkles are very apt to be connected for the entire length of a joint of pipe. Should any injury occur to one of these wrinkles, or a crack develop in it, which will undoubtedly be the case as oxidation goes on, it is not at all improbable that water, which would enter, would reach every place in a joint of pipe where the paper was not securely stuck on, and thus render the whole covering practically useless. Where asphaltum is used as a binder, the wrinkles that form will be filled, thus preventing the water from entering, even though the paper should in time crack at these points. Time alone, however, can solve this much-mooted question, since there are no lines in California protected in this manner that have been laid a sufficient length of time for these cracks to develop.

For covering the collars, the same method is used as with the spiral wrap, except that the binder is often omitted. This it would seem, is even more serious than omitting the binder from the main body of the pipe, since it gives the water a chance to get between the paper and pipe through the ends of the wrinkles.

Whether a binder is used or not, the lap should always be made on the top of the pipe with the outer portion of the lap looking down, and wires should be placed about every sixteen inches. This is necessary to prevent the paper from being pulled away from the pipe by its own weight before it can be lowered into the ditch and covered.

RATS AND PLAGUE.

The bacteriological examination of 100 rats, at the public health laboratory, of Manchester, England, which was commenced during the previous year, was completed in June last. No bacilli suggesting plague were discovered in any of the bodies, but in six cases parasitic cysts of the liver were found; in only one case were bacilli of a possibly pathogenic nature seen, but of course not plague producing; in nineteen cases putrefactive bacilli or cocci were discovered; in twenty-three trypanosomes were found in the blood. The last mentioned feature, although having no special indication so far as is known at the present time, is somewhat interesting. Trypanosomes are a species of protozoa or low form of unicellular animal parasite of a flagellate or whip-like shape which infest the blood of man and animals, and which are responsible for various diseases in reptiles, mammals, fishes, etc. One variety (trypanosomes gambiensis) produces sleeping sickness, and is introduced into the blood of human beings by means of a fly. Knowing the way these parasites are carried from one body to another, it is certainly interesting, if nothing else, to find so many of the rats thus infected.

NEW METHOD OF PURIFYING WATER.

What is understood to be a new method for the speedier purification of Thames water has been discovered by Dr. A. C. Houston, of the Metropolitan Water Board. He adds lime to raw water in such quantity as to kill all the germs. He states that when 1 part of quicklime (about 75 per cent. CaO) is added to 5,000 parts of raw Thames water, about .007 per cent. free CaO is left in the mixture, and this excess is sufficient to kill B. coli in from five to twenty-four hours. The result of this process is to make the water unusable on account of the quantity of lime in it, and Dr. Houston proposes to correct this by mixing it with natural water which has been purified by storage. It would require about one part natural water for three parts quicklime water to produce a potable mixture. Thus it would be sufficient to purify only a third of the water needed for London by storage. The rest could be dealt with by lime and then mixed. The principle is thus described by Dr. Houston:—

Fifteen lbs. of quicklime, costing three-halfpence, would be added to 7,500 gallons of raw unstored Thames water. This would kill within twenty-four hours the B. coli, and inferentially, but certainly, the microbes also of epidemic waterborne disease (e.g., the typhoid bacillus). The water would also be improved considerably, as judged by physical and chemical standards. The excess of lime (about .007 per cent.) would then have to be neutralized with 2,500 gallons of adequately stored water, which, according to all my experiments, would not contain any of the microbes of epidemic waterborne disease. Thus 75 per cent. of the water would be sterilized chemically, and the remaining 25 per cent. by nature's own method of sterilization (storage). The mixture would have lost about 75 per cent. of its total hardness, and would contain no undesirable excess of free lime, besides being perfectly innocuous. Rapid filtration alone would then be required to remove the precipitate of inert carbonate of lime, and to bring the water up to a reasonable standard of chemical purity.

The system would be more expensive—in fact, doubly so—than sand filtration, but it would have certain distinct advantages, notably, its adaptability, its special suitability for flood waters, the saving in soap, the capacity to render quickly an initially foul water absolutely safe, the postponement of the construction of new storage reservoirs, and the raising of the purity of the metropolitan water supply to a pitch of perfection never before attained.

TUNNEL UNDER COLORADO RIVER.

The task of boring a tunnel under the Colorado River has been accomplished. Reports received by the United States Reclamation Service announce that the top drift of the Yuma tunnel penetrated the California bank on May 3rd, making connection with the shaft on that side, and completing the crossing of the stream. This tunnel, or siphon, is one of the most dangerous and difficult engineering structures undertaken by the Reclamation Service. It is one of the features of the Yuma irrigation project, which will reclaim 100,000 acres of the arid lands in the delta of the Colorado, known as the American Nile. It will carry water from the main canal on the California side to the Arizona canal system.

The great siphon will be 1,000 feet long, with an internal diameter of fifteen feet. It crosses the turbulent Colorado River 100 feet below the surface of the stream, and penetrates for the entire distance a soft and pervious sandstone formation. Its construction required the use of compressed air methods similar to those employed on the Hudson River tubes.

THE LITTLE SALMON RIVER VIADUCT. NATIONAL TRANSCONTINENTAL RAILWAY.

In recent issues of *The Canadian Engineer* there was described the new Red River bridge for the National Transcontinental Railway. This bridge includes a bascule span

Fig. 1.—General View of Viaduct.

and is a most interesting structure. The Little Salmon River viaduct for the National Transcontinental affords another interesting example of bridge work on the new railway. Mr. R. F. Uniacke, the bridge engineer for the Transcontinental, has described the structure very fully in a paper before the Canadian Society of Civil Engineers. An abstract of the description is given below:

The Act of Parliament, authorizing the construction of the eastern division of the National Transcontinental Railway, provides for a location from its eastern terminus (Moncton) through the central part of the province of New

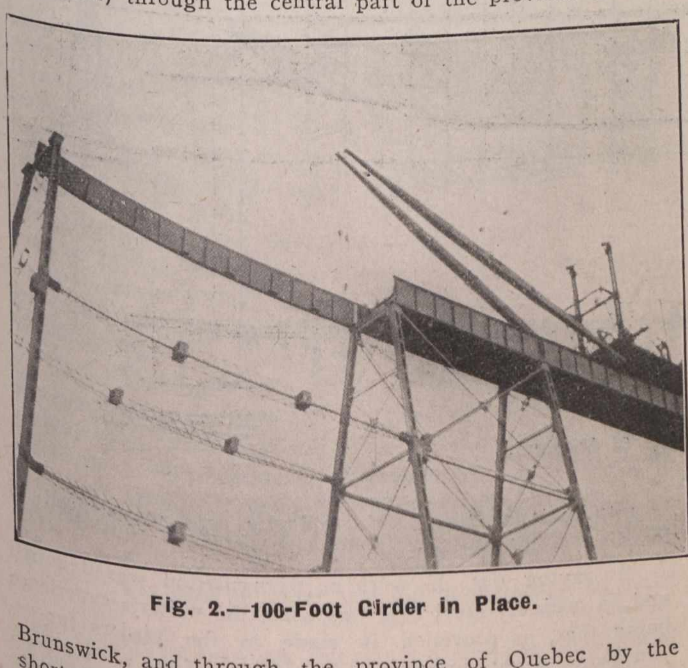


Fig. 2.—100-Foot Girder in Place.

Brunswick, and through the province of Quebec by the shortest available route to the city of Quebec.

The engineers of the Transcontinental Railway had located two lines, one known as the River route, following the St. John River, north from Fredericton, and the other the Central route; the latter was adopted as fulfilling more closely the provisions of the Act. That a line of railway has now been constructed along this route having a ruling point four compensated grade, with a maximum curvature of six degrees, is owing in a large measure to the advance in modern bridge and high viaduct construction. The valley of the Little Salmon River, 185 miles from Moncton, presented one of the obstacles to be overcome, as the grade development showed a crossing over 4,000 feet long, with a height of 200 feet above the water line.

The line approaches the west end of the structure with a six degree curve through a rock cutting and crosses on a tangent bearing N. 10°—27 ft. W., the grade rising 0.40 ft. per hundred. The layout consists of twenty-four towers 58 ft. 9 in. centres and twenty-five intermediate spans 100 ft. 3 in. c. to c., the end spans being 100 ft. 10½ in. centre of bent to outer end of steel; all the tower spans are alike and also the intermediate spans, except that the masonry ends are extended to give the required bearing. The towers and bracing are made alike as much as possible,

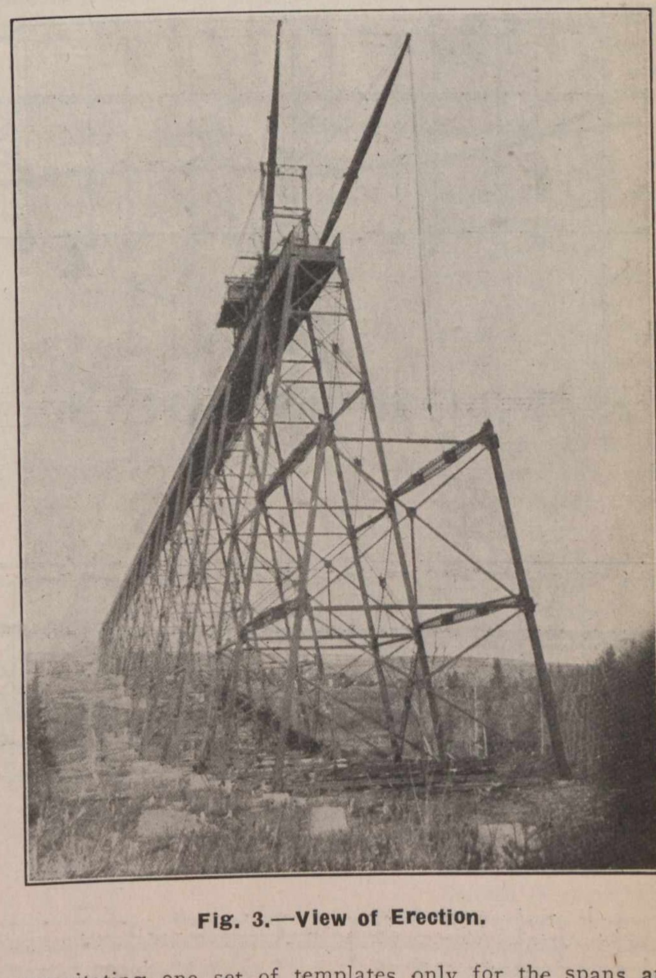


Fig. 3.—View of Erection.

necessitating one set of templates only for the spans and parts of towers which duplicate each other. A through girder system of construction was adopted, the girders being spaced 17 ft. 6 in. c. to c., while the floor beams with gussets were spaced 14 ft. c. to c., along the plate girders. The east end span is on a spiral to a 6 deg curve and in consequence the girders are deflected at this abutment 1 ft. 3 in. off the tangent to the structure produced. There were several reasons which led to the adoption of a through girder system. In high trestle construction where the use of falsework is out of the question, the most economical layout is that on an intermediate span as long as could be handled with a well designed traveller working from grade, so as to reduce the number of high towers, their pedestals and foundations. Spans of 60 ft. with 40 ft. towers are generally employed where deck girders are used, spaced 9 ft. c. to c., and bridge ties resting on the top flanges. Owing to the through girder system having a spacing of girders 17 ft. 6 in. c. to c., spans of 100 ft. are handled, since the bearings of the traveller rest on the flanges, thus giving that much more base to brace the traveller in handling loads. The stability of the erection outfit is amply provided for so that in this case girders weighing 30 tons were placed in position. It certainly gives a feeling of safety to see from the car window the flanges of a heavy steel girder, and that this is not altogether sentiment is shown by the fact that instances of derailment are recorded, in which the car held to the roadway by the lateral resisting power of these girders.

The approach at the east end being through a rock cutting, in order to avoid building the steel work on a curve, and also to utilize the material in the cutting without waste, an abutment of reinforced concrete placed on top of the rock fill was decided on. A buried pier built from the original line at the banks of the river were built with curved cutwaters, the axis of piers being parallel to the direction of the current, forming suitable icebreakers. The anchor bolts for pedestals consisted of two rods, two inches in diameter, the lengths varying according to the up-lift to be resisted. These rods were anchored at the bottom by spacers of 10-in. channels and washers, the concrete being built around them. In order to give room for a little variation in their position, conical forms were set around each bolt, a lip being left at the top extending beyond the base plate of column through which these voids were filled with grout after the steel was erected. The west abutment or buried pier was about 40 ft. in height above the footing course, and in order to reduce the pressure on the soil and allow the embankment to run through and surround it, an arched void was left in a

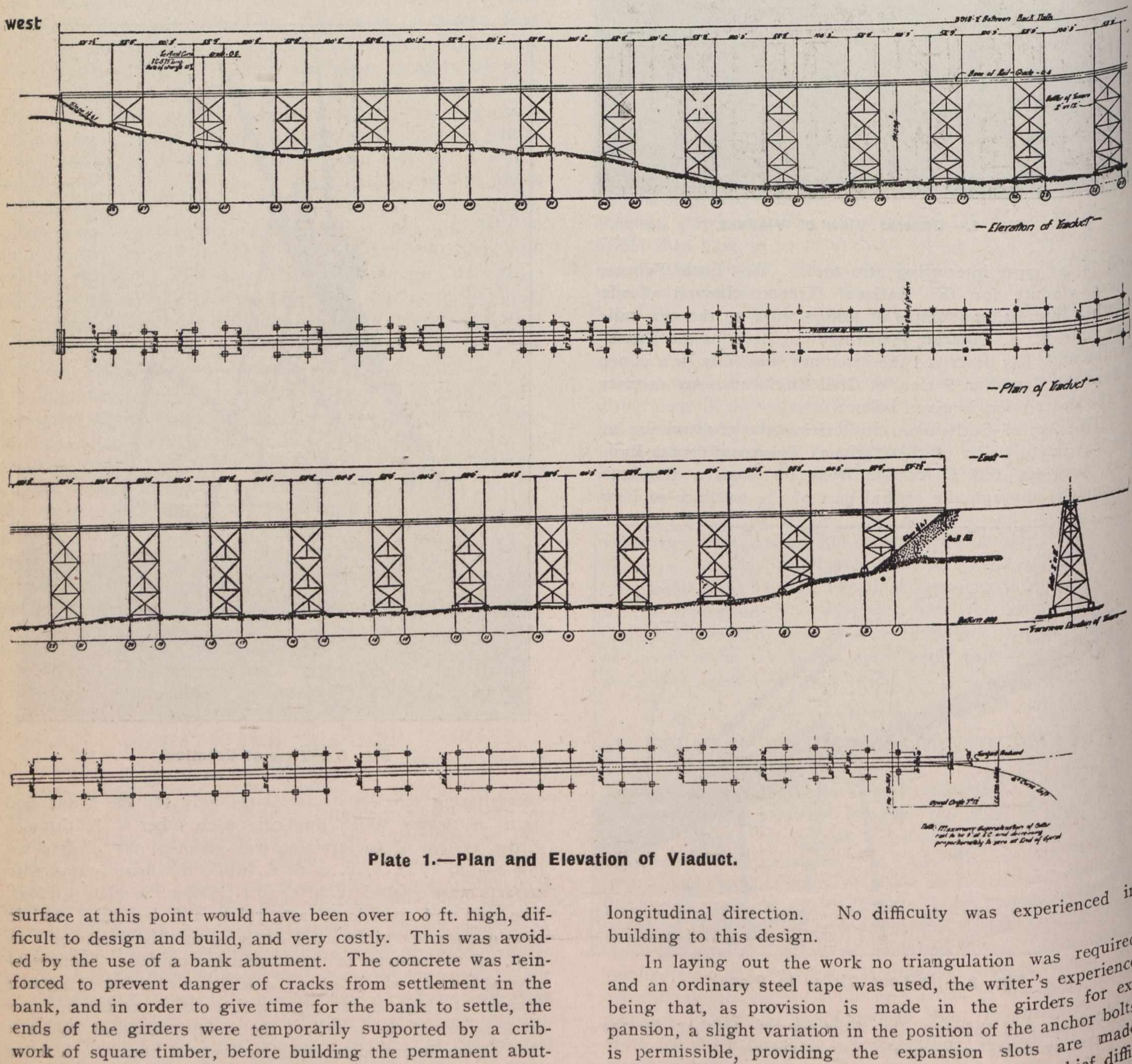


Plate 1.—Plan and Elevation of Viaduct.

surface at this point would have been over 100 ft. high, difficult to design and build, and very costly. This was avoided by the use of a bank abutment. The concrete was reinforced to prevent danger of cracks from settlement in the bank, and in order to give time for the bank to settle, the ends of the girders were temporarily supported by a cribwork of square timber, before building the permanent abutment.

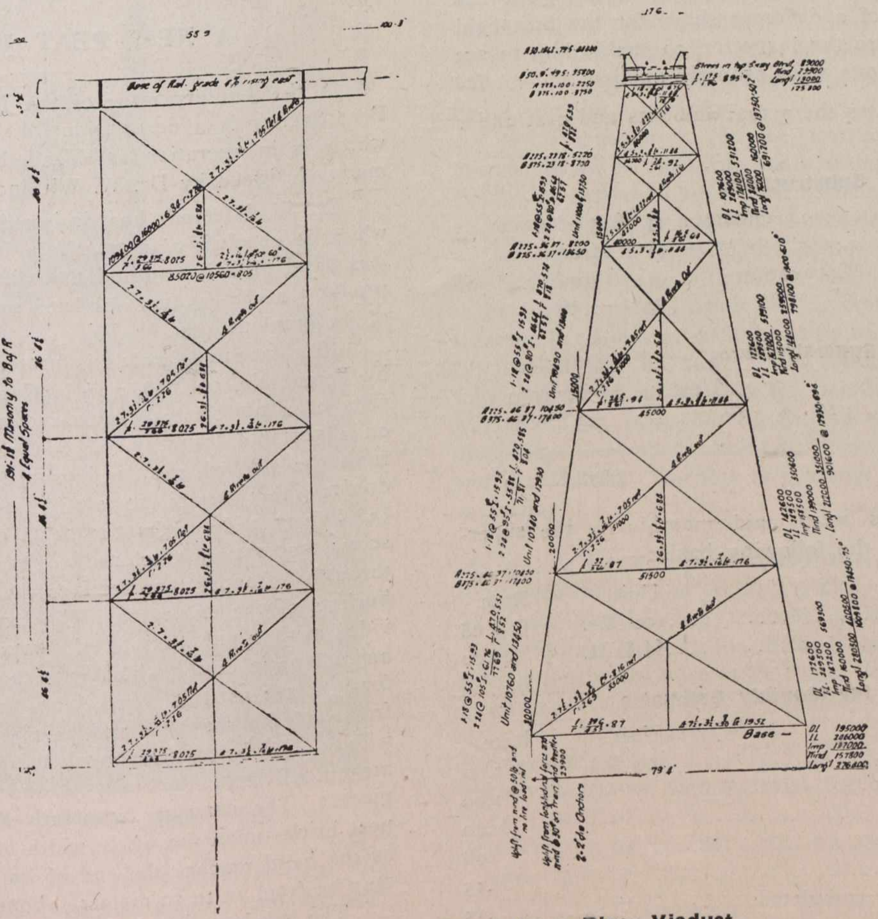
In the design of the pedestals and west abutment, borings and test pits were first made to determine the character of the soil. This proved to be of compact sand, gravel and hard pan, so that no piling was required, the footings being designed to distribute the load at a pressure of from 2.5 to 4 tons per square foot. The four pedestals near the water longitudinal direction. No difficulty was experienced in building to this design.

In laying out the work no triangulation was required and an ordinary steel tape was used, the writer's experience being that, as provision is made in the girders for expansion, a slight variation in the position of the anchor bolts is permissible, providing the expansion slots are made longer than the theoretical length requires. The chief difficulty consists in maintaining the anchors in a vertical position and protecting them from rough usage from swinging buckets of concrete and other causes.

The materials used in the concrete were international Portland cement, manufactured in Hull, Que., at present by the Canada Cement Company. The sand and gravel were obtained on the bank of the river near the bridge site. In this locality good sand is very difficult to obtain, and, after a test of sand from several pits, the local material was selected, the sieve test showing after the gravel was screened out:—

Retained on 20 mesh sieve	....	64 per cent.
" " 30 " "	....	17 " "
" " 50 " "	....	15 " "
" " 74 " "	....	2 " "
" " 100 " "	....	2 " "
		100%

After treating the finer residue with a 20% solution of sulphuric acid, it was found to contain 6% of soluble matter, which was eliminated by thorough washing, and a mixture of one part cement, two parts sand, and four parts gravel, varying from the size of a pea to three inches was obtained. As the sand was not of the best quality, the use of 1:2:4 mixture was ordered in shafts of pedestals, since they have to sustain a high concentrated load on a comparatively small volume of concrete. The concrete used in the buried pier and foundations was a 1:3:5 mixture. In obtaining a proper facing mixture the coarser material was kept away from the forms by the use of perforated spades, pushed down and drawn back while the mixture was still plastic. This method was found more satisfactory than that of attempting to bond a facing mixture into the body as required in some specifications.



A Typical Bent on the Little Salmon River Viaduct.

The Dominion Government specifications were strictly adhered to in the proportioning of the members. The compression members were figured for the pin ended formula of these specifications. In the tension members of the towers a limiting length of $200\frac{l}{r}$ was used to avoid sagging of members, to make them capable of resisting compression and to give initial stiffness. Attention is called to the use of bulb angles in the sway bracing of towers, which make a very stiff and economical section and avoid breakages in shipment. the great fault in box laced section of light angles. Traction and wind were figures as called for in the specifications.

