PAGES

MISSING

Volume 27. Toronto, November 19, 1914 Contents of this issue on page 3

The Canadian Engineer

A weekly paper for engineers and engineering-contractors

STREET IMPROVEMENT IN FREDERICTON, N.B.

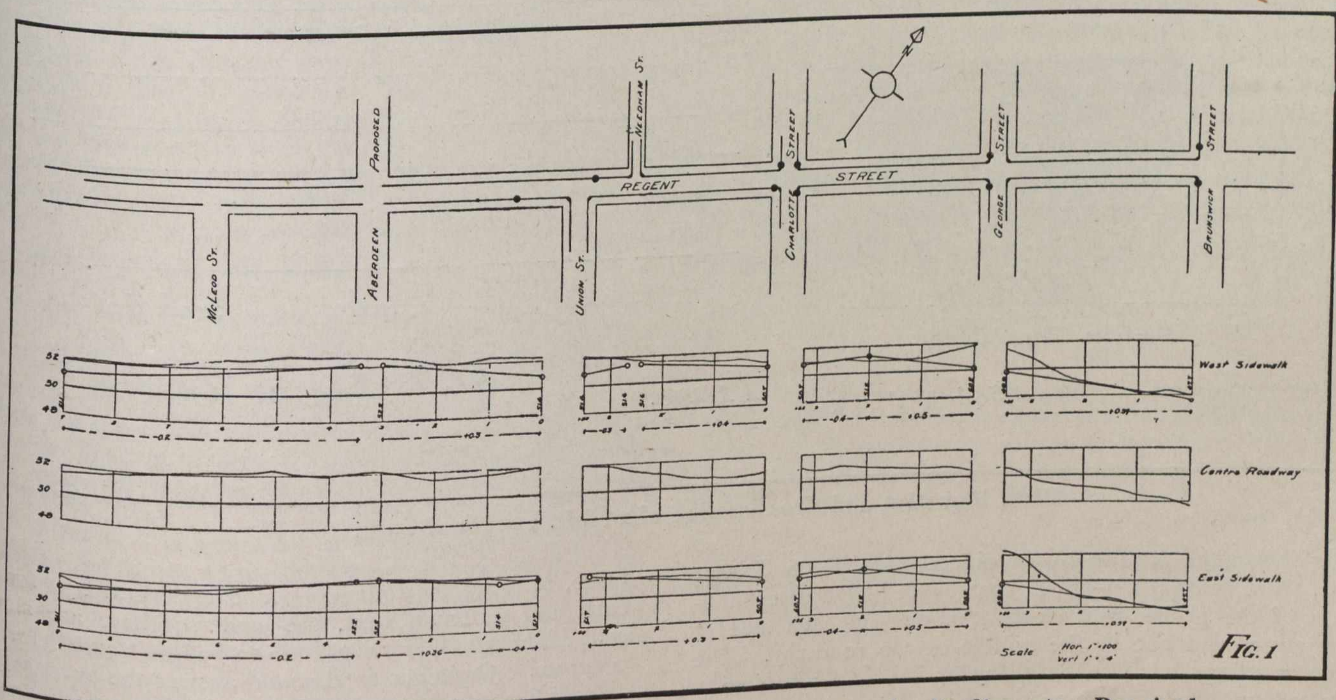
NOTES ON THE COMBINED CURB AND GUTTER, DESCRIBING THE METHODS OF LAYING AS ADOPTED IN THAT CITY—DATA ON LABOR AND MATERIALS.

MANY styles of curbs are in use to-day, with varied opinions associated with each. The combined curb and gutter type has been adopted by the city of Fredericton, N.B., and the past season has seen some interesting pieces of construction there. The following information has been furnished us by Mr. R. R. Stevenson, B.Sc., who, the office of city engineer being vacant at the time, did the engineering work for the city. The methods, forms and materials used are described below, and some valuable cost data is added.

Laying Out the Combined Curb and Gutter.—Fig. 1 shows a plan of a small section of the city showing Regent St., just laid with concrete curb and gutter, and the cross streets (which can be picked out from the plan as they are named). As in nearly every city, there are instances where old residents have encroached on the streets due to slackness on the part of the city in the past years, in holding them to the proper street lines. This has necessitated building the combined curb and gutter to fit the existing house lines of to-day.