The posts viewed from the stress sheets do not appear to be economical because of their relatively small radius of gyration when compared with a built up channel section; but the saving in weight of details and simplicity in shop work fully compensates for the extra main material. In the light of column tests it is reasonable to expect that the reduction in unit stresses for the increase of radii length would not be justified by practical tests. The metal is used mostly in directly resisting the primary stresses, as very little is required for secondary purposes (viz., lattice tie plates, etc.), and in this way a stronger column is obtained. The section used has also the advantage of continuous webs in each direction, which are greatly superior to the easily bent lattice bars, and moreover the interior of the column is much more accessible to the paint brush for shop and field coats. The section is symmetrical on both axes. having therefore its centre of gravity in the centre of the section, and no eccentric loading is induced from the girders. The small amount of redundant metal means uniformity of stress in the columns, and simplicity in the make up will decrease the cost of maintenance.

In calling for tenders for the steel work our usual practice was followed of furnishing bridge companies with a general design and details of girders and towers, together with a printed form of tender in which was filled in the estimated weights of steel, and number of feet B.M. of timber in the floor. With this system all bridge companies bid on the same basis, and are not required to make a single drawing to submit with tenders, but merely to fill in the unit prices for steel and timber erected in place, and to carry out the amounts on the estimated quantities furnished, viz., steel 14,000,000 lbs., timber 520,300 ft. B.M. After the tender is awarded the bridge company submit stress sheets and details for approval before ordering the material from the mills.

The rails were directly supported by 8-in. by 12-in. by 14-ft. bridge ties resting on the steel stringers, every fourth tie being 16 ft. long to support the plank footway placed outside the guard timber for the convenience and safety of the section men. An outside guard timber 8-in. by 9-in. dapped 1 in. over the ties, which were spaced four inches apart in the clear, the ties were secured to the stringers by ¾-in. hook bolts, and the guard timbers bolted through the tie with one ¾-in. bolt in every fourth tie. A steel guard rail 60 lbs to the yard will be placed inside the gauge line and eight inches therefrom in the clear, these guard rails coming together at the centre of the track one rail length beyond the end of the bridge and being protected by a cast steel point fitting the rail section and spiked to the road-bed ties.

Actual erection began July 27th, 1910; the steel was all assembled and last span swung February 8th, 1911, and all riveting and painting fully completed by August 19th, 1911.

The erection staff varied from 60 to 80 men, of which but six were employed on the big traveller, one sub-foreman and 14 men were used to assemble the steel work, and the rest formed from two to six gangs of riveters, also crew for derrick car used for unloading material in yard, and delivering same to traveller, and driver for light locomotive. The riveting gangs averaged 302 rivets per day of 10 hours per gang, a rate which would probably have been reduced by 50 per cent. if ordinary staging had been used, instead of the riveting cages.

One coat of Sherwin-Williams Black Metalastic paint was used in the shop, with a coat on each contact surface before assembling. Two field coats were applied, the first Metalastic brown, and the final coat Acheson Graphite. Rivet heads and shop marks were touched up before applying the field coats. The use of a different shade for the first field coat was a great help to the inspector, to enable him to see that the several coverings were properly applied.

In the final estimates the actual amounts and cost under the several items are:—

Substructure.

1,757	cu. yds.	1:2:4 concrete	@	$15.00
6,524	"	1:3:5 "	@	11.00
4,597	"	Excavation	@	1.00
10,534	"	"	@	2.50

Superstructure.

Steel	13,991,310 lbs	@ 4.68 cts. =	$654,793.31
Timber	518,041 ft. B.M.	@ 4.60 cts. =	23,829.89
			$678,623.20

Progress estimates were paid monthly on the superstructure according to the following basis:—

	Unit.	Rate.
Steel	100 lbs.	$ 4.68
Timber in floor	M.B.M.	46.00

Schedule for Monthly Estimates.

	Unit.	Rate.
Steel provided	100 lbs.	$ 2.00
manufactured	"	1.00
delivered at site	"	.40
assembled	"	.98
riveted	"	.15
painted and fully completed	"	.15
		$ 4.68
Timber delivered	M.B.M.	$40.00
framed and placed	"	6.00
		$46.00

The basis of payment was considered a fair and equitable distribution of cost throughout the different stages of manufacture. It is the result of experience on many bridges previously built by this and other bridge companies on the described method of working and specifications, and the writer believes may fairly be used in other similar cases, as proportionate cost data.

The work was carried out under the general direction of the writer from the bridge engineer's office in Ottawa, Mr. W. A. Duff, assistant bridge engineer, having charge of the general design and details. The Dominion Bridge Co., Limited, Montreal, were the contractors for the steel, which was efficiently carried out, Mr. F. P. Shearwood, C.E., having charge of the design for the bridge company.

The design and layout for the erection and the traveller were made under the direction of Mr. James Finley, superintendent of erection, who was responsible for the successful carrying out of the erection; also Mr. E. W. Nichols, foreman on erection.

The mill, shop, and erection inspection was satisfactorily carried out by the Canadian Inspection Company, Limited, Montreal.

The sub-structure was completed by Messrs. Powers & Brewer, sub-contractors under Willard Kitchen Co. The construction and laying out of this part of the work was performed under the direction of Mr. C. O. Foss, district engineer. Although the work was prosecuted in all seasons of the year there has been no accident or casuality of any kind.

A NEW PEAT MACHINE.

In the January issue of the Journal of the American Peat Society is a description of a peat digging machine which is in operation at Elizabethfehn in Oldenburg, Germany, designed by Dr. W. Wielandt.

Dr. W. Wielandt has designed a peat digging machine which is absolutely automatic in its working, so that much less hand work is required than formerly, and by its use the production of peat fuel has been reduced to a half or a third of its previous cost.

This machine, which is protected in the United States by Patent No. 996.898, and in Canada by No. 126,536, consists of a uniformly forward-moving truck or car operated on a portable tramway of 600 mm. (23.6 inches) gauge; from the side of the car is suspended a chain and bucket dredge 3 to 5 meters (10 to 16.5 feet) long and about 1 meter (3.28 feet) wide. On the same car is mounted a double-screw macerating machine, to which the raw peat is fed through a hopper that receives the peat as it falls from the buckets of the excavator. The macerating machine is provided with a mouthpiece of pentagonal cross section, and an automatic cutter which cuts the peat into bricks of uniform length as it is forced from the outlet. Coupled to the frame of the machine and moving forward simultaneously with it, is a belt conveyor which receives the bricks as they are cut off from the peat strand issuing from the mouthpiece. The conveyor automatically drops or lays out the peat bricks upon the whole width of the drying field as soon as the band reaches the end of its travel. The drying field may be from 12 to 30 meters (about 40 to 100 feet) in width.

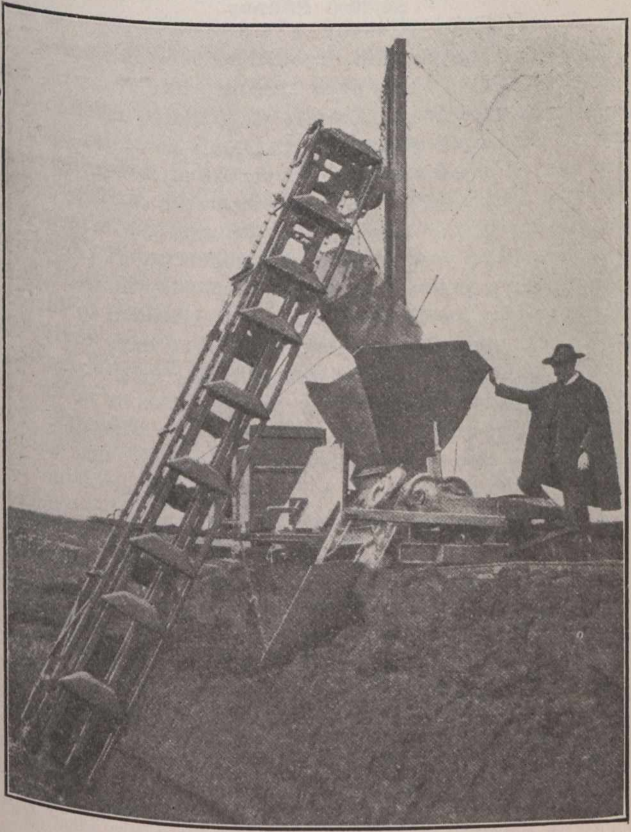
The machine can be modified in its details to suit the conditions of the bog on which it is to be operated. It can be operated by an electric motor or by a gasoline engine, which may be placed on the car or on a special, independent truck, so as to be usable as a locomotive to draw the dry finished fuel from the drying field to storage sheds.

The standard machines will produce from 6 to 7 tons of air-dried peat bricks an hour, equivalent to about 40 or 50 cubic meters (52.3 to 65.4 cu. yds.) of raw material. The power required to operate the machinery is 20 horsepower. The cost in Germany for this type of machine, including the cutting device and brick conveyor, is from M. 12,000 to M. 14,000 ($2,400 to $2,800), which with duty of 47 per cent. and freight charges would make the cost, delivered in New York, from $5,000 to $5,200.

During 1911, three of these machines were in operation at Elizabethfenn, Oldenburg, the oldest one having been used for three summers, and, in the opinion of peat engineers who have tested them, they have shown the highest efficiency and economy.

The machine, when compared with others, has the following advantages: (1) Every individual process is absolutely automatic, so that only 2 or 3 workmen are required, as compared with 12 to 15 needed by older types of machines. (2) All movements of the machinery are continuous and uniform, hence its construction is simple and it is easy to operate. The utilization of the power is also uniform and in this way the wear and tear is reduced to a minimum.

(3) As the dredging covers only the width of one meter (3 ft. 3.4 inches), only the drier material on the face of the cuts is worked. This drier material, as shown by experience, contains about 12 to 15 per cent. of dry substance, as compared with but 5 to 10 per cent. contained in the underlying material. In other words, the peat obtained in this way contains materially less water when dug and macerated, and dries faster afterwards, than that produced by the



Peat Machine in Operation, Rear View.

old style machines. These facts make possible more frequent use of the drying field and also a more extended drying campaign.

(4) The light weight of the machine, about 2,500 kilogrammes (5,500 pounds) and the production of a sloping cut or bank, instead of a perpendicular one, permits the working of either fresh, undrained bogs, or of those which have been cut up by cracks caused by too rapid drainage. As there is no necessity for supporting the outer dredging boom, it is possible to dig the lower layers of peat from below the surface of the water.

(5) The dredging boom can be lowered or raised while the work is going on, without stopping the machine. The boom has a wide range of movement, which makes it fit to any slope of cut and depth of opening desired. In other words, the machine can be adjusted to any bog condition desirable and can be made to avoid any obstructions in the cuts, such as sand hills or tree stumps, without loss of time. If it is desired to remove the machine from one ditch to the other, it is only necessary to raise the dredging rig and swing it parallel to the long axis of the machine, when it is out of the way. This arrangement makes it possible also to move the machine easily on any track, turntable, switch, etc., of a portable tramway, without dismantling the machine or any part of it; therefore, the time required for such changes is reduced to a minimum.

(6) The machine proper, together with the brick conveyor, can be moved for considerable distances without difficulty, as it travels on a standard gauge 600 millimeter portable track.

(7) The deposition of the peat bricks on the drying field in a horizontal position, and their pentagonal form, favors the free run-off of any rain water which may fall on them and this lengthens the campaign about 50 per cent., or from 6 to 8 weeks, because the water does not soak into them. The three of these machines at work in Elizabethfehn during 1911, were operated during September, under such conditions. Peat machines of all other makes in that part of Germany were closed down at the end of July. From 25 to 30 per cent. more production, in effect, is gained by its use, from the fact that the time needed for moving and swinging this machine is reduced to a minimum, whereas, by the old systems, out of a possible 100 working days, only 60 to 70 could be utilized, as the rest were taken up in moving the machinery.

(8) The machine can be worked day and night, with electric light, so that the daily number of working hours can be increased to 20 instead of being limited to 10 or 12, as manual labor is practically excluded.

(9) As the buckets of the dredge work all depths of the bog simultaneously, a thorough mixing of the raw material is obtained and the result is a more uniform and eventextured product than that made by other styles of machines.

The cost of operation is as follows: A production of 6 tons of dry peat an hour, 15 hours a day, for 100 consecutive working days, is assumed; 6 × 15 × 100 = 9,000 tons of air-dried peat for each machine for a working season. Three workmen to each machine at 8 marks ($1.60) a day each = 24 marks

	Marks.	Cents.
($4.80), or for a ton of air-dried fuel......	0.26	5.2
Power required, 15 to 18 h.p. or daily about 200 kilowatt hours = 22 marks, or ($4.40) amounting for each ton of air-dried peat	0.24	4.8
Drying the bricks on a large scale, per ton, about	0.70	14.0
Materials and repairs, about.............	0.20	4.0
Supervision	0.20	4.0
Transportation of raw material for each 3 or 4 k.m.	0.40	8.0
Depreciation of 20 per cent. on machine and track	0.50	10.0
	2.24	44.8

or under 2.50 marks (50 cents) per ton of air-dried peat at the factory. This amount can be reduced if work is done day and night.

REFORESTING IN HASTINGS COUNTY.

As a result of the Act passed by the Ontario Government last year empowering municipalities to engage in forestry, the county of Hastings has already taken steps to acquire waste lands for the purpose of reforesting them. During the coming summer the Dominion Commission of Conservation will supervise a survey of the county of Haliburton and the northern portion of the county of Peterborough. This survey is to furnish a detailed description of economic and natural conditions and resources of the watershed in Peterborough and Haliburton counties feeding the Trent Canal waters and to serve as a basis for a system of management.

AN ENGINEER'S FINANCIAL RETURNS.

There is no good reason, says Mr. Chas. T. Main, president of the Boston Society of Civil Engineers, in a paper read before that body, why an engineer should not be as well paid as a lawyer or doctor. Mr. Main says:

A fellow-engineer said one day: "The hardest thing which I have to do is to make out a bill for services." It is here again that the natural modesty of the man is such that he is unable to appreciate the worth of his own services.

Some of us are called upon to make investigations and reports on enterprises involving the expenditure of millions of dollars, and the conclusion reached and the signature at the end of the report may prevent our clients from losing large amounts, or may cause them to embark in an enterprise which will net them great profits.

The concentrated knowledge and experience of years may be given in a short period, and yet we are apt to measure the value of our services on a per-diem basis, which will amount to a pitiable sum compared with the importance of the service rendered. This condition should be remedied so that the returns will be commensurate with the value of the services rendered. A lawyer of high standing, in making his charges, would consider not only the time required but the importance of the case or value of services rendered.

There is no good reason, aside from custom, why the engineer should not be as well recompensed for his services as is the doctor or the lawyer. The engineer engaged in the industrial development furnishes his services, as a rule, to a clientele that can afford to pay the full value for services rendered. Where a problem has been carefully studied, and the work carried out in accordance with the final conclusions, the result enables a saving in cost of production or an increase in profits. The engineer who works along these lines is carrying on the work of efficiency of which so much has been said and written recently. The industries can well afford to pay the cost of obtaining the benefits derived from good engineering.

In the regular pursuit of design and construction, there seems to be no way of charging more than some definite fixed sum or percentage, the aggregate of which cannot be large unless the undertaking is unusually large.

Many of our profession hold salaried offices, and the salaries are not very large as a rule; but the tendency of later years has been to make a better return for services rendered.

To the younger members the progress seems to be slow, but with ability and willingness to work there is no reason why success should not follow. Some of the greatest engineers have been men who have not had the advantages of technical training and have forged their way to the front by close application and native ability.

The young graduate from a technical school is apt to think he knows it all; and if he is well balancel he will soon find that he has laid a good and substantial foundation during his studies on which to build his education for effective work which will be of value to his employer, and which will develop from day to day in the actual performance of his work. If he is well grounded in the fundamental principles of the profession he will be able to undertake and carry out any work which is assigned to him; but he should have patience, and not expect too rapid advancement in position and salary.

For these reasons the younger men should be modest in their expectations and consider a part of their remuneration the valuable experience which they are acquiring.

After an engineer has had many years of experience and hard work, and his work and judgment are of great value to his clients, he should rise above his modesty and charge a sum commensurate with the value of his services. At the present time, however, it does not seem as if a large percentage of the profession could derive more than a good living from strictly professional work.

Some time ago one of my clients, who is very successful in manufacturing, said that his son thought he would like to be an engineer, and the father desired some advice as to the best thing for a boy to do. I told him that if he wanted the boy to make a lot of money, he should take him into business with him, but if he wanted him to have an honorable profession which would probably procure a living for him, but not much margin, to make an engineer of him.

FLAT SLAB BRIDGES.

By W. H. Finley, Asst. Chief Engineer Chicago and Northwestern Railway.

Since the introduction of concrete for the construction of railroad bridges no type of structure has met with more success than the flat slab bridge. In the days of stone masonry we were confined to the flat top culvert for openings up to four or five foot spans. Beyond that it was necessary to use the arch type. This meant increased expense in construction due to the cost of the cutting of the masonry for the arches. For years after the introduction of concrete it was a common practice to use, for small openings, say up to eight or nine feet, old railroad rails embedded in the concrete to form the top covering. In those days there was more or less second hand rail that could be used economically for this purpose and it was thought that in using the material in this way a cheap and satisfactory structure could be produced. It was soon discovered, however, that second-hand rails were not always available, and if available they could be put to better use than burying them in concrete for culvert construction. In spans greater than nine feet and up to thirty feet it was the practice, for a number of years, to use I Beams embedded in concrete. Among some engineers the idea to use beams of sufficient strength to carry the live load and consider the concrete only as taking the place of lateral bracing. This form of construction required very careful work in the field, inasmuch as it is difficult to make a satisfactory bond between concrete and large areas of metal, as represented by an I Beam, and with the greatest care in the selection of the material and the placing of the concrete it was difficult to prevent the same from cracking or separating from the beams. Although there were a number of satisfactory bridges built of this type, yet it was gradually abandoned. As confidence grew in reinforced concrete these smaller openings were built of the reinforced flat slab type. This type not only took the place of stone arches of corresponding span but also at a much less price. It enabled engineers to satisfactorily solve a great many problems in places where a wide and low opening was particularly desirable. The ideal structure from a railroad standpoint of use is that type that entails the least cost in maintenance. Stone masonry, however carefully constructed, required from time to time repointing to prevent the infiltration of water and consequent disintegration of the structure. With concrete properly constructed this maintenance charge is completely eliminated. Not only is the maintenance charge eliminated but the first cost of construction is considerably reduced. In the building of a flat slab bridge as a monolith it is possible to use less material in the side walls than would be required for an arch of corresponding span.

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*Presented at the Eighth Annual Convention of the National Association of Cement Users, Philadelphia, Pa.

In railroad construction numerous instances occur where it is necessary to provide a wide and low opening and this condition is admirably met by the flat slab type of bridge. Before the introduction of this type of construction it would be necessary to provide an arch that would entail very much more expense than the flat slab bridge. Of recent years the flat slab bridge has been used to good advantage in cities where railroads were eliminating grade crossings by the elevation of their tracks. In the ordinary 66 ft. street where the city permits supports in the centre of the street and on the curb lines it is possible to use the flat slab type of bridge for spanning these openings. This results in a very economical form of construction as well as one that can be made aesthetically pleasing in general appearance. It also reduces to a minimum any maintenance expense. A steel structure for a similar opening requires painting every four or five years and if this work is not attended to the structure soon presents an unsightly appearance. This condition is very prominent in our elevated railroads in cities where the maintenance is not kept up.

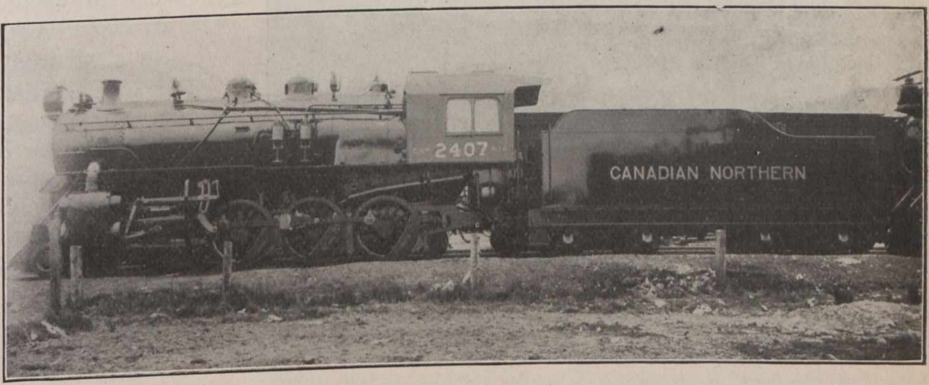
Twenty years ago, in railroad construction, it was the universal practice to use, in openings from six to thirty feet, open deck I Beams. These were usually placed upon concrete or stone masonry abutments and presented as much difficulty in maintaining good track as much larger spans for the reason that the dump ties were just as troublesome to keep up as the same ties on a 150-ft. span. I know of no greater use for flat slab bridges than in the replacing of these upon open floor I Beam spans. It is usually possible to remove these I Beams and replace them with flat slab bridges, carrying the ballast across the bridge and making a uniform track surface. The I Beams can be used for other purposes or at least they have a salvage value that goes toward reducing the cost of the improvement. I have in mind a certain stretch of railroad of about thirty-six miles that has over twenty small openings from six to twenty-five feet made up with of I Beams with open floors. However carefully the track work was kept up it meant a bad riding track as each one of the bridges represented an unyielding space that was very noticeable to the travelling public.