This entails the plotting of a plan and deciding the best location for the combined curb and gutter. As can be seen from the plan, it was impossible to get a straight line the entire length of the street, hence the engineers decided that the next best plan would be two straight lines with the smallest possible deviation in direction. The best place to make the turn, it was decided, was at Charlotte St. A ship's spike was driven at the exact middle of the street at Brunswick and another in the middle of Charlotte and Regent Sts.; another spike was driven at Aberdeen St., exactly in the middle of the roadway. The bend between these two straight lines was hardly noticeable, there being only an angle of 19 ft. between them. At each street crossing the curbs were carried around the corner so that if the curbs of the cross streets were later built the existing ones would be in a position to connect without the necessity of extra work. At the proposed extensions of cross streets the combined curb and gutter was carried only far enough to allow for the turn around the corner and a space left.

Method of Alignment.—The line could not be laid out in the middle of the road due to the interference of the traffic. It was offset 25 ft. on each side, which brought it on the asphalt sidewalk. The line was then laid down



Regent St., Fredericton, N.B., Showing Alignment Grades, Levels, Profiles, etc., Required.

at 25-ft. intervals by means of tar-paper tins and 8d. nails, the nails being driven through the tins and into the asphalt sidewalk on the exact 25-ft. line. This gave the contractor a good chance to place his forms on the exact line of the back of the curb, there being no possible chance to be out in distances less than 25 ft. Instead of measuring every 25 ft., a batter post was often put in every 200 ft. and a cord stretched between them. The line was hardly necessary every 25 ft., but in putting in the grade plugs, which are necessary every 25 ft., the extra alignment points proved very handy.

After the points were in, the contractor simply had to measure 10 ft. from them, which would give him the location of the front of the curb, it being decided by the city that a 30-ft. roadway would be allowed. This gave 18 ft. of sidewalk from the front of the curb to the house line, the streets being 66 ft. wide.

The alignment of the curb being established, the next thing was to determine the grades and elevations of the combined curb and gutter and to establish them. In Fig. 1 is shown the profiles on the different blocks on Regent St., there being 3 profiles of each block in the determination of the grades and elevations, one on each side of the street and one in the middle of the roadway. The level readings were taken every 25 ft., and after being plotted up, the grades, as shown in Fig. 1, were determined upon. The only parts that needed much judgment were at George St. and the block from Needam out.

At George St., as seen from the profile, there was a sudden rise which looked strange, whereas the rest of the town was level. It was decided that it would be best to cut this hill down, making a gradual slope which would be much easier on traffic than the sudden rise, a gradual 0.6% slope was put in from Brunswick to George St. After the road was completed it was seen that this was by far the best thing that could be done both from general appearance and the ease with which big loads were handled. From Union St. out one side of the road was much higher than the other, so that the combined curb and gutter had to be put in so that it fitted both in the best way possible.

Catch-basins were put in where necessary and are marked in Fig. 1 by small circles. These were built with loose rock with only a sand bottom, and each was therefore more of a cesspool than a catch-basin, the water draining out through the loose rock and the sediment being held in the basin.

Construction of Curb and Gutter.—The combined curb and gutter was constructed by J. M. Chappell, Esq., of the City of Fredericton, N.B., and his method of constructing is well worthy of comment, he having a system of forms which cuts down the cost of construction materially, as will be seen.

Fig. 2 is a drawing of a section taken through the curb and also giving a plan and elevation of one 8-ft. block showing another joining on each end. This shows the expansion joints which, in past years, has been a great trouble to get in correctly and cleanly. First, the trench has to be dug out to a depth of 30 in. below the top of the grade plugs. In this trench is placed about 16 in. of broken stone or field stone and tamped tightly into place, forming the foundation and underdrainage for the curb and gutter. Next, the cinders; these are simply coal clinkers and provide an even bed or "cush" for the concrete. (Gravel or sand would answer the purpose just as well but would make a difference in the cost, the gravel costing $1.25 per yard and the coal clinkers 50 cents.)

The form for the back of the curb is now put in place. This should be the most carefully done of any of the form-placing as on this all the rest of the form-placing hinges. If it is correctly done, all of the forms must, as a matter of course, come to their place. This form is a 2-in. plank 12 in. wide and of any convenient length. It is placed on the line of the back of the curb and just so that the top of the plank is level with the grade plugs. This brings the cinder "cush" just up to the bottom of the plank. It is then nailed and braced into place.