There is no class of reinforced concrete construction, however, that is entitled to more careful and intelligent supervision in the construction of the same than flat slab bridge. When concrete began to displace stone masonry unfortunately the sole idea of constructing engineers was to see how cheaply they could build structures in concrete. Apparently many engineers were so anxious to prove the superiority of concrete in both cost and durability that they frequently sacrificed the latter for the former. It is generally recognized to-day that to produce satisfactory concrete construction it is necessary to use the utmost intelligence and care in the selection of the materials and the execution of the work. Unfortunately reinforced concrete construction has, in the past, been exploited from the commercial side rather than from the engineering. This, I think, was largely due to the various patented types of reinforcing material. Concerns marketing reinforcing material looked upon it from the commercial side only and furnished all sorts of information as to not only the good points of their particular shape or type of reinforcing but also formulæ and information as to the construction of reinforced concrete that would apparently enable any one, engineer or otherwise, to undertake the work of designing and building reinforced concrete structures. Happily, we are passing out of that stage of development and it is now being generally recognized that it is necessary to have engineers of experience and trained to correctly design any reinforced engineering structure.

POWERFUL FREIGHT LOCOMOTIVES.

Serious consideration given to railway economics has shown that specific locomotive design is a potent factor in operating expense reduction and it is to this fact that the difference in a fast passenger locomotive and a mountain freighter are due. In fact, the locomotive of to-day may be divided into many classes; each class calling for particular differences which have been developed and have proved that a locomotive designed for a certain class of work gives better results than one taken from another section of the line and applied to the same class of work.

Thus it is that the great wheat belt of Western Canada has called for a locomotive that will haul grain in that section to the best advantage, and the management of the Canadian Northern Railway have commissioned the Canada



Foundry Company, Ltd., of Toronto, to construct twenty locomotives similar to the one forming the illustration to this article.

These monsters are among the largest locomotives operating in the Dominion, and differ, in the main, from smaller types only in their massive proportions and fuel-carrying facilities.

They are built for a standard gauge of 4 feet 8½ inches, and have a total wheel base (locomotive) of 25 feet 5 inches. The cylinders are of simple design. 24 in. by 32 in., and the boiler is of the extended wagon top with a working pressure of 180 pounds to the square inch; the boiler contains 272 two-inch tubes, while the smoke stack has a diameter of 17 inches.

When these machines were designed, the British Columbian Cabinet had not issued the edict that will compel all locomotives operating in that province to burn oil, hence, the fire grates of these locomotives have been designed to consume bituminous coal; but as they have been designed specially for wheat haulage in the prairie provinces, it is not likely that their fuel consuming facilities will have to be changed.

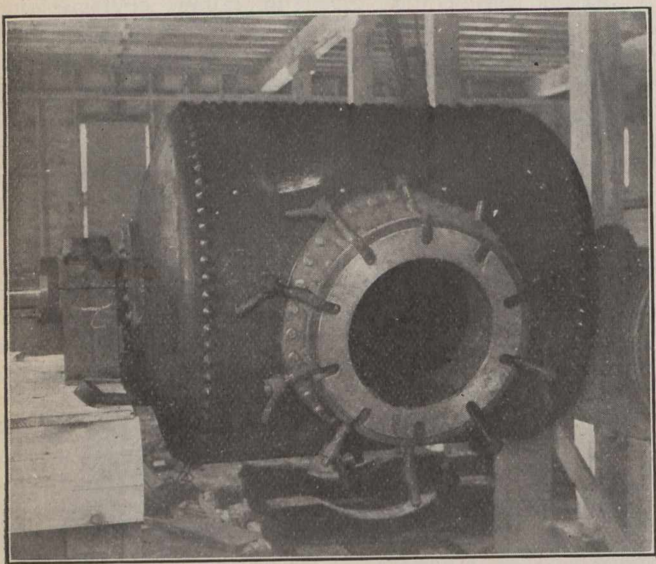
The driving wheels, of which there are six, have a diameter of sixty-three inches and a thickness of three and a half inches, the piston valves regulating the admission of steam to the cylinders have a diameter of twelve inches.

As may be readily seen from the cut, the design of the tender has been prepared in such a manner as to allow of exceedingly long haulages without stoppage for water or fuel; the water carrying capacity allows 6,000 imperial gallons to be taken at one time, together with ten tons of coal.

The total length of the engine and tender is about 65 ft.

THE HYDROLYSIS OF SAWDUST.

In a paper given recently to the Society of Chemical Industry, Professor W. P. Cohoe, of Toronto, gave an interesting resumé of his work on the hydrolysis of sawdust. The paper outlined briefly the history of the study of the reaction of various hydrolyzing materials on sawdust, beginning with the work of Bracconet in 1819. Most closely



View of Digester.

associated with the commercial study of this reaction are the names of Simonsen, Classen and Ewen and Tomlinson.

The work which the writer has done has extended over a period of two or three years, and although our attention has been chiefly confined to the action of hydrochloric acid upon sawdust, the action of many other acids has been studied.

The experimental work was conducted in three stages. In the first stage small scale laboratory experiments were made, in order to obtain in a general way the results which might be expected on a larger scale. In these experiments it was found that as high as 29 per cent. of the dry weight of the sawdust could be converted in a single operation into fermentable sugars. It was also found that by taking the material once treated and subjecting it to another operation, a further amount of this material could be converted also.

After having completed the small scale experiments, an apparatus was designed to enable the carrying out of experiments on a somewhat larger laboratory scale, under conditions more nearly approximating what would be the commercial conditions. On this scale it was found possible to treat about two pounds of sawdust at a time. On this scale the findings on the previous set of experiments were confirmed, and conditions necessary for a still larger scale anticipated.

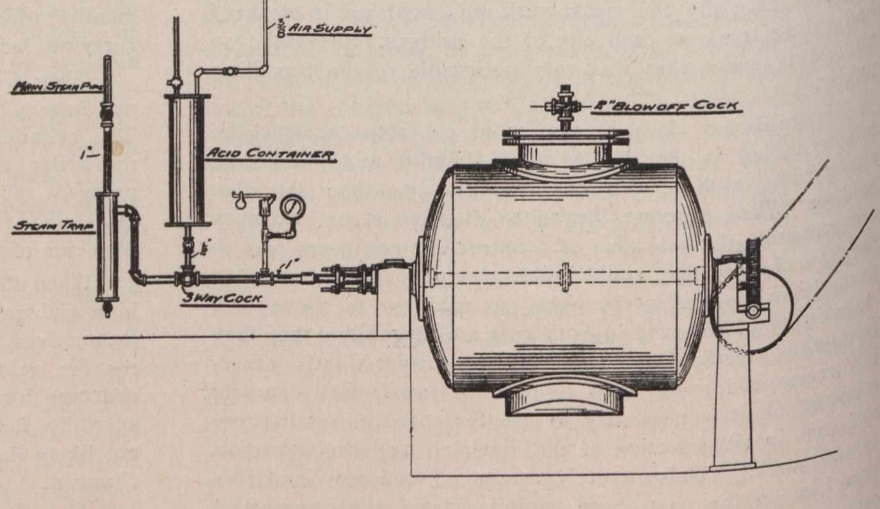
The third stage consisted of an operation on a semi-manufacturing scale. A digester was prepared capable of holding from eight to nine hundred pounds of ordinary sawdust. This was provided with a special lining, and also with the various necessary appliances for rotation and injection of steam and reacting materials, as shown in the accompanying diagram. The digester is filled when the manhole is in an upright position, after which it is closed. Steam is turned on, acting directly within the digester on the sawdust. The action of the live steam is to heat up the reacting mass inside, and to prepare it for the action of the reacting agent in the final stage. When the temperature and pressure conditions desired have been attained, the digester may be blown off in order to obtain any by-products which may have been formed. This part of the operation is known as the precook.

When the blow-off is complete the digester is again closed, steam is allowed to penetrate the mass, and with the steam is forced in the reacting agent. The action of the reacting agent is immediate, with the result that a certain percentage of the sawdust is converted into reducing sugars. The amount of this conversion depends on the temperature, pressure and percentage of acid present. We were successful in controlling these conditions to such an extent that the action hydrolysis was practically instantaneous, and it was only necessary to conduct the after cook for a sufficient length of time to insure a thorough mixing of the hydrolyzing agent with the contents of the digester. When blown off the sawdust has been converted into a golden brown color, resembling coffee grounds in appearance. This material may be extracted, and the extract, which contains glucose, may be fermented and subsequently distilled, in order to obtain alcohol, or, if it is thought desirable, the extract may be purified and clarified with the production of a pure white glucose sugar as the result.

The amount of the conversion which takes place from one operation varies from 20 to 40 per cent., depending upon the adjustment of the reacting phases. In no case, however, is all the converted material reducing sugars, as these are always accompanied by a certain percentage of what is probably intermediate materials.

As the result of our investigation several conclusions were reached which may be summarized as follows:

1. It is advantageous to have the sawdust heated up to the reaction temperature before introducing the acid.
2. A prolonged precook is not advantageous.
3. The recovery of valuable by-products, such as turpentine, is possible, using this method.
4. Coarse sawdust gives better results than fine.
5. By this method the time of conversion may be very much shortened over that consumed in existing methods, and consequently the output from a given plant may be very much increased.
6. Higher results have been obtained with hydrochloric acid than with other acids used by this method.
7. Commercial feasibility of the use of other acids.
8. Commercial advantage of double cook.



SKETCH OF DIGESTER.

Diagrammatic Sketch of Plant.

The Canadian Engineer

ESTABLISHED 1893.

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CONTENTS OF THIS ISSUE.

THE DEATH OF MR. GEORGE A. KEEFER.

It is with regret that we hear of the death of Mr. George A. Keefer. Mr. Keefer was one of the original members of the Canadian Society of Civil Engineers, and two years after its founding was elected as councillor. He served five different terms in that position, and did much to help guide the Society over the rough spots of its early life. He was one of the older men of the engineering profession in Canada, men who did so much in the early days to open up the country by surveys and railroad construction. During the past twelve years he was employed by the Dominion Government in British Columbia. Mr. Keefer's death will be regretted by the members of the Canadian Society of Civil Engineers and the engineering profession generally.

CONTRIBUTED ARTICLES.

The reader demands several things of a technical journal. "Good Roads," in a recent editorial, expresses sentiments on this subject which appeal to us as worthy of reproduction. One thing the reader demands is that a journal shall supply him with the general news of the field which it covers; another, that it shall place before him authentic accounts of particular events, such, for instance, as conventions; another, that it furnish him with descriptions, more or less detailed, of large and important works. But if we correctly understand the wants of our readers, the articles of the most real use to them are the accounts of work such as they, themselves, are called upon to do, written by those who have done the work. Such articles, telling how some difficulty has been overcome, what the cost of some operation has been, what success has attended the employment of some particular method, or what failure has resulted from the following of some plan, give information of everyday use.

The engineer engaged in actual work is in an excellent position to obtain the requisite data for interesting and useful articles. His thorough familiarity with the work enables him to arrange his facts properly and present them in the form most helpful to others. When he has done this he can submit it to the journal of his choice and be sure of a fair return for his labor if the article is accepted. And if it describes actual work, giving methods and costs in sufficient detail, he can be reasonably sure that it will eventually be printed.

As we have already stated, no journal receives too much matter of this sort. There are several reasons for this. In the first place, the man on the job is too close to his work to quite realize its importance; because it is his daily work he is prone to think it of too little consequence to be of interest to anyone else. In the second place, he does not always realize that he has anything to gain by preparing a description of the work as a whole, or of some special phase of it. And again, even if he realizes that such a description might be a source of profit to himself and others, he is apt to feel that he hasn't the ability to write an article.

None of these reasons is valid. The work that a man is engaged upon may not be of any particular interest, taken as a whole, and yet it may be of unusual interest in some of its details. For example, there would seem to be little of general interest in the construction of a bridge abutment; yet if some original and ingenious method were employed to deposit the concrete below water level, that detail would be worthy of note. Again, while the construction of an ordinary country road might not appear to be of any particular interest, yet if an especially efficient contractor's plant had been employed in its construction, a description of the equipment and of the way it was used would be of unquestioned value.

As regards the matter of personal profit, it is only necessary to remind the reader that all reputable publications pay for contributed articles when they are submitted on that basis. The compensation, though not apparently large, will often prove greater in proportion to the time required to earn it than the engineer's remuneration for his regular work. In addition to the money return, there is the benefit accruing to the writer from the publication of articles carrying his name.

The objection having the least weight of all is the average engineer's lack of confidence in his ability to "write an article." While a contribution should, of course, be prepared to the best of the author's ability, its literary excellence is its least important attribute. The matter for technical journals is judged chiefly by the facts and figures it gives, and if valuable data are presented the language in which they are set forth is of minor consequence. The publication has a staff whose duty it is to look after that matter, and if the article is otherwise available, its form will be attended to.

PULP LIMITS.

Ontario must be congratulated on the business-like manner in which they are disposing of their remaining pulp limits. Tenders for the Abitibi pulp limits, consisting of 1,560 square miles of pulpwood, will be advertised by the Government in a few days in accordance with the programme announced some time ago in the matter of development and colonization of the north country.

The successful tenderer must establish a pulp mill to cost not less than $500,000, to produce 100 tons of paper per day, to employ not less than 250 hands, and to run on an average of ten months in the year.

According to the conditions, $100,000 must be paid down the first year, $200,000 the second year, and the remainder, $200,000, the third year. It is stipulated that the pulpwood cannot be touched until $100,000 is spent. After the mill is operated continuously there must be an average output of 75 tons daily. The lessee must pay 40 cents a cord for spruce and 20 cents a cord for all other woods, subject to increases from time to time by Order-in-Council. The wood must be cut in such a manner as the Minister may direct, and it will be further agreed that no wood will be exported. The wood must all be used to supply the pulp mills. Failure to erect the mills within the specified time will entail a forfeiture of the bonus, etc.

The successful tenderer shall be entitled to obtain a lease of the Iroquois and Couchiching Falls on the Abitibi River, and the right to control the water on Abitibi Lake, subject to the stipulations that may be imposed by the Minister. Also, plans for water storage and water regulations must be approved by the Minister.

Other clauses in the conditions infer that the Crown reserves the right to erect dams or enlarge the dams of the pulp mills, to develop power to the fullest extent, and charge a fair and equitable sum for the benefits conferred, the rate to be fixed by the Hydro-Electric Commission.

The T. and N.O. Railway will be entitled to the delivery of all surplus power to the extent of 10,000 horse-power.

No doubt in the early future the railway will be electrified, for this has been the ultimate intention of the Government and its Commission for some time.

COST OF SURVEYS.

The following statement shows the average cost per mile of surveys executed by surveyors under daily pay and by surveyors under contract is taken from the annual report of the Topographical Branch of the Department of the Interior:

	Surveyed under daily pay.	Surveyed under contract.
Total mileage surveyed	3,962	13,927
Total cost	$388,600	$376,477
Average cost per mile	$98.08	$27.03

The high average cost per mile of $27.03 for contract surveys as compared with $17.97 for 1909 is due to the fact that all the townships subdivided during 1910 were wooded while of those subdivided in 1909, 169 were open prairie; the relative rates per mile for surveys in open prairie and in solid bush are as $7.50 to $31.

The average cost per mile for surveys performed under day pay increased from $49.33 in 1909 to $98.44 in 1910. The average per mile for block outline surveys was $175 as compared with $167 in 1909. When the party under Mr. B. J. Saunders, D.L.S., is omitted from the calculation the average cost per mile for block outline surveys is found to be about ten dollars per mile lower in 1910 than in 1909. Mr. Saunders was compelled to abandon the survey of the nineteenth base line west of the fourth meridian when only a few miles had been run, but after all the initial expenses of organization, travel, etc., had been incurred. Other factors to increase the average cost of the surveys in 1910 were the larger number of parties working in the foot-hills in Alberta and in the railway belt in British Columbia and the smaller number engaged upon miscellaneous surveys, resurveys and restoration surveys in other parts of Alberta and in Saskatchewan and Manitoba. Owing to the nature of the country surveys in the foot-hills and in British Columbia are much more difficult than in the level and settled districts, and consequently slower and much more expensive. The average cost per mile of surveys in the foot-hills in Alberta during 1910 was $79, and in British Columbia $85, while the cost in Saskatchewan and Manitoba and other parts of Alberta was $33 per mile.

COMPARATIVE RATES FOR CURRENT.

The following is a comparison of electric current rates in four of the cities of Southwestern Ontario:—

London—Dwellings, 5c. per kw., less 10 per cent.; no minimum rate. Business, same.

Guelph—10c. per kw., less 20 per cent. Business, same.

Berlin—5c. per 100 sq. ft.; 4c. per kw., less 10 per cent. Business, 12c. per kw. for first hour of installed capacity; 5c. per kw. for additional, less 10 per cent.

Woodstock—3c. per 100 sq. ft; 4c per kw., less 20 per cent. Business, 10c. per kw. for first hour of installed capacity; 4c. per kw. for additional, less 20 per cent.

PROPOSED PEACE MEMORIAL BRIDGE.

A student of modern political conditions is conversant with the fact that mankind in general is cultivating an abhorrence of war between nations and communities. Examples have not been few during the past decade when the voice of the people has ended pending hostilities and bloodshed by declaring, through the columns of the press and by other means, that war must not yet be, and if difficulties have arisen, arbitration must be given every possible opportunity to restore a peaceful attitude.

There are two pronounced reasons for this; first the national mental expansion which has kept pace with the unprecedented industrial expansion of the past few years, and secondly, the overwhelming expenditure of public money following a declaration of war between two or more nations.

It may be a coincidence or it may be the natural succession of events, nevertheless, it is a fact that the three nations who have not resorted to a force of arms for over ninety-eight years to settle international difficulties, are the foremost examples of mankind, speaking in general terms, among the nations; these three are Great Britain, France and the United States.

Prominent citizens of the first and last mentioned nations have assumed that was is over between these communities, and, acting upon this assumption, have made preliminary preparations for a tangible celebration when the ninety-eight years shall be increased by two.

The two illustrations show in which direction the plans for the event have turned; the erection of a permanent bridge across the Niagara River between Canada and the United States of America.

The Niagara River is an ideal spot for such a structure on account of the prominence enjoyed by the Falls, the ease of distributing the foundations equally and the possibility of welding into its members the idea that it is an indestructible link that shall bind these two nations together for all time to come. Just at what spot the structure is to be built has not been decided, but that it will be either crossing the river close to Lake Erie or just below the Falls is very probable.

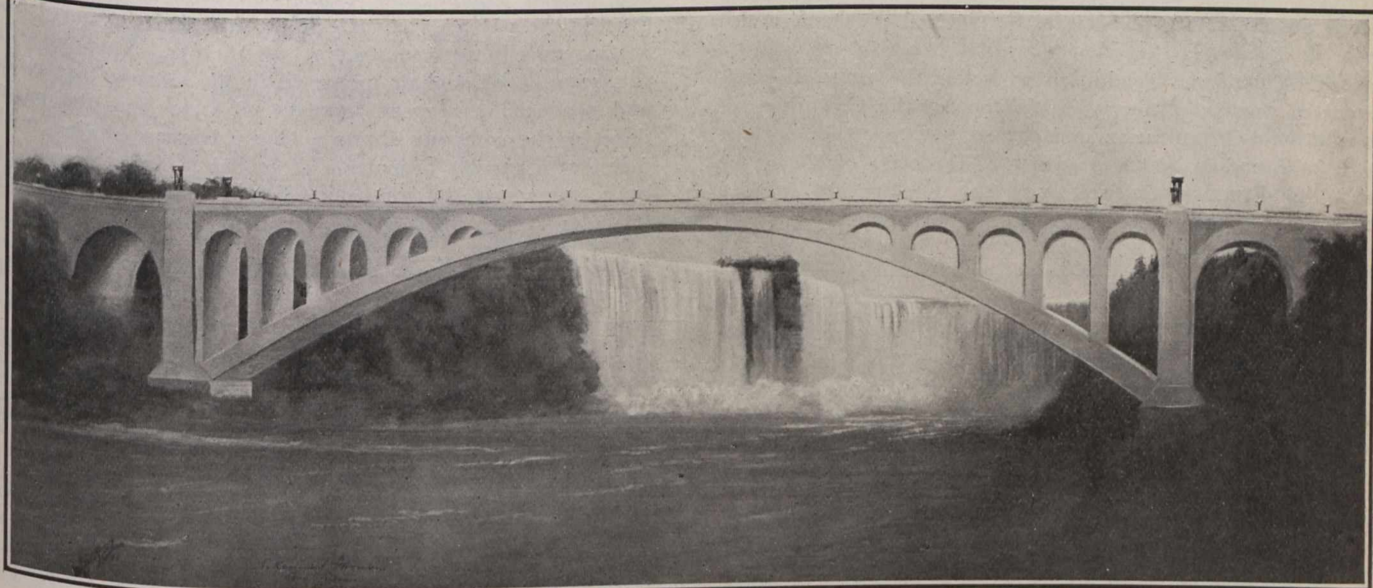


Fig. 1.—Proposed Memorial Arch Bridge at Niagara Falls.

Mr. T. Kennard Thomson, acting as consulting engineer to a committee of prominent men of both nations, has prepared the illustrations which we present to our readers. Figure 1 is a proposed structure to be erected and take the place of the present steel arch bridge a few hundred feet from the Falls. It has a clear span of 840 feet with a clear height of 144 feet, and the materials are steel encased in masonry; the design of the structure, both mechanically and aesthetically, has been prepared with a view of one hundred years' use.

The history of the bridges at this point has been somewhat varied, the first was a suspension bridge with a width just sufficient to allow one wagon to cross at a time; the second was of such a width that two wagons could cross, but the structure met an untimely end and fell a prey to a miniature hurricane which swept the structure from its anchorage. The third was, like its predecessors, of the suspension type, and it was removed to make way for the present structure, which is now considered too light.

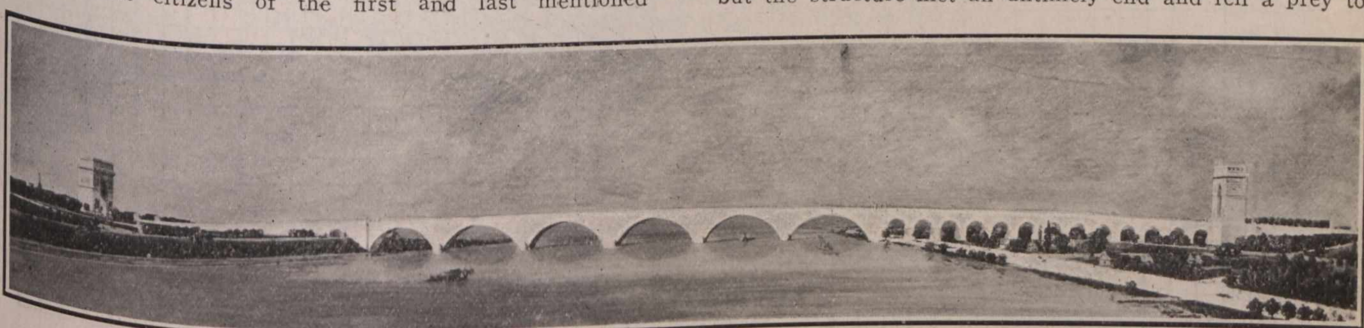


Fig. 2.—Proposed Alternative Memorial Bridge Between Buffalo, N.Y., and Fort Erie, Ont.

Figure 2 is an illustration of an alternative proposed bridge, and is of a much more pretentious nature, having a length of nearly 4,000 feet. The design of this bridge includes six main spans with a length of 300 feet clear each, and a height of 90 feet. The materials prescribed for this structure are granite with concrete backing. The width of this bridge is 100 feet, but a suggestion has been made that the structure be erected at Niagara-on-the-Lake, and should this be adopted the width will be reduced by 50 per cent. A beautiful boulevard is now being constructed from Niagara Falls southward, and it is very probably that this will be used as a connecting ling in connection with this driveway somewhere in the neighborhood of Fort Erie and Buffalo. In the design of this bridge Mr. Thompson received the assistance of Messrs. Griffin and Wynkoof, architects.

Mr. Thomson, in addition to being the consulting engineer of the committee, is a member of the Committee of International Organization and the Commerce on Memorials. He is a Canadian and a graduate of the class of '86 of the School of Practical Science, now the Faculty of Applied Science and Engineering, University of Toronto.

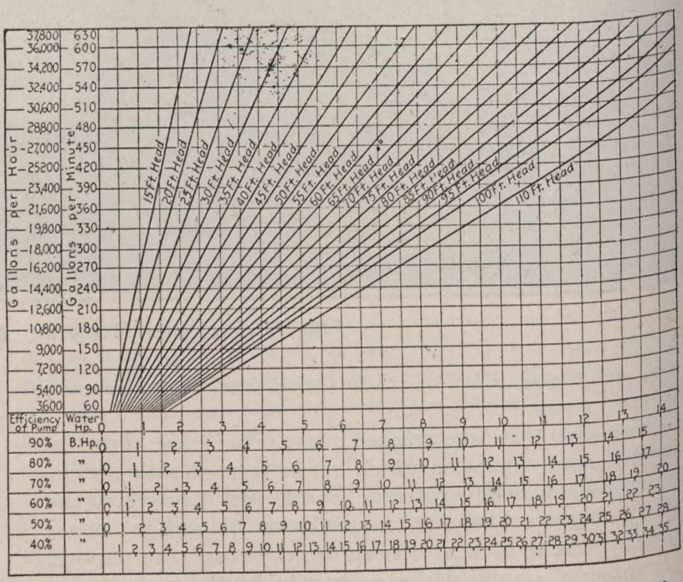
PUMPING DIAGRAMS.

The power required to pump a given quantity of water to a given height, when the efficiency of the pump is known, or how much water can be raised to a given height by the power available can be determined from the accompanying diagrams which were prepared by W. E. Wort for the American Machinist. These diagrams give the brake horse-power, number of U.S. gallons per minute and per hour, the pump efficiencies, and various heads in feet from 15 to 300 feet.

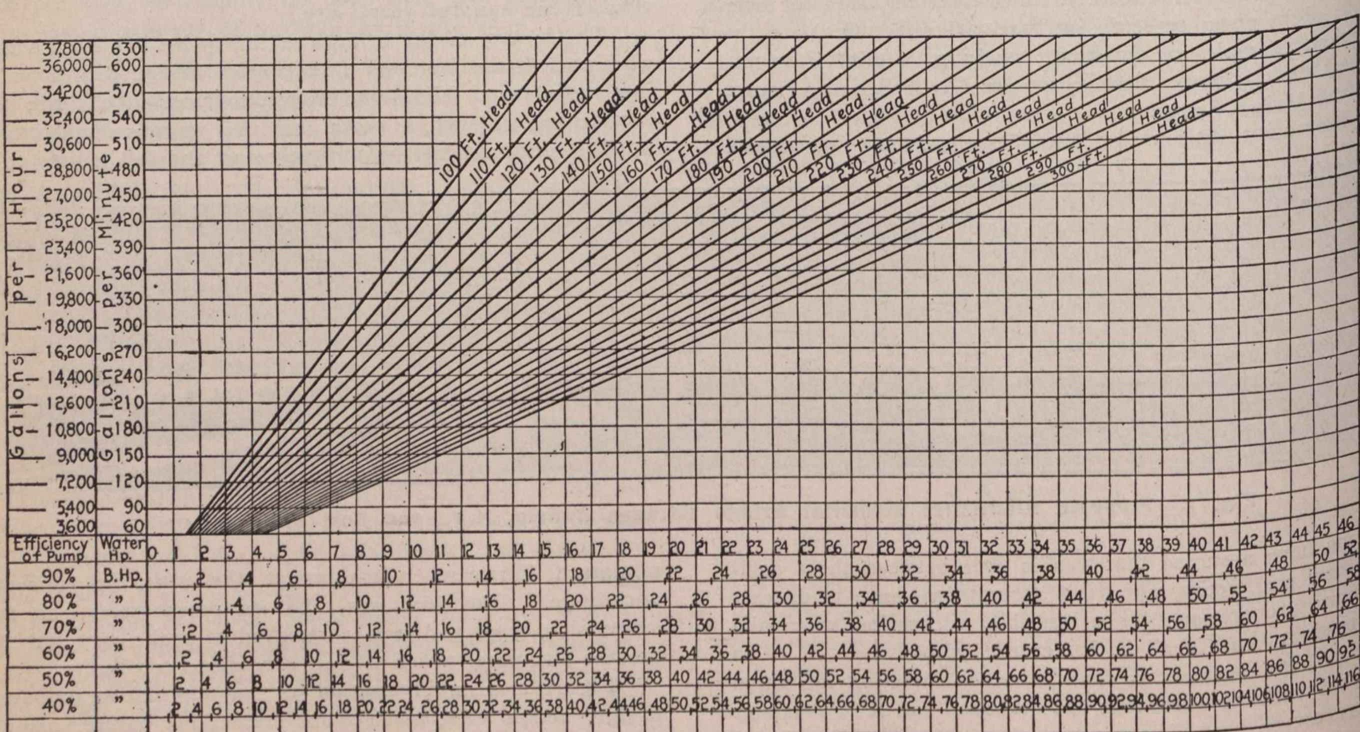
For example, if it is required to pump 350 gal. per min. against a total head of 85 ft. and the efficiency of the pump is 60 per cent., the brake horse-power is found by following the 350-gal. horizontal line to its intersection with the 85-ft. head diagonal, then following down the vertical line to its intersection with the 60 per cent. efficiency horziontal line at the lower part of the table. It will be seen that 15 b.-h.p. is the power required for the duty specified.

ASPHALT IN THE PAST YEAR.

Aside from its financial features, the annual report of the General Asphalt Company (owning the Barber, Trinidad and Bermudez Companies) issued May 14th, contains information of interest, especially to the paving and road-building industry. The total volume of business increased from $16,004,173.08 to $16,542,281.14. For the first time in the company's history the item "asphalt," which includes crude and refined asphalt and asphaltic products in all forms, exceeds the paving account. Sales of asphalt increased from 247,491 tons in 1910 to 265,677 tons in 1911. Thus while the consumption of asphalt increased in the amount just stated, and produced a revenue increase of $2,297,030, the paving done by the company shows a slight decrease, owing to the fact that a greater proportion of asphalt construction is done by customers of the company using Trinidad and Bermudez asphalts rather than by the company itself.



Pumping Diagram, 15- to 110-ft. Head (U.S. Gallons).



Pumping Diagram, 100- to 300-ft. Head (U.S. Gallons).

THE HYDRAULIC RAM—ITS POSSIBILITIES OF DEVELOPMENT AND USE.*

By Stirling B. Hill.

The hydraulic ram was first invented by John Whitehurst, in 1772, and was made practical by Joseph M. De Montgolfer in 1796. The latter made the action of the waste valve automatic, thus changing the ram from a laboratory toy operated by hand, to a useful pumping device. Although the hydraulic ram was invented and used over 100 years ago, there was but little improvement in its design up to fifteen years ago.

To-day little is known of the hydraulic ram, even by engineers. The average engineer seems to have the most hazy idea of the characteristics of this much neglected pumping device. It is usually looked upon as a type of pump of small capacity and low efficiency, useful for pumping water for isolated dwellings, or where but a small quantity of water is needed and efficiency of no consequence.

Operation.—The essential features of a hydraulic ram are (See Fig. 1) supply or drive pipe A, ram chamber B, waste or impetus valve C, discharge or check valve D, air or equalizing tank E, and discharge or delivery pipe F.

The mere physical operation of the ram is simple, though the attendant phenomena and hydraulic principles involved seem to be but little understood. The general principle of operation is the same in all rams, however the mechanical workings and construction may differ.

Ignoring, for the present, the cause of the action, suppose the waste valve (C) to have just opened, the water in the drive pipe and ram being stationary, when the valve opens the water in the drive pipe starts to flow through the open valve, gaining in velocity, until the increasing velocity and pressure behind the valve are sufficient to close the latter. When the waste valve closes, the water flowing in the drive pipe with the momentum and energy of the moving column of water behind seeks another means of escape, which is secured by opening the discharge valve (D), flowing through the latter into the air chamber (E), and thence out through the delivery pipe (F). The air in the chamber acts as a cushion to the sudden inflow of water and maintains a nearly constant pressure in the chamber and steady flow through the delivery pipe.

The velocity gradually decreases until all the energy of the moving column of water is expended in forcing water into the air chamber and the flow ceases. The pressure in the air chamber then starts a back flow similar to the oscillation of water in a U tube. This instantly closes the check valve, thus retaining the water pumped. The tendency to back flow together with the sudden closing of the check valve, causes a momentary reduction of pressure in ram chamber (B), which allows the waste valve to open. The water then starts to escape as before and the cycle of operation is repeated. The action after once being started is automatic and the ram will continue to operate.

The back surge is usually sufficient to create for an instant a partial vacuum in the ram chamber. This condition may be taken advantage of, to introduce automatically into the upper part of the chamber a small amount of air at each stroke. During the waste period this air rises to the top of the chamber and at the delivery period is carried through with the flow into the air chamber. Thus the air supply is maintained, which otherwise would be gradually absorbed by the water under pressure.

*Abstract of paper read before the Pacific Northwest Society of Engineers.

Details of Operation.—The operation of the ram may be divided into two distinctive periods, namely, the acceleration or power accumulating period, and the retardation or pumping period. In the former, the waste valve is open and the water escaping through it, while the check valve is closed. In the latter, the waste valve is closed and the water is being delivered through the check valve.

In addition to the two periods mentioned there is the instant between the closure of the waste valve and the opening of the check valve, and also between the closing of the check valve and the opening of the waste valve. Each of these periods, though extremely short, has its distinctive functions and attendant phenomena.

We will now follow more in detail a cycle of operation or a stroke as it is commonly called.

When the waste valve opens the static column of water in the drive pipe, due to the inertia of its mass, cannot get up velocity at once, but is accelerated gradually. The time required to attain a certain velocity depending upon the ratio of supply head to length of drive pipe, or, stated in another way, upon the slope of the drive pipe. Neglecting the effect of friction, the acceleration is constant like that of gravity, and may be expressed in the familiar form $V = GT$, modified, of course, by the slope of the drive pipe, into

$$V = GT\frac{H}{L} = GT \sin A,$$

where A equals the angle of slope of the drive pipe, H equals the supply head and L the length of drive pipe. This is approximately correct for small velocities, but the friction varies as the square of the velocity, hence it soon becomes an element that must be considered. For any size pipe on a given slope there is a fixed possible maximum velocity. This is found by the Chezy formula $V = C\sqrt{RS}$ where S is the slope of the drive pipe, $\frac{H}{L}$.

Water Hammer.—Up to a certain point there is practically no resistance to the flow offered by the waste valve, as it will pass the water faster than it comes to it. After attaining a certain velocity, the water begins to head up behind the waste valve and when sufficient velocity and pressure are attained the waste valve is closed. When the valve starts to close the area of flow is further restricted, the pressure rises rapidly and the valve goes shut with a bang.

The sudden stopping of the moving column of water produces an instantaneous rise in pressure, causing what is called "Water Hammer." The intensity of the hammer is limited by the pressure against which the ram is pumping, as when this pressure is reached the discharge valve opens and prevents a further rise.

Experiments have shown that the maximum pressure in the ram exceeds that in the air tank by only a few pounds.

When the waste valve closes the lower filament of water is compressed, and is followed by each succeeding filament under like compression to the head of the drive pipe, while at the same time, the pipe walls due to this compression, are expanded. As this compression wave reaches the open end of the drive pipe, the first filament is relieved, then each in succession as a wave of rarefaction moves down the pipe. Thus the pressure waves race up and down ordinary pipe at a rate of about 4,000 ft. per sec. until worn out by friction.

The intensity of water hammer depends upon the velocity of flow and the rate of its suppression. If it is stopped instantly, the pressure developed is found by the formula,

$$P = \frac{vVW}{G}$$

where P = water hammer pressure (in excess of static pressure) in pounds per square inch.

v = the velocity of wave motion in the pipe.
V = the extinguished velocity of the water.
W = weight of a cubic foot of water.
G = the acceleration due to gravity.

For ordinary conditions this would amount to about 60 lbs. for each foot of velocity extinguished.

Losses Involved in Ram Operation.—During the acceleration period the potential energy in the water supply entering the pipe is being changed into kinetic energy in the form of a moving mass of water, the power being accumulated and concentrated.

Without giving the matter consideration one naturally concludes that since water is running to waste, during the acceleration period, there must be a corresponding sacrifice of power and efficiency. This, however, is not the case, the only loss being the velocity head of discharge, which is usually but a fraction of a foot. The potential energy of this water has been stored in the form of kinetic energy in the moving mass of water in the drive pipe. When water power is used to raise water to a higher level it is self-evident that only a portion of the water can be raised to the higher level, hence, the remainder must be wasted at the lower level. For example, if a theoretically perfect machine were operating with a 10-ft. supply head and lift of 20 ft. ft. above the machine, it is evident that it would require two units of water with 10-ft. head to raise one unit 20 ft. The other unit is running to waste, yet no power whatever would be sacrificed, the machine in that case being 100 per cent. efficient.

The losses involved during the acceleration period are due to entry head, friction in the drive pipe, and the velocity head of the wasting water with the friction of its passage through the waste valve. These are all losses which can be determined definitely, hence the efficiency of the acceleration period is susceptible of accurate calculation when the co-efficients of friction for the design have been established.

In the case of the larger sized rams operating with medium drive head and moderate velocity the efficiency of the acceleration of power accumulating period may exceed 97 per cent.

The two periods of action are independent of each other, The action during the acceleration period is entirely independent of the conditions of delivery or retardation; that is, of the head against which the water is pumped. Likewise the retardation or pumping conditions are independent of the head used or time required in attaining a given velocity in the drive pipe.

The acceleration period ends when the waste valve is partially closed and the retardation period really commences before this valve is fully closed. The interval between this time and the opening of the check valve is really part of the retardation period though no water is pumped. The pressure is being raised in the ram accompanied by the water hammer effect.

A small amount of velocity is sacrificed in water hammer loss, the amount depending upon the head against which the water is pumped, or more directly the rise in pressure. The water pressure strikes the check valve suddenly and, due to its inertia, an increment of time is required to move it. This causes an instantaneous rise in pressure beyond that required to force the water through the valve and a small loss of efficiency is involved. The losses during the retardation period are: water hammer, opening discharge valve, friction through discharge valve, velocity head of discharge and slip of check valve at end of delivery.

Ram Capable of Mathematical Treatment.—Thus it will be seen that the action of the ram is capable of analysis and consequently of mathematical treatment.* When the various co-efficients have been determined by experiment for any given type of ram its performance under given conditions can be determined by calculation. The writer hopes later to acquire sufficient experimental data to be able to determine the proper value of the co-efficients.

Efficiency.—The efficiency of the ram is the product of the efficiency of the acceleration, or power accumulating period, and of the retardation, or pumping period.

There are two different formulas used for computing the efficiency of the hydraulic rams, namely, the D'Aubuisson and the Rankine formulas.

The former is expressed by the equation

$$E = \frac{q(H + h)}{(Q + q)H} \text{ and the latter by } E = \frac{qh}{QH} \text{ where:}$$

E equals the efficiency of the ram.
Q equals the water wasted.
q equals the water pumped.
H equals the supply head.
h equals the pumping head above supply.

The D'Aubuisson formula represents the efficiency of the machine itself, as it considers all the water flowing through the drive pipe as the working force and the work done that of raising the water pumped from the ram to this point of delivery. If Q equals the total water supply and h the pumping head above the ram, then the formula takes the simpler form of $E = \frac{qh}{Qh}$.

The Rankine formula represents the useful work accomplished in raising the water from the level of the supply to the point of delivery.

The losses in the supply pipe are included with those in the machine itself in calculating the efficiency of the ram.

The efficiency of the ram depends upon the size of the machine and the conditions under which it is operating. The efficiency, under ordinary circumstances, of small rams varies from 50 per cent. to 70 per cent., and the larger sizes from 70 per cent. to 90 per cent.

With a properly designed ram, operating under favorable conditions, it is possible to obtain as high as 95 per cent. efficiency (D'Aubuisson).

Effect of Varying the Conditions of Operation.—Supply Head.—The effect of the supply head upon the operation of the ram is confined to the acceleration period. Other things being constant, the efficiency is increased by increasing the supply head. However, the same efficiency can be obtained with different heads by proportioning the velocity to the head.

With the higher heads, a greater velocity, with corresponding increase of capacity, can be used without sacrificing efficiency.

Consequently, the effect of increasing the supply head is to increase the capacity of economical operation, or, if the capacity remains constant, to increase the efficiency.

Pumping Head.—The effect of the pumping head is confined to the retardation, or pumping period.

Approximately the same efficiency during the retardation period can be obtained with any pumping head, but the velocity required to obtain this maximum efficiency increases with the pumping head. The efficiency, however, with

* Leroy Francis Harza, in his paper, "An Investigation of the Hydraulic Ram," published bc the University of Wisconsin, as Bulletin No. 205, gives a very complete mathematical treatment of the operation of the ram. He also carried out an elaborate series of experiments to check his theory.

which this higher velocity can be produced in the drive pipe will decrease; hence, the combined efficiency of the ram will decrease with an increase of pumping head.

If all other conditions remain constant, there is one pumping head for which the efficiency of the ram will be a maximum.

Length of Drive Pipes.—Other things remaining constant, the efficiency with which a given velocity can be produced in the drive pipe decreases as the length of drive pipe increases. This is due to pipe friction. The time required to attain a certain velocity with a given head increases as the length of drive pipe.

The efficiency during the retardation period is theoretically independent of the length of drive pipe. Practically, however, on account of the slip in the check valves and the loss in waste valve closure, it is not. The slip depends upon the frequency of the valve action, which, other things being fixed, depends upon the length of drive pipe. The longer the drive pipe, the fewer the strokes and less the slips.

The proportion of loss due to slip increases with the pumping head, both on account of the greater tendency to slip and the shortening of the delivery stroke. Therefore, a longer drive pipe is required for high heads than for low ones.

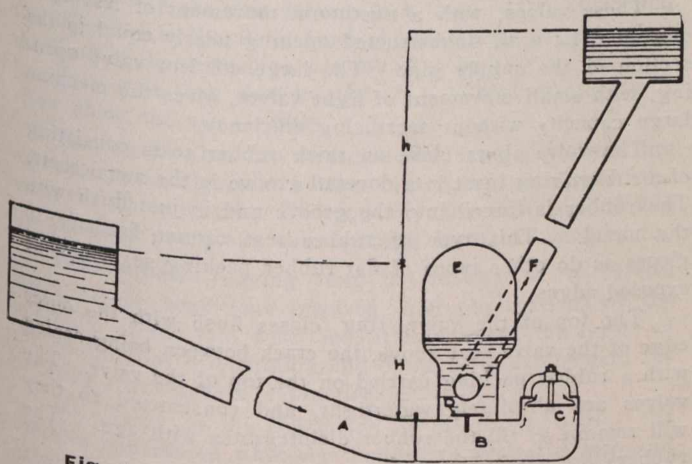


Fig. 1.—Essential Features of the Hydraulic Ram.