Next the steel forms that make the expansion joints are put into place. These are made of ⅛-in. steel and are the shape of the section of the curb. They are the same size as the curb and gutter except that they are just a little longer to supply a hold to enable them to be

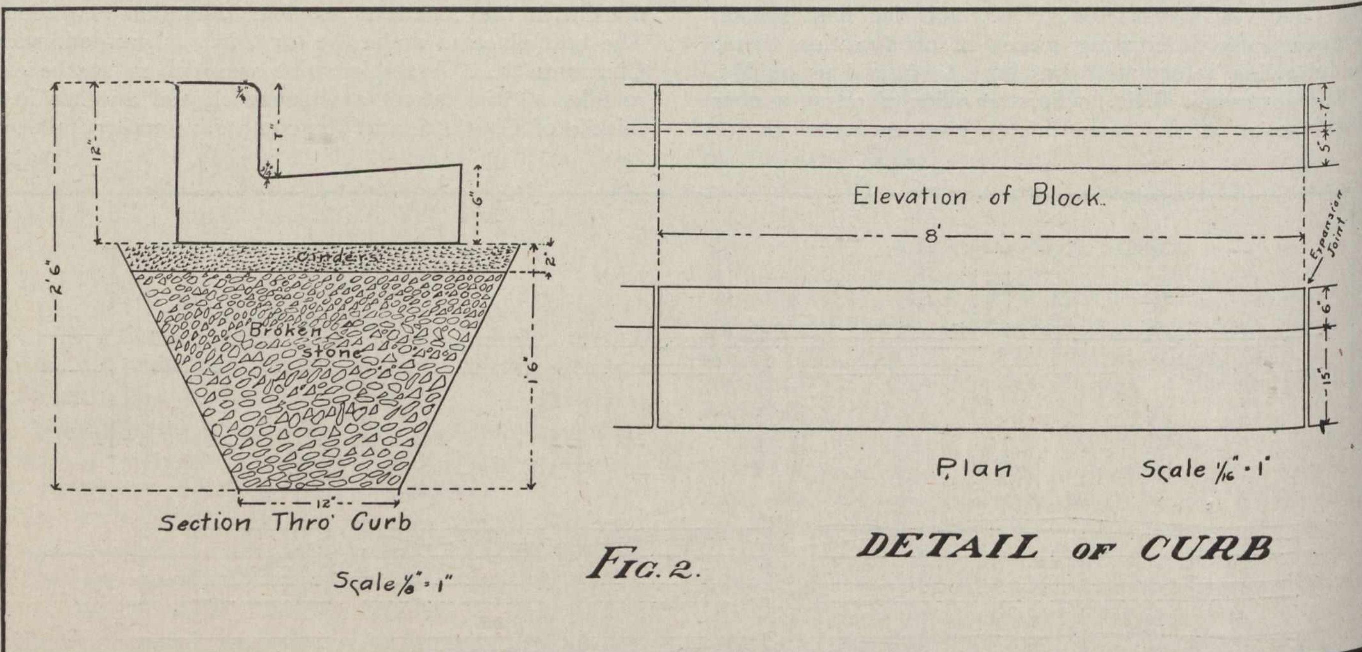
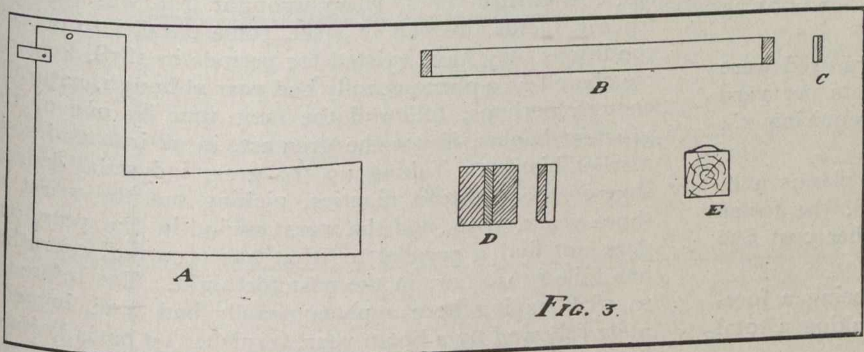


Fig. 2.

Plan, Elevation and Cross-section of an 8-ft. Length of Curb.

pulled out easily after the concrete has set. A small piece of steel is riveted on the side 12 in. from the bottom, or at just the height of the curb. In this way the plate stays in place, as shown by *A* of Fig. 3. One of these is placed every 8 ft. in the length of the curb.

The next step must be made with planks which must be made in a special manner and cut to fit. These are 2-in. dressed lumber with one edge bevelled, as shown in *B* and *C* of Fig. 3. These planks are in lengths of 7 ft. 11 in., and the ends of each plank are cut half through 3 in. from the end and this small piece cut out. *D* of



Details of Expansion Joint Forms.

Fig. 3 is the connecting piece between the plank. It is cut into 7-in. lengths, as shown. The boards forming the front of the curb are now placed on the steel forms, being held apart by means of blocks 6 in. square, as shown in *E* of Fig. 3. The ends of the plank are kept just an inch apart to allow the part *D* to fit in. This is put in place and makes the front form solid by the joint. Clamps are now put on and the back and front forms are clamped together, the wooden block only allowing them to be clamped to their proper distance—6 in. This is shown in Fig. 4.

The form for the edge of the gutter must be put in place. This is made of plank 6 in. wide and cut to any suitable length. The plank is placed against the gutter part of the steel form with the top of the plank just level with the top of the gutter part of the steel form. Earth is then filled in to keep the plank in place. The forms are now complete and ready for the concrete, as shown in *B* of Fig. 4.

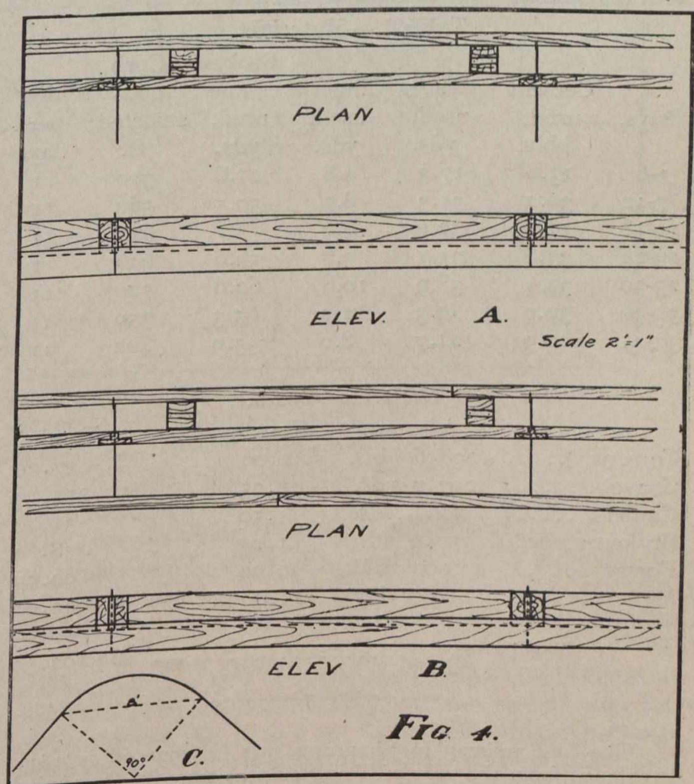
Mixing.—As one crew is mixing the concrete and placing the forms, another can be sprinkling the old work, backfilling, etc.

The mixing is done with a small hand-turned mixer capable of mixing 1/10 yard of concrete in one mix. This answered the purpose very well, mixing quite fast enough to keep a small crew of men busy. The mixer should be on wheels, to be wheeled easily from one part of the work to another, so that, while one man turns the machine, two shovel into the mixer and one man with a wheelbarrow may easily handle all the concrete being mixed.

Corners.—Taking the combined curb and gutter around the corners should be one of the most carefully done parts of the work, as an even, symmetrical corner adds more to the general appearance of the work than the ordinary workman would imagine. The general public is much more liable to notice a small error in the corner turn than a large one in the block length of the curb and gutter. A design of the turn is given in *C* of Fig. 4. The form for the back of the curb is the usual plank used on the block cut to a length of 8 ft. The steel forms are put in at the ends of this plank and the ordinary 7-ft. 11-in. plank put in to make the tangent to the curve. The form for the front of the curb on the turn is made of some pliable lumber, ½-in. thick, and is bent to the required circle. If necessary, it is braced into place until the concrete has taken its initial set. The forms are then taken off and the concrete is patched up at any place that the forms have not left in good shape.

Finishing.—In the finishing up of the work the trowel is used very sparingly on the concrete, the work being floated with wooden floaters and only where it is necessary to round the edges is the former used. It has been found by experience that a steel trowel tends to bring the cement in the mixture to the top, thus making a very rich mix on the surface, which, with age, will make hair cracks and cause checking. After the forms are taken off any rough parts in the concrete may be gone over with a concrete brick mixed in the proportion of 1 : 2, which fills up the small voids, takes off any rough edges and gives a general finished appearance to the work.