If the drive pipe is too long the friction is excessive, and if too short the slip is abnormal, hence there is for each size of ram with each combination of supply and delivery head a certain length of drive pipe that will produce the maximum efficiency.

There is also another working factor involved in the operation of the ram that has an influence on the minimum practical length of drive pipe. If the drive pipe is too short, or steep, the surging and vibration of the water column may interfere with the smooth operation of the valves, and the interfering waves will decrease the efficiency if the stroke is not carefully synchronized with the pressure vibrations. If too long a drive pipe is used, with the ordinary upward discharge, the automatic air supply will not work.

Size of Drive Pipe.—The main loss during the acceleration period is the pipe friction. During the retardation period the pipe friction is a minor loss. The efficiency of the ram will be increased by using the larger pipe, or a greater capacity will be secured with the same efficiency. The larger the size of the ram, with corresponding size of drive pipe, the greater the efficiency of the machine.

Strokes Per Minute.—Under any given conditions the capacity of the ram depends upon the velocity obtained in the drive pipe, and that depends upon the number of strokes per minute with which the machine is operating. The fewer the strokes, the greater the capacity, and the greater the number of strokes, the less the capacity.

A long, slow stroke allows the water to attain a greater velocity at each stroke and a corresponding greater average velocity, or flow through the pipe and ram.

For any given set of conditions there is a certain number of strokes that will produce the maximum efficiency. The efficiency increases with the number of strokes to a certain point, after which it decreases.

With a given supply head the efficient number of strokes increases with the pumping head to a maximum, and then decreases.

Limiting Factors.—The physical possibilities of the hydraulic ram are limited—first, by natural laws governing its operation, and, second, by human ingenuity in devising ways to make practical its possibilities.

Fundamental Limitations.—There seems to be no law law directly limiting the height of supply head that can be used, except that it must always be less than the lift above the ram. Let us, then, consider the pumping head. As stated before, the amount of pressure that can be developed by the sudden stoppage of water in the ordinary pipe is about 60 lbs. per sq. in. per second-foot of velocity stopped. Hence, the problem resolves itself into one of velocity obtainable in the drive pipe. In small pipes the limiting, or critical, velocity is soon reached. For example, a velocity of about 5.5 ft. only per second can be attained in a 1-in. pipe with a slope of 10 to 1, while in a 12-in. pipe with the same slope a maximum velocity of nearly 18 ft. per second could be attained. The practical operating velocity would probably be about two-thirds the maximum.

Thus it is apparent that, while a one-inch ram is limited to about a 400-ft. lift, under ordinary conditions, a 12-in. ram should be able to lift water at least 1,000 ft. The drive head that can be used must in each case be considerably less than the lift above the machine for practical operation. It is apparent that the fundamental limiting factors are beyond all practical requirements; hence, the problem resolves itself into one of practical design and mechanical construction.

Mechanical Limitations.—The design and operation of the waste valve seems to be the vital point. The ordinary hydraulic ram has an upwardly discharging waste valve of the disc type. The force of gravity—that is, the weight of the valve—is depended upon to open it and hold it open until it is forced shut, as previously described.

Machines of this type naturally have their limitations. Fifty feet seems to be the limit of the height of supply head that can be used. In the first place, the static head against which the valves will open is limited. They will not open with a long drive pipe or small ratio of heads. A moderate velocity will close them. For small rams, however, they answer very well. As the size of the disc valve increases, the area exposed to ram pressure increases as the square of the diameter, while the waterway around the circumference only as the first power. Thus the practical limit as to size is soon reached. This limit seems to be about 8 inches.

Certain manufacturers have lately cut the centres out of their discs and introduced light springs to assist the operation. This was quite an improvement, and they were enabled to increase the size of their machines, so that 12-in. rams may now be secured.

A Progressive Step.—Daniel W. Mead, now professor of Hydraulics at the University of Wisconsin, was the first to depart from the old rule-of-thumb design.

In 1895 he built and installed (under conditions that no ram manufacturer would attempt) a machine for the village of West Dundee, Illinois. In fact, no ram on the market today would operate under the same conditions.

This ram was installed with a 43-ft. drive head and 2,200 ft. of 10-in. cast-iron drive pipe. The makers assured Mr. Mead that such an installation was impossible, as the water hammer, due to stopping such a volume of water, would tear any machine to pieces. The ram was designed to suit the conditions; that is, with a large discharge valve area and with a very heavy spring to operate the waste valve, which was given a small movement. Needless to say, the machine operated successfully, and has continued to do so for the last 16 years.

The pressure in the ram exceeded that in the stand tower by about 2.5 lbs. There was no excessive hammer, as the column of water is not stopped or started suddenly, but gradually. This machine developed from 73 per cent. to 75 per cent. efficiency. This seems to be about the average efficiency of commercial rams in the larger sizes.

A New Type of Ram.—Last year the writer had occasion to investigate the subject of pumping machinery with a special view to the use of water power for its operation. The hydraulic ram, on account of its reasonable cost, automatic operation without the necessity of an attendant, low operating costs, durability and reliability, seemed particularly suited for use on irrigation projects, where conditions permit of its installation.

A particular case was presented to the writer some time ago for his consideration, where the supply head was so high that no ram obtainable would operate.

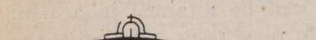


Fig. 2.—Section of 10-in. Sterling Ram.

After a careful study of the principles involved in the operation of rams, there appeared no fundamental reason why their operation should be limited to the narrow bounds of present practice. This being the case, it seemed that it should be possible to design a ram that would operate under a much wider range of conditions. With this idea in mind, a further investigation of existing makes of rams and their construction and operation was made.

It was apparent that a new type of waste valve was necessary in order to increase the strong, and have as large free capacity or field of operation of the ram. This valve must be so constructed as to eliminate the excessive hammer on its seat, must be light and strong and have as large free waterway as possible with a small movement of the valve.

The upward discharge was abandoned on account of the amount of head wasted on the larger sizes. The horizontal side discharge was considered, but passed because the machine would have to be submerged to above the valves to prevent their inhaling an excessive amount of air through the upper half of the valve during the fore part of the waste period. The solution seemed to lie in a balance valve of some description, having a downward discharge and operated with a heavy spring.

After numerous designs had been made and abandoned, a type of valve was finally evolved that seemed to fill the various requirements. This valve is composed of one or more concentric rings of increasing diameter, the number of rings depending upon the size of the machine. The plural rings are carried on a frame consisting of four radial arms, guided by a central stem, so they act as a single valve. The rings were changed from short cylindrical sections to ones having an arched cross section. See Fig. 2.

This allowed the water to escape over, as well as under, each ring when raised, thus nearly doubling the capacity of each ring with a given opening. This shape has the further advantage of offering smooth curved guides to the flow of the water and increasing the strength of the valve ring.

This arrangement of valves gives the greatest amount of clear waterway, with a minimum of weight of moving parts and space occupied, thus giving large capacity with high efficiency.

The valves being thin circular rings, with the vertical ram pressure practically balanced, they close very lightly, eliminating the excessive pounding. The hammer on the seats is the same in large rams, with this type of valves, as in the smaller ones, as they have practically the same shape and size of valve section.

A ram with valves of this type has been built and tested by Hill Bros. (See Fig. 2). It has a 10-in. supply pipe and a two-ring waste valve. The check valve is of similar construction, except that it has one ring and a central disc.

These valves, with a maximum movement of less than one inch, have an unobstructed opening nearly equal to the section of the supply pipe. The large efficient valve opening, with small movement of light valves, gives the machine large capacity without sacrificing efficiency.

The valve rings close on thick rubber seats consisting of a rubber ring inset in a dovetail groove in the metal seats. The rubber is forced into the groove and is just flush with the metal. This type of rubber seat cannot hammer to pieces as do other types of flat rubber packing seats having exposed edges.

The top of the valve ring closes flush with the outer edge of the valve seat above, the crack between being sealed with a rubber packing carried on the top of the valve. The valves are absolutely watertight, and constructed so they will remain so till the rubber disintegrates with age. The rubbers are easily renewed.

Test of 10-in. Sterling Ram.—The experimental machine was set up on the campus of the University of Washington, and a series of careful tests made under the supervision of the Department of Hydraulics. All measuring apparatus was carefully calibrated. A 50-ft. supply head was used and 140 ft. of 10-in. wrought-iron drive pipe.

The conditions were purposely made severe, the drive head being the highest yet used. The machine operated very satisfactorily, and the efficiencies developed were even better than anticipated. Various velocities were used, with lifts ranging from 100 ft. to 325 ft. The efficiencies ranged from 80 per cent, on the high lift, to 95 per cent. on the low (DeAubuisson formula). The drive pipe was too short to give the best results, especially on the higher lifts. Eight runs with a 115-ft. lift showed over 90 per cent. efficiency, the average being about 93.5 per cent.

It was hoped to secure a sufficient range of experiments to determine the characteristics and coefficients of the ram, but on account of the limited water supply available this proved impossible at the time. However, much valuable knowledge was obtained in regard to the fine points of ram operation.

A series of pressure indicator cards were secured on the ram, half way up the pipe and 20 ft. from the head of the drive pipe. These show the variations of pressure at these points. They seem to bear out the theory of the water hammer waves. The vibration in the drive pipe was very noticeable, especially near the head of the pipe, while in the ram there was hardly any vibration. The indicator cards explain this. The ram cards show an almost constant pressure during the acceleration and retardation periods. The pressure rises very abruptly at the closure of the waste valve, but drops more gradually at the end of the delivery. The rise in pressure is almost instantaneous and scales less than 0.01 of a second in some cases. The closing of the check valve and the opening of the waste valve seems to consume from one-tenth to one-twentieth of a second of time.

Due to the throw of the indicator arm it was impossible to get a reliable record of the actual maximum pressure attained in the ram and drive pipe. In order to secure this data a special device was later made and used. It consisted of a small chamber on which the pressure gauge was mounted, a drain cock was provided in its bottom, and its connection to the ram, or pipe, was through a check valve and stop cock. The chamber contained air so that when the stop cock was opened the pressure vibrations pumped water into the chamber, compressing the air, the check valve preventing the return of the water. When the maximum pressure was reached in the chamber the water nō longer was forced in. The gauge then indicated the maximum pressure.

The maximum pressure in the ram was found to exceed that in the air chamber from 3 to 4 lbs. After correcting for difference in the static head, the maximum pressure near the head of the drive pipe was found to be only 10 per cent. to 20 per cent. less than in the ram. The indicator cards show about the same result.

This shows that the stress in the drive pipe does not decrease uniformly from bottom to top, but is nearly constant the whole length. Consequently, the drive pipe should be designed practically full strength its entire length.

Possibilities.—Judging from the results of a careful study of the conditions involved, and observations of the operation of the ram described, it is believed the limits of the possibilities of operation and of capacity are beyond the ordinary requirements of practice.

Mr. Harza, at the conclusion of his paper, says: "If there is any reason whatever tending to limit the size and capacity of the hydraulic ram, it is the practical difficulties which might be encountered in the design of valves. It is believed that these are no more insurmountable than those encountered in the design of valves for other pumping engines of large size." It is believed that the proper valve required to solve the problem has been produced.

Head.—No difficulty should be encountered in operating these rams with supply heads from 1 ft. to 100 ft., and lifts from 5 ft. to 500 ft., the machines being designed to suit the service required.

In addition to the automatic hydraulic ram there is a current ram manufactured by the Lester Duplex Hydraulic Ram Co., of Portland, Ore. The waste valve in this machine is operated mechanically by a separate current wheel. The operating head for the ram is that produced by the velocity of the current of the ditch or stream in which the machine is set.

Capacity.—By the use of the multiple ring valve the size and capacity of the ram may be increased by adding more rings without changing any essential operating conditions. If the capacity is to be doubled, the length of valve ring, the unbalanced pressure on valves, the area of valve seats and the strength and resistance of the actuating spring are all increased in the same ratio. It is believed that rams having at least a 36-in. supply pipe can be built and operated successfully.

Uses.—The possible field of useful operation for the ram includes practically all those cases where water is to be pumped and local water power is available to furnish the power.

Water Works.—The ram is sometimes well adapted for pumping water for domestic supplies and city waterworks, as it operates continuously and efficiently without cost of attendance or power. Hydraulic rams in the past have been used mainly for supplying isolated dwellings and small villages. Now, however, the advent of this new type of ram makes these machines available for use in large city waterworks.

Irrigation.—There has been a great need in irrigation work for a cheap pumping machine that would work automatically, economically, and efficiently under all conditions, and having sufficient capacity to make them practical for large installations. Under some conditions the hydraulic ram is an ideal machine for the purpose. The new design makes possible the use of large units.

It operates automatically, no attendant being required. There are no bearings to oil and no moving parts exposed in the new design. It can be set up and operated miles from an attendant without housing or fear of molestation. It furnishes its own power without cost. The cost of maintenance is practically nil and the first cost of installation small. The machines are very flexible as to their operating conditions, the same machine operating equally well under a high or low head. The delivery head can be changed at any time without touching the machine or interfering with its continuous action.

The hydraulic ram could be included in the design of many gravity projects to advantage. Why construct the main gravity supply canal to the level of the highest land with the great additional length of canal and expense involved, when it is possible to locate the supply canal at an intermediate level using the power of the water dropped from the canal to the lower levels to raise the water to the higher levels? In many cases a great saving in cost could be made in this way and much difficult construction avoided.

On existing irrigation projects there are numerous cases where drops in canals and laterals can be used to operate rams to lift water to cover additional lands above the canals. In many instances the cost of the machines for this purpose would not exceed $3 to $10 per acre thus irrigated.

Mining.—The hydraulic ram is very well adapted for pumping water for mining operations. If there is water power available to do the work the ram is the cheapest and most economical pumping installation for the purpose. No fuel or power is needed, no attendant is required and there is practically no cost of operation. The rams will pump direct to the giant for hydraulic mining. Benches above the river bed could be economically sluiced by the use of these pumps to furnish the water required. It is often cheaper to install a ram for pumping than to construct a long gravity ditch, and much cheaper to maintain.

NEW METHOD OF UTILIZING HEAT FROM GASES.

Prof. W. A. Bone, F.R.S., Professor of Coal Gas and Fuel Industries at Leeds University, in a lecture at Leeds, described a new method of gas heating without flame, which, he believes, may work a revolution in fuel economy and have very important industrial effects.

Prof. Bone is one of the greatest living authorities on the subject of combustion. The new process has already been put into practical operation at Leeds. Hot surfaces promote the combustion of gases in contact with them, and it is on this property that the process is based.

AUXILIARY PLANT FOR POWER STATIONS.*

By A. H. Finch, M.A.

In this paper it is proposed to notice some of the points that should bear on the design of that part of a power installation which is referred to in general terms as the auxiliary system. In its widest sense, the term auxiliary might be taken to include everything except the principal agents involved in the cycle, which would mean practically everything except main engines, feed pumps and boilers.. More commonly the feed pumps are included as auxiliaries, which term will be taken to include also: (a) Thermodynamic appliances not essentially involving moving parts or power (e.g., economizers). (b) Apparatus requiring motive power independent of the main engines. Such a definition excludes transformers and certain small elements, such as oil pumps, which are often driven by the main engines.

The importance of this section of any large power plant is to be gauged by the proportion which it bears to the whole, whether in capital or running costs; figures are given subsequently which exhibit the ratio of auxiliary to main power in the case of some typical stations; but it presents a sufficiently accurate picture at this stage to say that in a modern power station of 30,000 kw. capacity the auxiliaries would account for 2,000 h.p., and probably £12,000.

To illustrate the divergence that can exist in the auxiliary equipment of a power station according to size and circumstances, it is only necessary to enumerate the apparatus employed. Thus it is possible to conceive of a station wherein the simplicity of the early marine engine is copied; where the boiler feed pump, air pump, and circulating pump are driven by levers from one of the main engine crossheads; a chimney produces all the requisite draft; ashes and coal are handled in all their stages by hand labor; and the exciter, if required at all is directly coupled to the generator shaft. Such a system, with the addition of a donkey feed pump or injector, is perfectly possible, and is approached, if not examplified, in many small stations. In fact, in non-condensing stations, a feed pump is the only really needful auxiliary. Its outstanding features are simplicity and thermodynamic waste.

In the opposite direction it is not unusual to find the following independently-driven pieces of apparatus: Exciters, feed pumps, air pumps, circulating pumps, exhaust (or other large) valves, cranes, ash hoists, coal hoists or conveyers, bilge pumps, boiler cleaning pumps, mechanical stokers, fans for induced draft, fans for generator ventilation, fans or pumps for cooling transformers, motor-operated switches, air exhausters for syphon circulating mains, air compressors for cleaning electrical apparatus, circulating water-straining appliances, economizer scrapers, oil pumps, and barring or engine-turning gear. Where what is known as a complete unit system is adopted, some of the above items are multiplied by the number of generators, resulting in an enormous aggregate installation.

Condensing Auxiliaries.

Assuming that for any condensing plant air and circulating pumps are required, it is of interest to consider the opportunity for simplification offered by the development during the last two or three years of rotary forms of air pumps. Whatever their merits or demerits as regards capacity for subduing air leakage on a system when contrasted with reciprocating pumps they possess two attractive attributes from the point of view of simplification in that (1) they occupy a very small space, and (2) they can be directly driven by any high-speed motive agent, whether electric motor or steam turbine. If it can be shown that they require no more maintenance than reciprocating pumps, which is reasonable to suppose from their exceedingly simple construction, a strong case for their adoption exists on these considerations alone. But where a complete use can be made of the exhaust steam, there is a further advantage in adopting a steam-turbine drive, as is shown in the following argument:—

Although such small turbines cannot be constructed to make any expansive use of steam below atmospheric pressure, by using the exhaust steam for feed heating advantage is at once secured even over a drive by electric motor. Let it be assumed that a small turbine is employed to drive on the same shaft the air pump circulating pump and water extraction or life pump attached to a main generating set. And for the sake of illustration let a plant of 3,000 kw. be considered. Then the power may be arrived at thus:—

Steam consumption, 42,000 lbs. per hour.

Circulating water, 65 times feed = 273,000 gallons per hour.

Head across circulating pump (for cooling tower conditions) 45 feet.

Power for circulating pump at 60% efficiency, 100 h.p.

Power for lift pump, dealing with condensed steam, and raising it 30 feet, with 50% efficiency, 1½h.p.

Power for air pump, 30 h.p.

Hence the power required for the combination is about 135 h.p.

At 35 lbs. per b.h.p. hour, the steam consumption of this auxiliary unit, exhausting at atmospheric pressure, is, therefore, 4,725 lbs. per hour. Such a quantity of steam would heat the feed water from 90 deg. to 200 deg. F. Thus the equivalent of $\frac{4725}{6.5}$ or 727 lbs. of coal per hour drives the circulating auxiliaries, and heats the feed 110 deg. F. The alternative, if electric drive be substituted for the small turbine, is 135 h.p. or 112 kw. at 3 lbs. = 336 lbs. coal for power, plus $\frac{4500}{6.5}$ = 692 lbs. of coal for feed heating. Total, 1,028 lbs. of coal as against 727.

Reciprocating air pumps are made with a high degree of efficiency, and may even take less power than the rotary type. But the power, small as it is in comparison with that of the main engine or turbine, is almost wholly dissipated in friction in reciprocating pumps, whereas it can be conserved in the form of heat in some forms of rotary pump, and where, as is the usual practice, separate motors or engines are used to drive the air and circulating pumps, the actual size of motor installed for a reciprocating air pump must is settled by the consideration that a reserve of power must be provided in the motor, unless dangerously heavy fuses are used to deal with the case of flooded pumps, such as occurs after a stoppage (from any cause) while the prime mover is running. This means additional cost, and (in the case of induction motors) a bad power factor. No such reserve of power is necessary with a rotary pump. Consequently, the method of independent motors with reciprocating air pumps involves not only two motors instead of one, but that one of those motors should be larger than necessary. This arrangement, too, is likely to consume more energy than a single motor for the combination, and a fortiori more than the steam-turbine drive, if feed heating is placed to the credit of the latter.

* Abstract of paper read before the North-East [illegible] Institution of Engineers and Shipbuilders and printed in the "Transactions" of the institution.

It will be noticed that in the example given above, cooling tower conditions were assumed in calculating the power of the circulating pump. Their absence would have reduced the power for the pump from 100 h.p. to perhaps 60 h.p., depending on the location of the source of water. Natural-draft towers are responsible, therefore, for an appreciable increase in the motive power installation, and fan-draft towers for a considerable increase.

Economizers.

The question of economizers is almost entirely one of thermal efficiency. It is interesting, therefore, to note that they have been excluded from much important American practice. They are, on the other hand, used extensively in British and Continental work, though to very different degrees. Heating surface may be arranged for either in a boiler or outside it, with the qualifications that if in a boiler, it must be made of steel; but if outside, it can be made of cast-iron; and further, that gases cannot, in a boiler, be cooled below the temperature of saturated steam at working pressure, or in some cases superheated steam. In most designs of boiler these limitations result in a standard form, and a temperatutre of outgoing gases between 450 deg. and 600 deg. F. Such a standard form is accepted—and properly so—as being the outcome of the boiler-maker's experience; and the additional heating surface is arranged for apart from the limitation due to the presence of saturated or super-heated steam. But, while a certain uniformity is to be found in boiler surface provided for a given output, the number of economizer pipes may vary from nothing up to 12 per 1,000 lbs. evaporated. This variation in practice may be accounted for by the space available; but it is often influenced by consideration of the draft necessary.