Cost Data.—The work in Fredericton was handled by one foreman with a crew of 11 men, arranged as follows: One man turned the mixer and dumped it; two men placed the cement and gravel in the mixer while one man wheeled the concrete from the mixer to the forms, thus making a total of 4 men required to do the mixing. One man placed and tamped the concrete in the forms, putting in the top dressing as the concrete was placed; two men were required to place the forms, leaving them ready for the placing of the concrete, while two more



Details of Forms.

dug the trench and placed the broken rock and cinders. One experienced man was needed to do the finishing and floating while the rest of the workmen were common laborers without much knowledge of concrete.

Materials.—*Cement*: The cement used was Portland in bags, the work requiring 20 bags per 100 ft. of combined curb and gutter. The price of the cement, taking out the refund on the bags, was 50 cents per bag.

Gravel.—The fine aggregate and coarse aggregate was combined in the form of river gravel, the work requiring about 5.6 cu. yds. per 100 ft. of combined curb and gutter. The gravel cost on the work $1.25 per yard.

Broken Stone: The stone for the foundation and underdrainage was ordinary building stone broken to the proper size. The work required 8.7 cu. yds. per 100 ft. of combined curb and gutter. This stone cost $1.25 landed on the work.

Cinders, Forms and Labor: The cinders used were ordinary hard coal clinkers, costing 50 cents per yard landed on the work; 100 ft. of curbing requiring 1.4 cu. yd.

The forms used were made of spruce planks and, roughly speaking, 3,000 ft. B.M. was used, the forms being used over and over again. This lumber cost $30 per M.

In this work 11 men were used, there being a foreman at $3 per day and 10 laborers at $2, making a total of $23 per day.

Following is the cost data given in tabulated form. Table I. gives the amounts of the different materials used and the number of feet of curb constructed every 6 days in the 41 days needed to finish the work. Table II. gives the total costs of the different materials and the total wages paid.

The total amount constructed was 4,032 feet, while the total cost was $2,192.30, making the cost per lineal foot 54 cents.

Table I.—Materials.

Days.	Cement used, bbls.	Gravel used, yds.	Cinders used, yds.	Broken stone used, yds.	Curb constructed, ft.	Men per day.
1-6	15.6	17.3	4.8	27.8	320	11
7-12	30.2	31.3	8.7	50.5	580	11
13-18	31.7	32.9	9.6	53.1	610	11
19-24	33.8	35.1	9.7	56.6	650	11
25-30	37.4	38.9	10.8	62.6	720	11
31-36	39.0	40.5	11.2	65.3	750	11
37-41	20.9	21.7	8.0	35.0	402	11

Table II.—Costs.

	Amount.	Cost.	Total.
Cement	208.6 bbls.	$ 2.00	$ 417.20
Gravel	217.7 yds.	1.25	272.10
Cinders	62.8 yds.	.50	31.40
Broken stone..	350.9 yds.	1.25	438.60
Forms	3,000' B.M.	30.00	90.00
Men	11 per day	23.00 per day	943.00
Total cost			$2,192.30

The first railway in Shantung was commenced in 1899. It extends from the port of Tsingtau to Tsinanfu, the capital of the province (a distance of 395 kilometers), and has been built by the Shantung Railway Company, which was founded in 1898 for the purpose of taking over the railway concession granted to Germany by the treaty of 1898. The capital of this German-Chinese company is 54 million marks, in 54,000 fully paid-up shares. The company is registered at Berlin, where is also its head office. It is a single line throughout, of a 1.535-metre, or normal gauge; but sufficient land to build a double line is provided for.

THE IRON AND STEEL SITUATION.

Regarding the iron and steel market in the United States as it stood at the beginning of the month, the "Steel and Metal Digest" observes that it was not in a state of stagnation but of complete prostration. The closing fortnight of October witnessed an absence of buying, of specifying on contracts, and of general interest in the market on the part not only of buyers but even of sellers, that certainly has never before been witnessed in the history of the steel trade, now some quarter century old. In earlier years, when wrought iron was the controlling factor, instead of steel, some parallel to present conditions may have existed for periods in 1878, long remembered as a phenomenally bad year although, naturally enough perhaps, followed the next year by one of the greatest booms, if not the greatest, in all iron and steel market history. Taking up the great industrial depression of the eighteen nineties, picking out the worst of those years, 1896, and the worst period in that year, one does not find a parallel to what has occurred, or rather has failed to occur, in the past fortnight. The reference to 1878 having been a phenomenally bad year, immediately followed by a boom year, furnishes no basis in itself for predicting much better things next year, though the reference contains a suggestion. There was a similar boom in 1899, but while 1879 was preceded by a year in which pig iron production was less than in three much earlier years, 1872, 1873 and 1874, the boom year 1899 was immediately preceded by two years which while dull each broke all previous records for pig iron production. It was a sudden change from 1878 to 1879, but the change from 1896 to 1899 was slow.

The rate of steel production at the beginning of November is approximately 40% of the capacity. Only in very exceptional instances, as when many mills have been closed over Christmas holidays, or when there has been a sudden but largely temporarily closing by reason of a panic, has the percentage rate fallen so low. The steel mills have never run for more than three consecutive months at a lower rate than 50% of capacity.

There is no definitely established price situation. Prices are not a consideration. Usually in dull periods they are an issue, and a very important one, but at present the buyers have nothing like a definite position. They are waiting for a chance to act, not a chance to buy at certain prices. Indeed, with many products it is a question where the market price really stands. There is actually not enough business offered, in some instances, to disclose at what prices mills would be willing to sell. The great majority of producers have nominal asking prices, which they would be only too glad to be tempted to cut in an effort to start business moving.

COST OF SUPERVISION OF HIGHWAY CONSTRUCTION.

The following statement shows the annual cost of supervision of construction of highways by the State highway department of Ohio in percentage of the amounts expended by the State in such construction:—

	Per cent.
1914	4.03
1912 and 1913	5.71
1911 and 1912	6.18
1910 and 1911	6.40
1909 and 1910	5.39
1908 and 1909	5.43
1907 and 1908	5.28
1906 and 1907	7.55

THE MAXIMUM POWER CAPACITY OF A PIPE LINE.

By T. H. Hogg, C.E., Toronto.

In hydro-electric power plant design it is sometimes interesting to know the maximum possible power output of a prospective development which is to have a long feeder conduit. This information is desirable in fixing the diameter of the pipe to be used. To do this accurately entails a study of the economics of the design with reference to the value of the power consumed in friction, the cost of the pipe, transportation conditions, speed-regulation, etc.

The electrical horse-power to be obtained from a given installation is obtained from the formula:

$$P = \frac{62.5\ Q\ h\ E_t\ E_g}{550}$$

where P = electrical horse-power; Q = quantity of water in cu. ft. per sec.; h = net head; E_t = efficiency of turbine; and E_g = efficiency of generator.

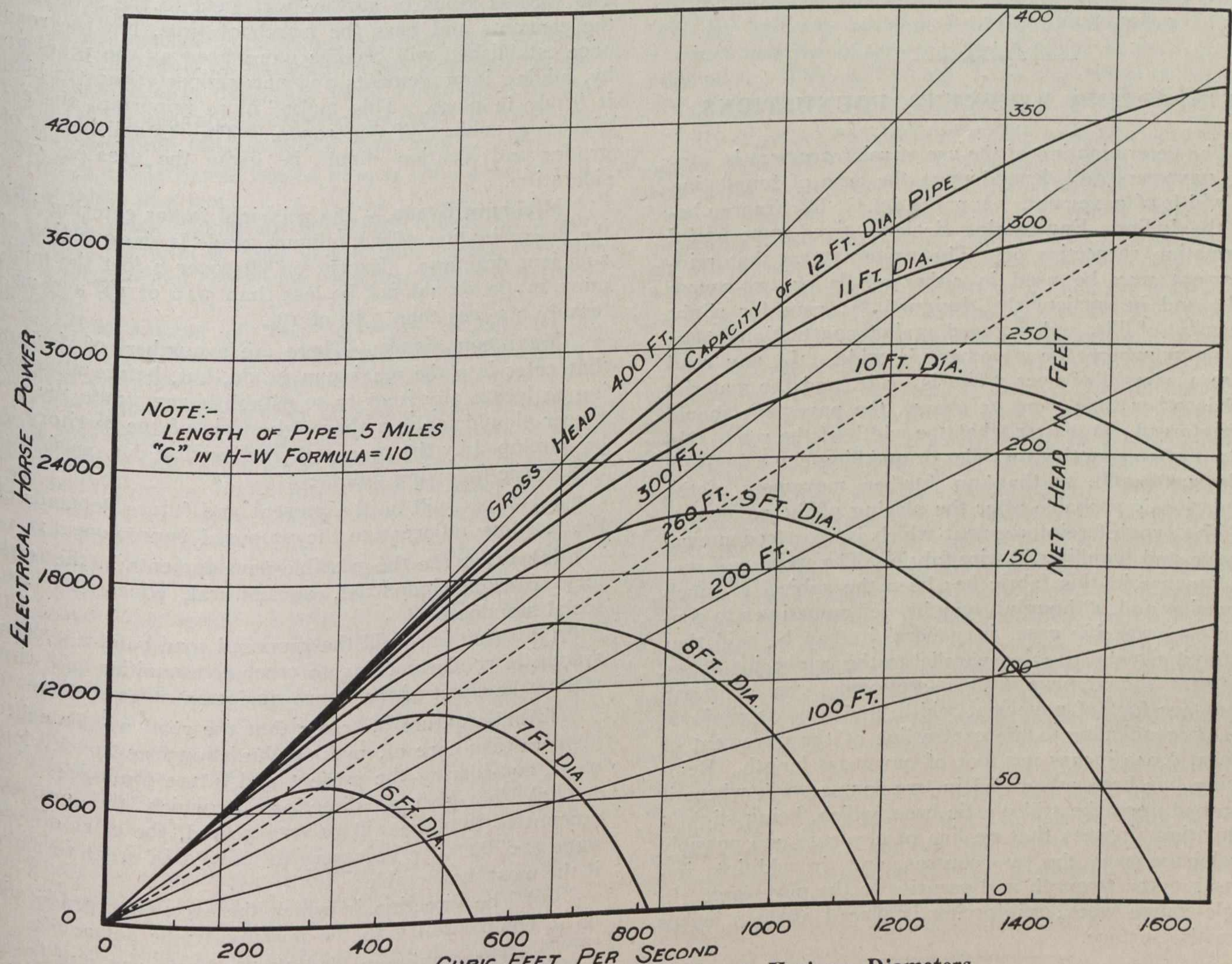
This may be written in the form $P = n\ Q\ h$, where n is a constant, and equal to $\frac{62.5\ E_t\ E_g}{550}$; or $P = n\ A\ v\ h$, where A = area of conduit, and v = velocity in ft. per sec.