Draft.

Draft may be created either by a fan or by a chimney. Where there are peculiar conditions such as the existence of long and tortuous flues, or the absolute necessity for drafts upwards of 1½ in., the question is settled automatically in favor of the mechanical method, practical considerations making it impossible to create a high draft by chimney alone. With a chimney the gases cannot be cooled below a certain temperature; otherwise insufficient draft will result. On the other hand, with a fan, gases may be cooled to any degree desired. Practical limitations are soon set in this direction by the space occupied by the economizer; and the result is that, though at first it might be expected that natural draft would necessarily be associated with smaller economizers than mechanical draft, in practice examples can be found of natural draft stations employing as large an economizer surface as even modern fan-draft installations. The mechanical arrangement has, however one advantage in facility of regulation independently of the weather, and in rendering a short chimney practicable.

The value of control over the draft cannot be assessed except in general terms by those who have had extended experience with both methods. Apart from this, the cost of power absorbed by the fans much outweighs the difference in capital charges due to a high natural-draft stack, as the following illustration, applicable to installations of about 10,000 kw. shows:—

For natural draft—	
Cost of chimney 250 feet high, with foundations	£3,000
For mechanical draft—	
Cost of chimney 100 feet high, with foundations	£1,200
Cost of fans and motors and extra flues........	1,400
	£2,600
Balance of capital expenditure in favor of mechanical system	£ 400
Representing an annual charge, at 15%., of........	£ 60
Against this is to be set running costs of motors, calculated on 200 h.p. for 5,000 hours at 0.25d. per unit	£ 780

The circumstances of load may, however, demand great elasticity in the steam-raising plant, in which case mechanical draft takes the place of additional boilers, and so may justify itself. Moreover, under normal conditions combustion is effected more economically with a high draft, if boiler and economizer surfaces are ample, less air of dilution being required per pound of coal.

The foregoing discussion is applicable only in cases where very moderate drafts are sufficient; and little variation is called for. The more usual case with an installation supplying power for general uses is that a certain latitude of draft is necessary for the purposes of the load, but the obstruction due to large economizers, coupled with the reduction at the chimney caused by lowering the temperature of the gases would result in insufficient difference of air pressure at the grate. In such cases the choice must be between natural draft with small economizer, or mechanical draft with large economizer; and the following treatment is put forward as being applicable.

The conditions assumed are as follows:—

Gases issue from boilers at....................	550° Fahr.
Air per lb. of coal, on average....	23 lbs.
Temperature of atmosphere	60° Fahr.
Specific heat of products of combustion.........	0.25

In the case of fan draft, it is further assumed:—

Gases leave economizer and enter fan at..	320° Fahr.
Maximum water gauge required at fan.........	3 inches.
Usual water gauge required at fan............	2 inches.
Efficiency of fan, 50% per cent. on average.	

In the case of chimney draft:—

Gases leave economizer at...........	450° Fahr.
Height of chimney	220 feet.

Then heat rejected from boiler per ton of coal fired is $(2,240 \times 24 \times 0.25) \times 490$, or 6,585,600 B.T.U. In the case of chimney draft the economizer absorbs $(2,240 \times 24 \times 0.25) \times 100$, or 1,344,000 B.T.U., and of this amount about 70 per cent., i.e., 940,800 B.T.U., is conveyed to the feed water, the balance being dissipated in flues, radiation and influx of cold air through economizer chain holes. In the case of fan draft, the power of the fan to create 3 in. water column, with an assumed efficiency of 50 per cent., may be found to be 16.6 h.p. per ton of coal burned per hour.* The usual h.p. required is, therefore, $16.6 \times ⅔$, or 11 h.p. per ton of coal per hour. The number of B.T.U. required to produce this energy, by way of boiler, turbine, alternator, transformer, and motor, with a combined assumed efficiency of 10 per cent., is $\frac{2,545 \times 11}{0.1}$ or 280,000 B.T.U. The quantity of heat usefully absorbed by economizer is $(2,240 \times 24 \times 0.25) \times 230 \times 0.7$, or 2,170,000 B.T.U. Consequently, of the total heat rejected from the boilers per ton of coal burned per hour, viz., 6,585,600 B.T.U., the natural-draft

* Height of column of heated products of combustion equivalent to 3 inches water column = 306 feet. Maximum horse-power required, with efficiency of 50%—

$$\frac{306 \times 24 \times 2,240}{60 \times 33,000 \times 0.5} \text{ or } 16.6 \text{ h.p. per ton per hour.}$$

method, with small economizer, realizes 940,800 B.T.U., while the fan method, with large economizer, realizes 2,170,-000; less power to fan 280,000 = 1,890,000 B.T.U., or about double. Thermodynamically, therefore, under the assumed conditions, there is a gain of over 3½ per cent., really due to the use of the large economizer which is made possible by mechanical draft.

Next, as to the relative cost of the arrangements. This will vary in every case, and no two opinions on the matter will be the same. On the basis of an evaporation of 60,000 lbs. steam per hour, or a combustion rate of 3.84 tons of coal per hour, the capital cost of a fan installation with economizer of 9.6 pipes per 1,000 lbs. evaporated per hour, and short chimney, will be found to be, roughly, the same as for a natural-draft installation with 220 feet chimney and economizer of four pipes per 1,000 lbs., viz., £1,800. Capital charges can, therefore, be left out of a comparison, which might take the following form:—

	Per 60,000 lbs. Steam per Hour.	
	Mechanical Draft. £	Natural Draft. £
Saving of heat expressed as coal at 8s. per ton, 12,000 B.T.U. per lb., and 80% efficiency of evaporation........	774	336
Maintenance	180	108
Power reckoned for 5,000 hours at 0.25d..	255	16
	435	124
	£339	£212

showing an advantage, in the case of mechanical draft, of £127 per annum. To this saving, which will obviously be greater still with greater load factors and in districts where coal is dear, must be added, for whatever it is worth, the convenience of being able to control draft independently of atmospheric conditions, and to force it to a degree unattainable with any chimney. It may be argued that this proposition depends entirely upon the manner in which the capital expenditure is made up. In the example cited above, variation of 25 per cent. in calculating the capital cost made, so as to swell the mechanical cost and reduce the other, would just about make the final results equal. But even in that case there would remain the practical advantages indicated.

Cost of Auxiliary Power.

Of more importance is the objection that an increase of the cost of power from 0.25d. to 0.38d. would extinguish the saving altogether. And this leads us to enquire what is the cost of power for auxiliary purposes. For most calculations it may be taken as the cost at generator terminals, plus some addition for transformation if necessary; less wages, as these are practically unaffected by the small proportion of output used on the station. The cost thus resolves itself into coal repairs and capital charges on generating and transforming plant. Many stations can now produce energy at 3 lbs. of coal per unit—some, of course, for much less—but at that figure and 8s. per ton the coal cost is 0.13d. Capital charges, at 15 per cent. on £15 per kw. with load factor 40 per cent., amount to 0.154d., repairs to 0.02d., making a total charge, for auxiliary power, of 0.304d. The figures adopted here are liberal with respect to good modern practice, and the price of 0.25d. assumed in former calculations, if low, is not by any means unattainable. On the whole, it would seem that the deciding factor in settling the matter of draft is the nature of the load. In isolated cases such a question as ability of the ground to carry a high chimney might be important—or again, the quality of ease in removal might recommend a short chimney and fan.

Feed Pumps.

It is only by elasticity of definition that feed pumps can be regarded as apparatus to render a thermodynamic principle advantageous. Yet they do not fall naturally into any other subdivision, being rather one of the main organs for carrying out the cycle. The power station designer has here a wide choice, between steam and electrical drive, and between reciprocating and rotating pumps. The latter possess many of the advantages of rotary air pumps already discussed, and practicable forms have been evolved. Such pumps, in respect of minimum wear, absence of valves, elimination of shocks to feed pipes and check valves, inseparable from reciprocating pumps, are almost ideal for power station work.

If a rotary pump can be combined with the circulating auxiliaries already described, and the whole be driven by a turbine on one shaft, a peculiarly compact and economical piece of apparatus results. There are naturally drawbacks in giving effect to this idea: one is that it may be difficult to find one speed suited to four different rotating objects; to a circulating pump, which may possibly have to deal with seventy times as much water as the feed pump, or to an impeller drawing against 29 inches vacuum and one delivering against 250 lbs. pressure.

Though not necessarily dependent upon rotary feed pumps, the closed-cycle system, whereby the feed water is at no stage exposed to the atmosphere, is rendered so much more attractive by their use that it may be noticed here. The idea underlying its application is that by reducing or altogether eliminating the aeration of the feed much trouble with economizers, feed pipes and boiler shells may be prevented. Since the feed is at no stage exposed to view as a current, it cannot be measured by the ordinary methods, and where anything more accurate than a Venturi tube test is required, an alternative arrangement of pipes must be installed for diverting the feed to the test tanks or recorders. For this reason it cannot be heated at atmospheric pressure, and surface heaters are, therefore, necessary. Then some elasticity is required between the discharge of the extraction pump and the suction of the feed pump to meet the case of boilers not requiring, minute by minute, exactly the same quantity as the steam condensed. And again, make-up feed for wastage has to be provided for. There are two or three methods of meeting these points. The simplest, but also the crudest is to provide a relief valve on the feed discharge, and regulate the admission of make-up feed to the condenser by hand. A more elegant suggestion, due to Mr. Sargent, and shown in Fig. 1, is to provide a tank into which the extraction pump delivers, and from which the feed pump draws. The tank is furnished with an overflow to a main reserve tank below, and a float mechanism controlling a make-up feed valve from reserve tank to condenser. When there is a surplus of water discharged from the condenser it overflows to the reserve tank, and when there is a shortage the float valve opens the connection from reserve tank to condenser. In this manner the system is rendered absolutely automatic, while the external make-up for wastage can be introduced by a float-controlled valve in the reserve tank fixed at a suitable level. By introducing the external make-up at this stage it becomes completely de-aerated before reaching the feed pump. Some stand-by pumping plant might be required for the case of banked fires.

In Fig. 2 is shown an alternative suggestion, proposed by Mr. Fullagar, with a tank floating, as it were, between the two pumps, but no provision is made here for de-aerating the make-up feed.

(To be continued.)

PROCESSES OF PULPWOOD MANUFACTURE.

In Quebec, seven-tenths of the wood used for pulpwood was spruce, balsam fir made up 28 per cent., and the remainder consisted of small quantities of hemlock and poplar. Both Quebec and Nova Scotia cut the four species used for pulpwood in Canada. No hemlock was reported from Ontario, in which province 90 per cent. of the consumption was spruce and the remainder was balsam fir. Spruce made up four-fifths of the consumption in Nova Scotia, balsam being used for practically all the balance. New Brunswick used spruce only.

Nearly four-fifths, namely, 78 per cent., of the pulpwood manufactured in Canada in 1910 was manufactured by the mechanical process; the sulphite process produced one-fifth, and the remainder (2 per cent.) was manufactured by the soda process. Quebec made 63 per cent. of the total mechanical pulp in Canada—more than twice as much as did Ontario. Of sulphite pulp, Ontario produced the most, although Quebec was a close second. The latter province manufactured over three quarters of the pulp made by the soda process.

Spruce, as in former years, was the chief wood used in each process. Over two-thirds (68.8 per cent.) was used for mechanical pulp; over one-quarter (28.7 per cent.) was made into sulphite pulp, and the remaining 2.5 per cent. was manufactured by the soda process.

Balsam fir has not yet been used in the soda process and is used to almost the same extent with the two other processes. The mechanical process consumed some 53 per cent. of this wood, while 47 per cent. was manufactured by the sulphite process. Eighty-four per cent. of the hemlock was manufactured by the soda process, which is adapted for most species of wood. One sixth of the hemlock was used to make mechanical pulp.

The physical properties of poplar wood do not adapt it for grinding by the mechanical process, and practically no poplar was manufactured by this process during 1910. It was used in almost equal quantities by the other two classes of manufacturers. Ontario manufactured a little by the soda process; only ground pulp was made in Nova Scotia; while New Brunswick produced small quantities of both sulphite and soda pulp.

Pulp manufactured by the mechanical process forms a greater percentage of the total during 1910 than at any time in the past. In the United States the percentage of ground pulp used is decreasing. The cause of the increase this year in Canada is probably due to the interruption of manufacture by the sulphite mills of New Brunswick. Unlimited supply of clean water is a necessity in the manufacture of wood by the mechanical process. A species of wood is also required which has a long loose fibre, which will not lose its shape and texture in the grinding. For these reasons Quebec with its spruce and balsam fir tracts and numberless waterfalls is the province best adapted for mechanical pulp manufacture.

Spruce furnished 83.2 per cent. of the wood used for mechanical pulp, and balsam fir contributed 16.6 per cent., with small quantities of hemlock and poplar making up the balance. The average cord of wood reduced by the mechanical process in Canada during 1910 produced 1,908 pounds of pulp. This is 257 pounds more per cord than was produced last year, but such comparisons depend greatly on the relative condition of air-dryness of pulp. Slightly over half this amount of pulp is produced per cord of wood by either the sulphite or soda processes, but the quality of texture is much better. The paper used in the average newspaper of to-day is compos.d of about twenty-five per cent. of sulphite fibre and seventy-five per cent. of the ground wood fibre made by the mechanical process.

In British Columbia, experiments are being carried on with the sulphite process, and, in 1910, 440 cords of spruce were used in the manufacture of paper. Seventy per cent. of the wood used in the sulphite process was spruce, mostly from Ontario. Balsam fir furnished 29 per cent., about three-quarters of which was from Quebec, and the same province used 1,800 cords of poplar to make sulphite pulp. The average production of pulp for every cord of wood used in the sulphite process during 1910 was 997 pounds.

Canada has the distinction of having the oldest soda mill in America, although the process is, at present, not in general use, and is found in only a few small mills. The production by this process, however, will shortly be increased by the completion of a large new mill, for the manufacture of 'Kraft' paper from soda pulp.

The soda process was the principal method used in the reduction of hemlock. Small quantities of spruce and poplar were also used in 1910. Balsam fir, however, is not suited to this process. Of the total, spruce formed 71 per cent.; hemlock, 19 per cent., and poplar, 10 per cent.

Quebec manufactured over three quarters of the pulp made by the soda process; 17 per cent. of the soda pulp was from New Brunswick, and 1,100 cords of poplar consumed by this method in Ontario made up seven per cent. of the total.

The average amount of soda pulp produced per cord was 987 pounds, or 10 pounds less than by the sulphite process.

The annual consumption of pulpwood per mill in Canada, during 1910, was 11,735 cords, as compared with a consumption of 12,442 cords per mill in 1909. The largest mills are those in Ontario, which used an average of 14,037 cords per mill. The average consumption per mill in Quebec was 13,710 cords; in Nova Scotia, 4,934 cords, and in New Brunswick, 3,783 cords.

Canada's foreign trade in pulpwood and wood-pulp is growing greater. Unfortunately, the tendency is still to export wood in the raw form of pulpwood rather than in the manufactured form of wood-pulp. This is a direct loss to the country, for the increased value due to manufacture is given away. In 1910, for the first time, $49,000 worth of pulp was imported into Canada, four-fifths of which was from the United States.

Although pulpwood production was less in Canada during 1910 than during the year previous, exportations of wood-pulp were increased by 48,233 tons. Wood-pulp exportations amounted in 1910, to 69.3 per cent. of the total amount produced in Can da, whereas in 1909 it was only 63 per cent. Of the 328,977 tons of wood-pulp exported, 288,807 tons, or 87.8 per cent., was mechanical pulp, which is a little greater percentage than in 1909. Only 78 per cent. of the pulp manufactured in Canada was mechanically prepared. While the increase in export for 1910 consisted of mechanical pulp, 1,173 tons more of chemical pulp also were exported in 1910 than during 1909. The 40,170 tons of chemical pulp shipped made up 12.2 per cent. of the total export.

The average value per ton of the pulp exported in 1909 was $14.67 for the mechanical, and $36.35 for the chemical pulp. This is an increase over the 1909 price of 70 cents for the mechanical, and a decrease of $2.64 for the chemical pulp. The average price for all pulpwood exported was $17.31, or 14 cents less per ton than the previous year's price. The prices per ton paid to Canadian exporters by the different importing countries were as follows for mechanical pulp: United States, $16.09 (exactly the same as in 1909); United Kingdom, $15.78 ($5.52 more than in 1909); other countries, $10.35 (37 cents more than in 1909). For chemical pulp: United States, $36.32; United Kingdom, $41.60; other countries, $38.30.

During 1910, over three-quarters of the wood-pulp exported went to the United States. This country took 74.3 per cent. of the mechanical pulp, and over 99 per cent. of the chemical pulp exported from Canada in 1910. Except for an increase of 3,000 tons of mechanical pulp to small transatlantic countries, export to other countries decreased. The export of chemical pulp to the United Kingdom has declined from 7,519 tons in 1908, to 178 tons (not one-fortieth as much) in 1910. The mechanical pulp shipped to the British Isles also decreased by 16,407 tons during 1910. The United Kingdom received in 1909, 32.5 per cent. of the mechanical pulp exported from Canada while in 1910, only 21.5 per cent. of the amount exported was used in those countries.

BRITISH COLUMBIA'S COAL MINES.

British Columbia's production of coal, estimated at 2,435,000 long tons, is 365,000 tons less than that of 1910. Coke also shows a decrease of about 140,000 tons; the output in 1911 was only about 78,000 tons as compared with 218,000 tons in 1910. The coal was produced in the several districts in the following approximate proportions:—Vancouver Island, 1,785,000 tons; Nicola Valley and Similkameen, 225,000 tons; and South-East Kootenay, 425,000 tons. Practically all the coke was from the last-mentioned district. The effects of the strike of the coal-mine and coke-oven employees on the production of coal and coke in the Crowsnest District, South-east Kootenay, has already been mentioned; in quantities of products it brought about this position: there was a decrease (net) of 605,000 tons of coal and 140,000 tons of coke. As the net decrease for the whole province was 365,000 tons, it will be seen that in other districts the decrease from the Crowsnest collieries was in part offset by increases in other parts—in the output of Vancouver Island, Nicola Valley and Similkameen coal mines.

Of the average yearly value of the mineral production of the province for the last five years, the production derived from coal and coke has been about 35 per cent. of the whole, while for the year 1911 it was nearly 39 per cent., and this despite the decreased output of the Crowsnest mines. It is true that the output of the collieries for 1911 is considerably less than for 1910, but the year 1910 was the record year in the history of coal-mining in the province, with a production valued at $11,108,335. The output for 1911, with its total value of $8,987,500, in the proportion of $8,522,500 for coal and $465,000 for coke, is second only to that of 1910, and is greater than that of any other year.

No branch of the mining industry of British Columbia appears to have a better prospect for expansion and consequent enlargement of production than that of coal-mining. A gratifying feature in this connection is that the promise of extending operations and increasing the output is general; that it appears evident that all the coalfields in which there has already been production may be expected to show a steady increase in output. That this is so will be manifest if attention be turned to local conditions in these several fields.

Briefly reviewing these conditions it may be noted that recent progress has been general. On Vancouver Island, the Western Fuel Company made the largest production in 1911 it has ever made; not only so, but a new mine is being opened, which it is expected will commence production next autumn, and be rapidly developed to a producing capacity of 1,200 to 1,500 tons a day. At the mines of the Canadian Collieries (Dunsmuir), Limited, there is also evidence of much progress, especially at its Union colliery, in the Comox District, where a new shaft mine is being opened and hydro-electric power for use at the mines is being developed. Production returns for 1911 have not yet been received from the last-mentioned company. It is expected the output of coal in 1911 was not less than 900,000 long tons. The Pacific Coast Mines, Limited, increased the output from its Fiddick mine at South Wellington, and further developed its Suquash mine in the northern part of Vancouver Island. The Vancouver-Nanaimo Company also made headway, for it arranged to provide shipping facilities at tidewater and to add to its coal-mining plant.

In both the Nicola Valley and Similkameen Districts progress was also noticeable, additions having been made to the coal-mining plants, and the output of coal in 1911 was larger. The Nicola Valley Coal and Coke Company increased its output from 141,000 long tons in 1910 to about 190,000 tons in 1911, and enlarged its coal-handling plant to a capacity of 1,000 tons a day. Three other coal properties in the Nicola Valley also had development work done on them in preparation for mining coal on a commercial scale, though as yet their production remains comparatively small. Coal was reached by a long crosscut tunnel on the property of the Columbia Coal and Coke Company, situated between Granite Creek and Collins Gulch, in the Tulameen Valley, and the work of equipping this mine with plant and machinery is in progress, while railway transportation has already been provided. At Princeton, the Princeton Coal and Land Company has made arrangements with a coal-mining machinery firm to supply a tipple and other equipment, the handling capacity to be 500 tons of coal a day and the plant to be ready for use early in 1912.