Now, $h = H - c\,v^m$, where H = gross head and $c\,v^m = h_f$, or the friction loss in feet. Therefore, $P = n\ A\ v\ h = n\ A\ v\ (H - c\,v^m) = n\ A\ v\ h - n\ A\ c\ v^{m+1}$. In order to get the maximum value of this expression, differentiate with respect to v and equate to zero.

$$\frac{dP}{dv} = n\ A\ H - (m + 1)\ n\ A\ c\ v^m = 0$$

Therefore $H = (m + 1)\ c\ v^m$.

The value of m is a constant usually taken, as a result of experiment, at some value between 1.8 and 2.



Maximum Power Capacities of Conduits of Various Diameters.

Hazen and Williams, in their tables for the losses in pipes, use the value of m equal to 1.85.

Substituting, $H = 2.85\ c\,v^{1.85}$. Now $c\,v^{1.85} = h_f$.

Therefore $c\,v^{1.85} = h_f = \frac{H}{2.85} = \frac{\text{gross head}}{2.85}$. Or, for maximum power in a conduit, the friction loss is equal to the gross head divided by 2.85. If we assume that the losses vary as the square of the velocity this expression will become the gross head divided by 3.

If we use velocities higher than those sufficient to give these losses, the power will decrease as the velocity is increased, until, at the limit, all the available energy in the water is being used up by friction; or when $c\,v^{1.85} = h_f = H$.

The accompanying chart illustrates this very well, as a short study will show. It will be noted that the maximum power for each diameter of pipe falls on the head line for 260 feet, or when the loss of head is $\frac{400}{2.85}$ equal to 140 feet.

It will be appreciated, of course, that no conduit would ever be designed for this maximum condition, as the losses of head are too large for economical operation unless water economy is of no object. In any case, conditions at this point are far too unstable to permit of any speed regulation. Probably, in an actual case, the maximum velocity to be used will give losses about one-third of that for maximum power.

REINFORCING PAVEMENT FOUNDATIONS.

The determination of the use of reinforcement in concrete pavement will depend upon the type of foundation and width of pavement. A paper by C. D. France, before the Indiana Engineering Society, gives some useful information respecting it. The writer states that reinforcement may be used in either single or two-course work, and is particularly designed to care for slight settlement of fills, and to guard against contraction cracks developing where the pavement is wide. In any road where a new fill of over 2 feet is made, and the material used is other than sand or gravel, the pavement should be reinforced, no matter what the width of the road. No amount of compacting by roller or puddling can effectively settle such a fill, so that no further movement of the foundation is probable after the placing of the pavement.