In East Kootenay, apart from the suspension of production while the employees were on strike, there were interesting developments. The Crow's Nest Pass Coal Company opened three or four practically new mines at its Coal Creek colliery, and it is claimed that from these a comparatively large quantity of coal of excellent quality can be mined. This company also did some effective prospecting at its Carbonado colliery, where new seams were found, and the work done on some of the old seams led to the hope that mines can be opened there in ground where the rock-structure is more favorable to mining coal. At the Hosmer colliery, of the Hosmer Mines, Limited, another level has been made along the outcrop of the coal-seams, about 500 feet above the level of the main entry to the mine, and facilities have been provided for transportation of the coal down to the main incline and thence to the shipping tipple. At the Corbin Coal and Coke Company's colliery an enormous deposit of coal has been opened at the surface and preparations have been made to work this coal open-cast, literally like a quarry. This most unusual occurrence of coal is situated at an elevation of from 800 to 1,200 feet above the main entry to the mine, in which latter the body of coal is also of great size, having a maximum width of about 300 feet.

There was little change in the situation affecting the large coal areas of the upper Elk River region of the Crowsnest District, described in the annual report of this department for 1909, for railway transportation has not yet been provided, and until it shall have been there will not be any commercial production of coal in that part of the province.

Concerning coal in the Skeena country—here, too, there can be no production until after railway transportation shall have become available. Public attention has been directed to what is known as Groundhog Basin, where the occurrence of much anthracite coal is known. A press bulletin, issued recently by the Geological Survey of Canada, gives information relative to this field, as follows: "Considerable interest has been manifested during the past season in the Groundhog coal-basin, which lies at the head of Skeena River. Probably 600 square miles have been staked and several groups of capitalists are interested in the field. Mr. G. S. Malloch, of the Survey Department, who spent the summer investigating the southern end of the basin on behalf of the Geological Survey, furnishes the following notes on this new coalfield:—

"'The coal-measures so far as known have a northwestward extent of at least seventy miles, and a width at the southern end of thirty miles. The sediments have a thickness of upwards of 3,000 feet, but contain coal in commercial quantities near the top and bottom only, though there are a few thin seams in the intermediate beds. The upper horizon contains seven seams with thicknesses varying from 2 to 6 feet, and, so far as is known, is limited to an area of twenty square miles. The lower horizon contains at least three seams 4 to 6 feet thick, and extends over most of the area occupied by the coal-measures.

The coal is anthracite in character. Some of the seams are high in ash, but from one of them some excellent analyses have been obtained. The basin is faulted considerably, and there are numerous local flexures associated with the faults. The development of a coalfield of this character near the Pacific coast would be of great importance to British Columbia. It lies about ninety (nearer 140) miles from tidewater at Stewart, Portland Canal, along a possible route for a railway, and about 150 miles from Hazelton on the Grand Trunk Pacific railway.'"

On Graham Island of the Queen Charlotte group prospecting of the coal-measures was done, but no coal was mined for the market. A Vancouver company bored for oil on the west side of that island.

With the considerable growth of the Coast cities there has been a correspondingly increased demand for building-stone, brick, lime, cement, etc. Various quarries from which granite, sandstone, andesite, and other building-stones are obtained had considerable demands made upon them. No marble was quarried at Nootka, but the marble-quarry situated about eight miles from the head of Kootenay Lake was re-opened and marble again shipped from it. The Vancouver Portland Cement Company, with works on Vancouver Island, made much cement.

PERSONALS.

MR. H. W. D. ARMSTRONG has been appointed to the position of chief engineer on the Gibson and Minto Railway.

MR. P. S. WEISBROD has been appointed to the position of superintendent of the Canadian Pacific Railway at Moose Jaw, Sask. He was formerly trainmaster at Cranbrook, British Columbia.

MR. ANGUS SMITH has been appointed to the position of city engineer for the municipality of North Vancouver, B.C. For over two years Mr. Smith has held a similar position in Victoria of the same province.

MR. ALEXANDER B. MANSON has been appointed to the position of city engineer for the municipality of Stratford, Ont. For some time Mr. Manson has been superintending construction work for the Canadian Northern Railway near Gowganda Junction, Northern Ontario.

OBITUARY.

MR. GEORGE ALEXANDER KEEFER, according to report received from Victoria, B.C., is dead. Mr. Keefer was a well-known civil engineer and was district engineer of the Department of Public Works of Canada in British Columbia. He entered the government service in 1872, on the preliminary surveys for the C.P.R. and the Rocky Mountains. For a time afterwards he was engaged on general engineering work in Vancouver, but since May, 1900, has been with the Dominion Government. Mr. Keefer was 76 years of age.

MEETINGS.

The regular meetings of the Western Canada Railway Club was held in the city of Winnipeg on the evening of April 8th last. A paper on "The Passenger Department," read by Mr. W. P. Hinton, general passenger agent of the Grand Trunk Pacific Railway, formed the major portion of the evening's programme.

In the course of his address the speaker stated that the organization of a general passenger department may be comparatively simple as it is on a small line or very complex, but nevertheless firmly welded together and carefully shepherded, on a large line. The department proper may be divided into the following branches: Traffics, tickets, excursions; statistics and accounts; train schedule and equipment; advertising; tourist, immigration and colonization; baggage; dining, sleeping and parlor cars.

A detailed description of the various sub-departments followed and concluded the paper.

CANADIAN RAILWAY CLUB MEETING.

The regular monthly meeting of the Canadian Railway Club was held in the city of Montreal on April 9th last. The speaker of the evening was Mr. A. R. Roy, Ph.D., who addressed the gathering on the subject of "Swedish Steel."

In the course of his lecture the speaker first defined steel as an alloy of impure iron and carbon, and then led his audience to a consideration of why one steel with similar apparent analysis possessed different qualities, and stated that there were three answers to this question.

1st. Incorrect analysis, showing equality, when not equal, of the composing factors of the various steels.

2nd. More skillful manufacture. This includes the better experience and practise of the workmen, as well as higher excellence of apparatus and mechanical conditions, such as fuel, etc.

3rd. The undetected presence of enchancing factors or beneficial elements.

The latter possibility received the major portion of the consideration on the part of the speaker.

It is noticeable, he continued, that iron brought from Spain, the Urals, America, Germany, France and Sweden produces different qualities of steel, although the analysis, so far as is known, is exactly the same and all other conditions equal and identical. Yet there is a decided difference in the quality of the steels, for one will do better than another when put to work on the same piece of material, at the same rate of speed, and given the same depth of cut and an equal amount of lubrication. All the composing factors of the steel are supposed to be equal in proportion. Where is the undetected factor?

Steel is a complex alloy, not merely of Fe. & C. but of the complex combinations of Fe. & C. known as Ferite &

Cementite, and Silicon as a base. To this, other elements such as Vd, Wo, Ni, Ti, Mn, etc., are added. Of these only C. & S. are found pure and free in nature but all of the elements can be separated at a certain stage in the laboratory. Iron is never found pure in nature. Late discoveries have detected various foreign elements in combination with iron. Therefore, it must be in the iron that the difference lies. Especially as the phenomenon of variance is found only between the steels produced with irons of different localities. In proof of which experiments have shown that Swedish steel or steels made from a Swedish iron ore base, are able to do more and better work than any other kind of steel. We also know that the Swedish iron ore, in its natural state, is freer from the detrimental combinations of sulphur, phosphorus and nitrogen, etc., than any other ore found on the European continent or America. But even when these harmful elements were removed or reduced to the proportions found in Swedish iron ore, the quality of the steel, although greatly improved, was not found equal to the product compared with, that is Swedish steel.

The presence of varying quantities of vanadium was given as the main reason for the variances.

COMING MEETINGS.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—May 22nd-25th. Annual Convention at Chicago, Ill. Secy., D. B. Sebastian, La Salle St. station, Chicago.

FOURTH NATIONAL CONFERENCE ON CITY PLANNING.—May 27th-29th. Meeting, Public Library, Boston, Mass. Sec'y, Flavel Shurtleff, 19 Congress Street, Boston, Mass.

AMERICAN WATER WORKS ASSOCIATION.—June 3rd 8th. Annual Convention at Louisville, Ky. Secy., J. M. Diven, 271 River St., Troy, N.Y.

CANADIAN ELECTRICAL ASSOCIATION.—June 19th-21st. Annual meeting at Ottawa, Ont. Sec'y, T. S. Young, 220 King St. West, Toronto, Ont.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—June 26th-28th. Annual meeting at Boston, Mass. Sec'y, H. H. Norris, Cornell University, Ithica, N.Y.

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

CANADIAN PUBLIC HEALTH ASSOCIATION.—Second Annual Meeting to be held in Toronto, Sept. 16, 17 and 18.

ENGINEERING SOCIETIES.

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

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

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

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

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

VANCOUVER BRANCH—Chairman, C. E. Cartwright; Secretary, W. Alan, Kennedy; Headquarters: McGill University College, Vancouver.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-jack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

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

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

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

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

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

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

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

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

UNION OF ALBERTA MUNICIPALITIES.—President, Mayor Mitchell, Calgary.; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

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

CANADIAN TECHNICAL SOCIETIES

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

CONSTRUCTION NEWS SECTION

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

PLANS AND SPECIFICATIONS ON FILE.

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

Bids close		Noted in issue of
5-25—Sanitary sewer, Islington, Ont.	(P. & S.)	5-16
5-29—Water works, sewerage and electric light systems, Melfort, Sask.	(P. & S.)	5-2
6-10—Electrical equipment, Vernon, B.C.	(S.)	5-16
6-3—Electric Generating Station Equipment, Bassano, Alta.	(S.)	5-16

(Bassano specifications also on file at the office of The Canadian Engineer, Montreal).

(Melfort plans and specifications are also on file at The Canadian Engineer Offices, 820 Union Bank Building, Winnipeg, and B33, Board of Trade Building, Montreal).

(Vernon specifications are on file at The Canadian Engineer Offices, Winnipeg and Montreal; Canadian Electrical News, Toronto; Contract Record, Toronto; Mather, Yuill & Company, Limited, Consulting Engineers, Vancouver, B.C.)

TENDERS PENDING.

In Addition to Those in this Issue.

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

Place of Work.	Tenders Close.	Issue of.	Page.
Australia, steel rails and fish plates	May 29.	May 2.	60
Bassano, Alta., electric generating machinery	June 3.	May 16.	66
Fredericton, N.B., wharf	June 4.	May 16.	60
Hamilton, Ont., castings, meters, etc.	May 30.	May 2.	72
Hamilton, Ont., motors, turbine pumps, etc.	June 3.	May 16.	74
Islington, Ont., sewer	May 25.	May 16.	66
Lebret, Sask., school house	May 31.	Apr. 25.	61
Lunenburg, N.S., sewerage system	June 1.	May 9.	60
Melfort, Sask., waterworks, sewerage, etc.	May 29.	May 2.	72
Melfort, Sask., school building	May 29.	May 16.	60
Moose Jaw, Sask., water works fittings	May 30.	May 16.	74
Moose Jaw, Sask., retaining wall and sidewalks, Collegiate Institute	June 5.	May 16.	60
Ottawa, Ont., coaling stations	May 31.	May 9.	72
Ottawa, Ont., station and other buildings	May 31.	May 9.	74
Ottawa Ont., designs for monument	Oct. 1.	Apr. 18.	60
Ottawa, Ont., fishing protection vessel	June 17.	Apr. 18.	74
Ottawa, Ont., design and construction of steamship	June 30.	May 16.	76
Owen Sound, Ont., wharf	June 4.	May 16.	60
Port of Quebec, Que., proposals for drydock	July 2.	Apr. 18.	60
Point Grey, B.C., plans for university	July 31.	Feb. 7.	60
Quebec, Que., leasing of waterpowers	June 26.	May 2.	72
Saskatoon, Sask., garbage incinerator	June 25.	May 2.	74
Sault Ste. Marie, Ont., sewerage works	May 27.	May 9.	76
Sault Ste. Marie, Ont., approach to wharf	June 4.	May 16.	60
Sault Ste. Marie, Ont., cement walks	May 27.	May 9.	76
St. Lazare, Man., bridge	May 24.	May 16.	60
Toronto, Ont., bridge	May 23.	May 9.	72
Toronto, Ont., bridge	May 25.	May 16.	72
Toronto, Ont., cast-iron penstocks	June 4.	May 9.	74
Toronto, Ont., storm overflow sewer	June 4.	May 16.	72
Trout Cove, N.S., breakwater	May 23.	May 9.	60
Upper Maugerville, N.B., wharf	May 23.	May 9.	60
Vancouver, B.C., bridging, grading, etc.	May 31.	May 9.	62
Vernon, B.C., electrical equipment	June 10.	May 16.	72

TENDERS.

Bassano, Alta.—Tenders for electric generating station equipment will be received until June 3rd, 1912. Specifications at the offices of The Canadian Engineer, Toronto and Montreal. (See advt. in The Canadian Engineer).

Belbeck, Sask.—Tenders will be received up to noon of May 23rd, 1912, for plans and specifications for the erection of a 40,000-bushel elevator for grading-in purposes at Belbeck. W. H. Beesley, Box 74, Belbeck, Sask.

Berlin, Ont.—Tenders for waterworks improvements at Berlin, Ont., will be received by the Water Commissioners. (See advt. in The Canadian Engineer).

Kenora, Ont.—Tenders for the erection of a fire hall in the town of Kenora, will be received up to noon of Friday, May 31st, 1912. Plans and specifications at the Town Office, Kenora, Ont. M. McCulloch, Clerk.

Montreal, Que.—Tenders will be received until June 1st, 1912, for the construction of a steel and cement bridge over Bevan's Creek, in the Township of Arundel, Argenteuil Co., P.Q.; length of span, 50 feet. Plans and specifications may be seen at the office of Cushing & Barrow, 112 St. James Street, Montreal, or at the office of the secretary-treasurer. Wm. Thompson, secretary-treasurer, municipality of Arundel, Quebec.

Montreal, Que.—Tenders will be received by the Board of Commissioners, City Hall, up to noon of May 28th, 1912, for the construction of sewers on the following streets:—

Beresford Street, from Rushbrooke to Wellington.

Western Avenue, from city limits eastwards.

St. Charles Street, from Dorchester Street to its limits.

Sterling Avenue, from Cote Ste. Catherine Road to its limits.

Madison Avenue, from Sherbrooke Street northwards.

Belgrave Avenue, from Canadian Pacific Railway to Sherbrooke Street.

De Repentigny Street, River St. Lawrence to its limits.

De Grosbois Street, from Azilda to De Repentigny.

Bellevue Street, from De Rocheblave, 250 feet eastwards.

Lebrun Avenue, River St. Lawrence to its limits.

Cadillac Street, from Montreal Terminal Railway, to 1,100 feet north of Sherbrooke Street.

Fortune Street, from Wellington to Favard Street.

Full information can be obtained in the office of the Engineer Superintendent of Sewers. L. N. Senecal, secretary, Board of Commissioners, City Hall, Montreal.

Montreal, Que.—Tenders for the supply and delivery of granite and artificial paving blocks, will be received by the Board of Commissioners, City Hall, until noon of May 29th, 1912. Specifications, etc., may be obtained from the Sales & Purchasing Agent, City Hall. L. N. Senecal, secretary, Office of the Board of Commissioners, City Hall, Montreal.

Moose Jaw, Sask.—Tenders will be received until May 27th, 1912, for the laying of approximately 6,700 feet of 12-inch cast-iron pipe. Plans and specifications may be obtained from J. Antonisen, City Engineer. A. W. Maybery, L. W. Rundlett, W. F. Heal, City Commissioners, Moose Jaw.

Moose Jaw, Sask.—Tenders for cast-iron pipe and specials, will be received up to noon of June 1st, 1912, by the City Commissioners. (See advt. in The Canadian Engineer).

Moose Jaw, Sask.—Tenders will be received by the City Commissioners up to noon of June 1st, 1912, for the supply and delivery of valves and hydrants, f.o.b. cars, Moose Jaw. (See advt. in The Canadian Engineer).

Moose Jaw, Sask.—Tenders for the delivery f.o.b. cars, Moose Jaw, of sewer pipe and specials, will be received by the City Commissioners up to noon June 1st, 1912. (See advt. in The Canadian Engineer).

Ottawa, Ont.—Tenders for dredging Toronto Harbor, Ont., will be received until June 4th, 1912. Combined specification and form of tender can be obtained on application to R. C. Desrochers, secretary, Department of Public Works, Ottawa. (See advt. in The Canadian Engineer).

Ottawa, Ont.—Tenders for the construction of a pile wharf at Edmonton, Alta., will be received until June 17th, 1912. Plans, etc., at the offices of F. G. Goodspeed, Esq., District Engineer, Emonton, Alta. L. B. Elliott, Esq., Acting District Engineer, Calgary, Alta., and at the office of R. C. Desrochers, secretary, Department of Public Works, Ottawa.

Ottawa, Ont.—The Department of Public Works, Ottawa, is open to receive tenders for the supply of sorting cases for post offices, until May 30th, 1912. Plans, etc., to be seen on application to Mr. T. A. Hastings, Clerk of Works, Postal Station "F", Toronto and at the Department of Public Works, Ottawa.

Port Arthur, Ont.—Tenders will be called for shortly for the Sailors' Institute. Estimated cost, $30,000. Mr. Potter, Upper Canada Tract Society, Toronto, superintendent; F. Urry, Port Arthur, architect.

Regina, Sask.—Tenders for all of the works required and necessary in connection with the erection and completion of Westminster Church, Regina, will be received until May 27th, 1912. Plans and specifications may be seen at the office of N. R. Darrach, architect, Western Trust Building, city. J. J. McRae, Secretary, Building Committee, Box 455, Regina, Sask.

Regina, Sask.—Tenders will be received up to Tuesday, May 28th, 1912, for the construction of the following reinforcing concrete bridge work:—

Group 1.

(a) Two reinforced concrete bridge abutments for a bridge west of Lumsden.

(b) Two reinforced concrete bridge abutments for a bridge south of Estevan.

(c) Two reinforced concrete bridge abutments and a small reinforced concrete bridge south of Drinkwater.

Group 2.

(a) Two reinforced concrete bridge abutments for a bridge south of Webb.

(b) Two reinforced concrete bridge abutments for a bridge south of Maple Creek.

Group 3.

(a) Two reinforced concrete bridge abutments for a bridge east of Davidson.

(b) Two reinforced concrete bridge abutments for a bridge west of Dundurn.

(c) Two reinforced concrete bridge abutments for a bridge north of Asquith.

(d) Two reinforced concrete bridge abutments for a bridge north of Melfort.

Plans, specifications, etc., may be obtained on application to A. J. McPherson, Chairman Highway Commission, Regina, Sask.

Saskatoon, Sask.—Tenders for the erection and completion, with the exception of heating and plumbing, of a reinforced concrete office building to be erected on 2nd Avenue, Saskatoon, will be received until May 25th, 1912. Owner, Chester Thompson, Esq. Plans can be obtained at the architect's office, or the Builders' Exchange, Winnipeg. Frank P. Martin, Architect, P.O. Box 515, Thompson Chambers, Saskatoon.

Toronto, Ont.—Tenders will be received by W. J. Hanna, Provincial Secretary, Parliament Buildings, Toronto, up to noon, May 28th, 1912, for the delivery of coal as required in the sheds of the following provincial institutions, on or before the 31st day of August next, viz.: Brockville, Cobourg, Hamilton, Kingston, London, Mimico, Penetanguishene, Toronto, Hospitals for the Insane, Orillia Hospital for Feeble-Minded, Woodstock Hospital for Epileptics, also the Central Prison and Mercer Reformatory. Specifications of the qualities, etc., may be obtained on application to the department, or from the bursars of the respective institutions.

Toronto, Ont.—Tenders for concrete abutments for a bridge over a branch of the River Humber, Lot 2, Con. 11, Township of King, will be received up to five o'clock p.m. of Wednesday, June 5th, 1912. Tenders for concrete breakwater to protect the highway at or near Woodbridge in the Township of Vaughan, County of York, will be received up to five o'clock of Thursday, June 6th, 1912. Plans and specifications may be seen at the office of Frank Barber, Civil Engineer, 57 Adelaide St. East, Toronto. (See advt. in The Canadian Engineer).

Toronto, Ont.—Tenders for the construction of: (1) One quarry stone abutment for Islington bridge, over Mimico Creek, on Dundas Street, near Islington, and (2) for concrete truss superstructure for bridge over Highland Creek, near West Hill, Township of Scarboro, will be received up to five o'clock p.m., of Tuesday, May 28th, 1912. (3) Tenders for a concrete arch bridge over a branch of the Don on the Townline, Concession 3, between the Townships of York and Markham, County of York, will be received up to five o'clock p.m. of Thursday, June 6th, 1912. Plans, etc., at the office of Frank Barber, Esq., Civil Engineer, 57 Adelaide St. East, Toronto. (See advt. in The Canadian Engineer).

Vernon, B.C.—Tenders for the construction of approximately 50,000 feet of combined sidewalk and curb, will be received until May 27th, 1912. Plans and specifications can be obtained from the City Engineer's office, Vernon, B.C. D. G. Tate, City Clerk.

Vernon, B.C.—Tenders for the supply and delivery of 17,000 feet of 4-inch cast-iron pipe and 10,500 feet of 6-inch cast-iron pipe, will be received until June 10th, 1912. Specifications can be obtained from the City Engineer's office, City Hall, Vernon, B.C. D. G. Tate, City Clerk.

Vernon, B.C.—Tenders for the supply and delivery of 125 gate valves and 36 hydrants, ranging in size from 4-inch to 8-inch, will be received until June 10th, 1912. Specifications can be obtained at the City Engineer's office, Vernon, B.C. D. G. Tate, City Clerk.

Vancouver, B.C.—Tenders will be called for immediately for the construction of ten steel bridges along the line of the Canadian Northern Railway on the Fraser and Thompson Rivers. The bridge plans were designed by J. A. L. Waddell, City Engineer of Kansas City. The first one will be a 420-foot arch span across the Fraser, directly above the Canadian Pacific Railway bridge at Casco, a few miles below Lytton. Then comes a semi-cantilever bridge across the same river at Lytton. The entire cost of the bridges will be a million and a quarter dollars.

Winnipeg, Man.—Tenders for the erection of a court house in the city of Winnipeg, will be received up to noon of June 1st, 1912. Drawings and specifications may be seen at the office of the Provincial Architect, 261 Fort Street. R. P. Roblin, Acting Minister of Public Works, Winnipeg.

Winnipeg, Man.—Tenders for construction of a pile bridge (over Boundary Creek on the Gimli Road), and approaches thereto will be received until May 23, 1912. Plans, etc., can be seen at the clerk's office, Gimli; municipal office, Winnipeg Beach; Public Works Department, Winnipeg; J. D. Forster, secretary-treasurer, Winnipeg Beach.

Winnipeg, Man.—Tenders for the construction of reinforced concrete tunnels at the Agricultural College, St. Vital, will be received up to noon, of May 27th, 1912. Plans and specifications may be seen at the office of the Provincial Architect, 261 Fort Street, Winnipeg. R. P. Roblin, Acting Minister of Public Works, Winnipeg.

Yorkton, Sask.—Tenders will be received up to noon on May 29th, 1912, for the ventilating, plumbing and heating work in connection with the new west end public school building at Yorkton. Plans and specifications at the office of the architect, J. Pender West, 607 Somerset Block, Winnipeg, 9 Dunlop Block, Yorkton.

CONTRACTS AWARDED.

Calgary, Alta.—Grant Smith and Company and McDonnell, of Vancouver, have been awarded a contract running into over $500,000 for the construction of a large reinforced concrete aqueduct two miles in length near Brooks.

Jansey Bros. and Boomer and Hughes, of Calgary and Spokane, have been awarded a two-year contract amounting to about $300,000 for the construction of a large number of reinforced concrete structures on the canal system in that section of the irrigation block lying between Bassano and Brooks and the Bow and Red Deer Rivers.

The Canada Foundry Company have also been awarded a large contract for the supplying and erection of 30 steel bridges of the main canal system, containing about 1,500,000 lbs. of steel, which, with masonry abutments, will provide practically permanent structures.

Calgary, Alta.—A very large contract has been entered into by Messrs. Jennings & Foster, owners of Lake View Heights, for improvements which call for an outlay of $95,000. They will build a concrete wall around the lake; also boulevards, parks, pleasure grounds and pavilion.

Fredericton, N.B.—Messrs. James H. Corbett and Sons have secured the contract for the construction of the sections of the St. John Valley Railway from this city to Gagetown and from Gagetown to Rothesay, a distance of 66 miles.

The contract for the building of the railway from this city to Woodstock, a distance of sixty-two and one-half miles, was awarded to the Quebec Construction Company, and the contract for the line from Woodstock to Centreville, a distance of about twenty-five miles, has been awarded to Messrs. Kennedy and MacDonald.

Goderich, Ont.—Extension to the north breakwater and dredging; contractor, Wm. Bermingham, Goderich.

Hamilton, Ont.—The Hamilton and Toronto Sewer Pipe Company, Limited, have secured the contract for a considerable quantity of sewer pipe at the town of Exeter, Ont.

Kent County, N.B.—Mr. Whitman Brewer has been awarded the contract for the construction of the James Jardine bridge. The contract price was in the neighborhood of $8,000.

Kamloops, B.C.—Two tenders were received by the city council for construction of cement walks. F. Walkley, $24,000, extra sidewalk 15c per square foot, extra crossings 40c. per square foot and curb 75c. Graff Construction Co., $21,985, extra walks 16c., crossings 14c., curb 40c. per lineal foot. It was decided that the contract be given the Graff Construction Company.

Lion's Head, Bruce Co., Ont.—Extension to wharf; contractor, J. E. Johnston and J. T. Crawford, of Wiarton, Ont.

Moose Jaw, Sask.—The following contracts have been awarded in connection with the Public Library: For heating and plumbing, Frost Bros., and for electrical wiring, the Acme Electric Company. The contract for the heating and plumbing was awarded for $6,695.70; to the Acme Electric for the wiring at $690. Other tenders for the work were the Alexander Plumbing and Heating Company, for plumbing and heating, $6,908; Moose Jaw Hardware Company for same work, $6,980.

Niagara Falls, Ont.—Contracts have been let for the construction of an addition to the plant of the Niagara Falls Canning Company. The papers were executed by Frank H. Boulter, the manager of the company, and call for the expenditure of $100,000.

Ottawa, Ont.—Machinery for 3½ yard dipper dredge; contractor La Cie Pontbriand, Ltd., Sorel, P.Q.

Port Colborne, Ont.—Post Office fittings; contractor, A. E. Augustive, of Port Colborne, Ont.

St. John, N.B.—Dredging in St. John Harbor, N.B., alongside the deep water wharf of the Intercolonial Railway. Contractor, J. S. Gregory, of St. John, N.B.

St. John, N.B.—Messrs. Norton, Griffiths & Company have let the $4,000,000 contract for construction of the mile-long breakwater to Messrs. MacDonald & Boheny, Alexandra, Ont., and G. T. Hervey, Montreal.

Toronto, Ont.—Contracts have been awarded by the Canadian Northern Railway for an electric railway connecting Toronto with Guelph and another line connecting Toronto and Bowmanville.

Vancouver, B.C.—City Engineer Fellowes has successfully recommended the acceptance of the following sewer tenders: Sewer on Keefer Street, Templeton to Union, to Messrs Bruce and Ford, $15,500; sewer on Sixteenth Ave., Manitoba to Ontario, to J. Shunn, $4,258; sewer to China Creek, Seventh to Twelfth Avenue, to the Graff Construction Company, $85,022.20.

Winnipeg, Man.—The following tenders were received and opened by the St. Boniface Council, for the construction of the trunk sewer on Dawson Street to serve the Public Markets, Limited.:

Van Horenbeck and Company, $147,650.75.
Marivet Cotteiner and Graham, $206,970.
Guilbault and Company, Ltd., $149,487.50.

The Van Horenbeck Company was awarded the contract, its tender being the lowest.

Winnipeg, Man.—The contract for the erection of the new St. John's College building, at a cost of approximately $40,000, has been let to Messrs. Worsick Bros.

RAILWAYS—STEAM AND ELECTRIC.

Galt, Ont.—Work has commenced on the spur extension of the Galt, Preston and Hespeler Railway. This will provide railway accommodation for the newly opened factory district.

Province of Manitoba.—A report states that work will be commenced on the line of the Grand Trunk Pacific to Brandon.

Montreal, P.Q.—Recent calculations made by the management of the Canadian Autobusses, Limited, who are negotiating for running rights into this city, show the fifty million persons must be carried to allow a margin of profit on the investment and pay a dividend of 6 per cent. to the shareholders. The company purposed investing five million dollars in plant and rolling stock in Montreal and employing two thousand persons, provided it obtained from the city an exclusive control for ten years. They will put on a service in four months of the date of signing the agreement with the city. In all 286 autobusses will be kept in continuous operation, and the company will have, besides, over sixty autobusses in reserve, bringing the total number to 350.

Saskatoon, Sask. — A report states that the Canadian Northern Railway are about to make a start on improvement work in this locality. The work includes the enlargement of the depot and freight sheds and a new yard. The plans for this work have been approved and the contract will be called in a few days.

South Western Ontario.—It is the intention of the Grand Trunk Railway to lay new 100-pound rails between Woodstock and Sarnia this summer. Sixty section men from Sarnia and points west of London, Ont., have been brought to the latter point, where the work is being started.

Windsor, Ont.—After several months' negotiations between the city and the Detroit River Tunnel Company an agreement has been arranged by which the original assessment of $2,500,000 placed by the Windsor assessor upon the property has been reduced to $444,444. This gives the city $10,000 a year in taxes.

LIGHT, HEAT AND POWER.

Beaverton, Ont.—The municipal council have applied to the Hydro Electric Commissioners for a specific volume of current. Beaverton is the first municipality in this district to make such an application.

Guelph, Ont.—The annual report of the Light and Heat Commission shows that this department has produced a profit of nearly $23,000 for the year ending December 31st, 1911. The following shows the manner in which this amount is made up:—

Total income	$110,188 35
Total expenditure	76,748 97
Net gain	$ 33,439 38
Debenture interest	10,738 85
Balance carried to credit of profit and loss account	$ 22,700 53

The income in the gas department was $55,495.34, and in the electric department $54,693.01. The total income was $110,188.35. Expenditures in the gas department were $37,603.59, of which salaries, $6,074, and labor (purification), $21,082.22, were the chief items. In the electric department's expenditure of $28,004.09, the cost of the Hydro-Electric power, $16,437.01, and $3,291.49 for general repairs were the chief items. There were $6,141.29 of general expenditures, depreciation $5,000, showing a grand total of $76,748.97 for expenditures. The balance sheet submitted by the auditors showed assets of $464,400.28, and total liabilities of $269,253.96, principally for debentures, due bank, city of Guelph and open accounts. The contingent fund for depreciation stands at $75,000, and there is a premium of $4,337.20, written up for reserve fund.

Saltcoats, Sask.—The municipal authorities of this town are about to issue debentures for the installation of elecrtic light facilities. The estimated cost for this work is placed at $17,000. Mr. C. E. Boake is secretary-treasurer of this town.

GARBAGE, SEWAGE AND WATER.

Bordeaux Ward, Montreal, P.Q.—The ratepayers of this ward will get a supply of filtered water at an increase of three cents per 1,000 gallons more than the regular price for the crude article.

Berlin, Ont.—The Canadian Fire Underwriter's Association have made a report on the deficiencies in the town fire preventive appliances. In this report attention is drawn to the fact that the water supply is below the requirements of the number of residents and that the pumping facilities are below the amounts required for a single system.

Edmonton, Alta.—The new water filtration plant has been placed in working order, and is reported to be entirely satisfactory. The sedimentation basin has been repaired, and it is now expected that the water supply of the future will be received favorably by the ratepayers.

Montreal, P.Q.—The Board of Control has resolved to send a report to the City Council asking for an appropriation of $17,000 for the purchase of an engine and pump and the construction of a large reservoir tank, which will contain 200,000 gallons of water. The supply is for the higher levels of Montreal, which cannot be served out of the present upper reservoir.

Nanaimo, B.C.—The municipal council will give serious attention to a proposed increase in the water supply to the outer districts of the city.

North Bay, Ont.—Mr. John Shaw, C.E., has presented a report on a proposed water supply from Four Mile Lake, to the municipal council.

Four and one half or five miles of pipe are required in his recommendations.

This lake has an area of 208 acres and a depth of from 10 to 40 feet and with the watershed contains a sufficient supply for a population of 28,000 persons.

Vancouver, B.C.—Two 18-inch water mains have been placed in position for laying across the Second Narrows.

BUILDINGS AND INDUSTRIAL WORKS.

Courteney Bay, St. John, N.B.—The harbor improvements, etc., at this point, for which the Dominion Government has awarded a contract to Norton Griffiths and Co., Ltd., (Canada), are to be completed by March 30th, 1917, and embrace:

The construction of a breakwater 4,570 ft. long, including that of five groynes each 150 ft. long.

The dredging of a channel about 6,800 ft. long and 500 ft. wide at bottom to a depth of 32 feet below low water, from the main ship channel leading into the St. John River to the head of the breakwater mentioned above.

The dredging of a basin to a depth of 32 ft. below low water in Courtenay Bay.

The construction of about 4,890 lineal ft. of quay walls.

The filling of an area of about 28 acres.

The construction of a dry dock of the first-class.

Fort William, Ont.—A report states that an announcement has been made to the effect that the projected programme calling for the erection of a large plant of the Canada Car and Foundry Company in this city has now reached a definite stage and that work on the same will commence at an early date.

Fort William, Ont.—The members of the Fort William Rowing Club have arranged for the erection of a new club premises during the coming year. The cost of this work is estimated at $10,000. Mr. A. A. Wilson is the president of this organization.

Kenora, Ont.—The Public Works Department will commence the construction of a new dock at this point. The dock will cost about $11,800 and will be under the supervision of W. G. Earle, district engineer of this department.

Moose Jaw, Sask.—Mr. R. G. Bunyard has prepared plans for the erection of a new Roman Catholic school building to cost about $25,000. It will be of brick construction with a generous amount of stone trimming, 50 × 82.

Moose, Jaw, Sask.—Plans for the erection of a $60,000 Young Men's Christian Association building for this city have been prepared. It will be three stories in height.

Niagara Falls, Ont.—The American Cyanamid Company have decided to proceed with the extension of their plant. The work involves the expenditure of about $400,000 in reinforced concrete buildings alone.

Port Arthur, Ont.—The Ruttan Estates have begun the construction of a large block for stores and offices on Court St. Estimated cost, $80,000.

J. J. Carrick will erect a two-story brick block for stores and offices on south end of Cumberland St. Estimated cost, $30,000.

It is stated that the James Whalen interests will erect an office block on corner of Lorne and S. Water. Carl Wirth, of Fort William, architect.

Port Colborne, Ont.—Construction work on the plant of the Canadian Union Furnace Company will be undertaken in the course of a few days.

Stratford, Ont.—As soon as the plans for the new Grand Trunk passenger station have been approved by the Railway Board, construction work will be commenced. Mr. U. E. Gillen, superintendent of the middle division has the matter under his jurisdiction.

St. Catharines, Ont.—Messrs. Whitman and Barnes are about to commence building operations on an addition to their plant. The work will entail an expenditure of about $35,000.

Toronto, Ont.—The Engineers' Club have completed the purchase of property in this city, and will erect a new club house. The site of the purchase is near the corner of York and Richmond Streets, and has a frontage of 46 feet.

Vancouver, B.C.—Messrs. Braunton and Liebert, architects, will let the contract within the next ten days for the construction of a modern warehouse, five stories high, on Alexander Street, between Columbia and Main Streets. This building will be 50 feet × 125 feet, and will represent an expenditure of $125,000. It is to be of mill construction faced with with pressed brick.

Vancouver, B.C.—Plans have already been prepared and tenders will be invited in the near future for the erection of a fully modern apartment building on Hastings Street East, for Mr. J. A. Cockburn. This building will be 75 feet square and three stories in height.

Winnipeg, Man.—A report states that a start will be made on the new provincial legislative buildings this year. It is expected that the completed drawings of the successful architects will be finished by July 15th.

BRIDGES, ROADS AND PAVEMENTS.

Dauphin, Man.—The municipal council are making preparations for the construction of certain bridge works to be completed upon the sale of a bond issue now on the market. Mr. J. A. Gorby is secretary-treasurer of this town.

Port Arthur, Ont.—The municipal council have accepted the gift of a tract of land near the reservoir and will commence the construction of a driveway around it.

Moose Jaw, Sask.—The following tenders have been received by the municipal council and will be reported upon by the city engineer. The Bithulithic Paving and Contracting Company, Winnipeg, for $2.90 per square yard for bithulithic paving of five inch thickness, with additional cost of 30 cents per square yard for work between the tracks. The

Moose Jaw Paving Company, for 16 pound treatment creosoted block at $2.94 per square yard, with an additional 65c. for between the tracks. Fielding and Shepley of St. Paul, for 16 pound treatment creosoted wood paving at $2.84 per square yard, this being the lowest tender. Extra per yard between the tracks in this tender is 30c. The National Paving aind Contracting Company on sheet asphalt at $2.60 per square yard. R. Bangha, Windsor, Ont., at $3.44 per square yard for 2½ asphalt block with an additional 60c. per square yard for between the tracks.

FIRES.

Hamilton, Ont.—The factory of the Diamond Flint Glass Company was badly damaged by fire on the evening of May 18th last. The loss is estimated at $6,000.

Montreal, P.Q.—The premises of the British American Dye Works were damaged by fire on the evening of May 15th last. The damage was confined to the boiler room and the rear portion of the premises.

New Westminster, B.C.—The main factory of the Royal City Mills, together with two boiler-houses, landing platforms and docks, were burned early this afternoon. The loss will be in the vicinity of $100,000, fully covered by insurance.

Owen Sound, Ont.—The saw mill plant of the Carney Lumber Company was destroyed by fire on May 20th last, with a loss of $150,000.

CURRENT NEWS.

Calgary, Alta.—The Civic Industrial Bureau have appointed a committee to confer with the municipal council regarding the erection of an auditorium to house a display of "Made in Calgary."

Calgary, Alta.—The newly formed Tregillus Clay Products Company have awarded the contract for the supply of machinery to Bonnot Company of Ohio, U. S. A. This brick and tile company are arranging for the largest output of materials of this nature in Western Canada and are estimating 10,000 brick per hour as a reasonable output. These will be baked in twenty kilns of the down draft type. The raw material will be brought to the plant entirely by gravity, the location of the plant being admirably adapted by nature, and allowing for excellent drainage. Natural gas and the finest shales in this portion of Canada are at the disposal of the company.

Lethbridge, Alta.—A colony of seventeen ready-made farms will be established by the Canadian Pacific Railway near this city during the coming summer.

Montreal, P.Q.—Improvements to cost $2,000,000 will be begun on the Montreal harbor in a few days. They include the erection of a new 1,200-foot pier, the lengthening of several others, and the deepening of basin No. 1. The entrances to the Lachine Canal will be moved over in their entirety to a point opposite an open space between Mackay Pier and Windmill Point, which is being reserved for the Georgian Bay terminals.

Northern Canada.—The Clergue interests, which are promoting the proposed construction of the Nottoway River Railway, are sending up the steamer Baeotic with a party to make surveys, and the railway department is negotiating to send along a staff of engineers by the same boat to investigate further the question of terminals of the Hudson Bay Railway in connection with the proposal to have a second outlet from the Hudson Bay by way of a railway connecting James' Bay with the N.T.R.

Ottawa, Ont.—It is expected that competitive drawings and designs will be invited for the new Government buildings to be erected on the recently acquired Wellington Street site.

Prince Albert, Sask.—The ratepayers recently voted in favor of the following by-laws:—To raise $73,800 for extensions to the water mains; to raise $19,000 for storm sewers; to raise $21,500 for the city's share of granolithic walks; to raise $55,000 for common sewers. F. H. Creighton, city engineer.

St. Catharines, Ont.—The ratepayers approved of the concessions being granted to the management of the Warren Axe and Tool Company. The management will receive a free site and be exempt from certain taxes for a term of ten years.

St. Croix River, N.B.—Work has commenced on a dredging job that is designed to greatly improve the St. Croix River channel for a distance of four miles. The work is being carried on by the United States Government working under an agreement with the Canadian Government, each country paying a proportionate share of the cost and the Canadian Government maintaining an inspector on the work to protect its interests. The spoil is to be dumped into the river some distance below Mark Point, where the river has a depth of between 60 and 100 feet.

Sydney, C.B., N.S.—A report states that the management of a shipbuilding concern now carrying on negotiations with the municipal authorities of this city has made the following offer:—They ask a bonus of a million dollars in the shape of fifty-year civic bonds in instalments beginning when the plant is completed. They guarantee an expenditure of six millions, five dry docks, minimum of a million on shipbuilding plant. The dock proposed is to be 1,160 feet long, 44 feet at low water and 136 feet in width.

Thorold, Ont.—The head gates at Lock 24, of the new Welland Canal, at Thorold, had a narrow escape from being carried away on Sunday evening last. The steamer Beaverton entered the lock, bound up, when the steel cable that secured her broke and she drifted ahead and opened the head gates a foot or more, pushing them out of mitre. This allowed the water to rush through. This particular pair of lock gates kept back nearly a mile of water in the long and wide level that reaches south to lock 25.

TRADE ENQUIRIES.

The following were among the enquiries relating to Canadian trade received at the office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ended May 5th, 1912:—

A Yorkshire firm of varnish, paint and color manufacturers, oil boilers and tar and rosin distillers are prepared to consider the appointment of Canadian agents.

A Scottish manufacturing firm producing all classes of paints and enamels, and specializing in export trade, are prepared to undertake Canadian business.

A Toronto correspondent desires to secure the agency of a United Kingdom firm manufacturing lines saleable to the drug trade from Winnipeg to Vancouver.

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

A Midlands firm manufacturing springs of all kinds, also every variety of specialties in wirework and presswork, are looking for a suitable resident Canadian firm prepared to act as their buying agents.

A British firm manufacturing fancy metal photo frames, calendars, cigarette cases, and advertising novelties, desire to appoint a resident representative in Canada.

A German firm of merchants who have experience in chemicals and drugs, dyes and colors, glass and earthenware, machinery, metals and hardware, ores, scientific instruments, textiles, toys, etc., wish to enter into business relations with Canadian houses, either in a buying or selling capacity.

REGINA ENGINEERING SOCIETY WANTS CATALOGUES.

Mr. Edgar I. Wenger, Librarian of the Regina, Sask., Engineering Society, the formation of which was referred to recently in The Canadian Engineer, is starting a catalogue file for the use of its members and would be very pleased to receive trade literature of all kinds from manufacturers of machinery and engineering equipment generally. Mr. Wenger's address is Whitmore Building, Scarth Street, Regina, Sask.

CONCRETE SUB-CONTRACTORS WANTED.

We have about twenty thousand cubic yards of concrete work distributed in small bridges, abutments, head-gates, drops, etc., which we will let to responsible contractors in quantities to suit at good prices.

JANSEY BROS.; BOOMER & HUGHES,
No. 1-2 Mackie Bldg.,
Calgary, Alberta.