The type of reinforcement which is most economical in price and handling is wire fabric. The weight of material to use in this fabric has been the subject of much discussion and, although it may be well sometimes to consider each specific case, in general it may be said that reinforcing metal running parallel to the centre line of the pavement should have a cross-sectional area of 0.038 inches per foot of pavement width, and a cross-sectional area perpendicular to the centre line of the pavement of at least 0.049 inches per foot of pavement length. Reinforcing has been advocated in two-course work where it is spread upon the still plastic base, which, being slightly undulating, insures that no line of cleavage can possibly develop between the two courses, and, in addition, imparts greater strength and security to the pavement. In single-course work, reinforcing is placed about 3 inches from the surface.

PROGRESS ON SOOKE LAKE AQUEDUCT.

In *The Canadian Engineer* for July 23rd, 1914, the essential features were published relative to the project under way at Victoria to supply 16,000,000 gallons per day through 27.3 miles of reinforced concrete gravity pipe line and 10 miles of 36-inch steel pressure pipe, the supply to come from the Sooke Lake watershed. The work has progressed very favorably since that time. On October 8th the steel pressure main was successfully tested under a maximum pressure of 200 lbs. per square inch. Construction on the 42-inch concrete pipe line is well under way. It is to be noted that little success was achieved in the steam treatment used to hasten the setting of the pipe in the molds at first, and many of the sections had to be culled. Later on, however, the improvement of the steaming process gave much better results, and has proved a decided advantage in the construction of the pipe, and well worthy of note.

GRADES AND EXCAVATIONS.*

By A. D. Williams,
Chief Road Engineer, State of West Virginia.

In the past two or three years stress has been laid upon the subject of permanent roads. Many articles have been written bearing upon the various kinds of surfaces, but the ever-important subject of grade and excavation has received only passing notice. Yet the only permanent thing about a road is its grade and location. The various kinds of surface will yield to the actions of the elements and pass the march of time, but the road once established will become more fixed as the years go by, adding improvements and new property lines to bind it firmly in place. This makes more important the engineering subject of our roads. The establishment of grades and location should be given the greatest consideration.

Minimum Grade.—The principal factor entering into the determination of a minimum grade is the question of sufficient drainage. Except on fills over 2 feet the minimum grade should not be less than 3/10 of 1% and preferably not less than 5/10 of 1%.

Maximum Grade.—There are a number of factors that enter into the maximum grade, but, before attempting to locate any road or to establish any grade the engineer should make a thorough study of the territory to be developed by the proposed road, giving due consideration to the following points:

(1) What will be the present and future demands of the territory adjacent to the proposed improvement;

(2) What are the possible developments in the territory from an industrial, agricultural, educational and social standpoint;

(3) What part will the proposed road be of a general system of roads reaching to other communities and what will be the effect of the improvement on other sections;

(4) The nature of traffic that the road will be called upon to take care of, making due allowance for development, considering the present and future tonnage;

(5) The general direction in which the greatest amount of tonnage will be transported, the class of tonnage and the time necessary to move it in order to make it the most marketable;

(6) The direction in which the ascending grade will be in comparison with the possible traffic demands;

(7) The maximum load that a horse can pull based upon the length of grade and the time required to make the trip, from the standpoint of the horse and the time necessary to get the best results for the kind of material the country will produce;

(8) Consideration should always be given to climatic conditions and to the season that the roads will be required to take care of the heaviest traffic, as well as a study of the foothold for horse-drawn vehicles. The possible amount of frozen or icy weather should be noted in determining a maximum grade;

(9) The class of material over which the road is to be made and the cost of construction on the longer distance compared with the steeper grade and shorter distance have a certain bearing upon the subject, because the most important subject in connection with the cost of roads on grades is that of maintenance which increases very rapidly with the increase of grade. Roughly speaking, the destructive effect of violent and periodical storms

*From a paper read at Fourth American Road Congress, Atlanta, Ga., November 9 to 14, 1914.

is four times as great on a 5% as on a level ground, and nine times as severe on a 10% as on level grade. Thus if no other factors were to be considered on earth roads alone the cost of upkeep in a very few years would justify the elimination of bad grades;

(10) The condition of the right-of-way and the possible chances for disposition of water and drainage are factors of much importance when considering the maximum grade, because on steeper grades the increasing velocity demands more drainage and greater skill in handling the water, which, if kept on or near the road, will soon destroy it;

(11) The consideration of a grade from the ascension is not the only angle of approach in the location of highway grades because important items enter into the descending grade that should be given as much, if not more, consideration than the ascending direction;

(12) A grade should not be steeper than a horse can descend safely in a trot;

(13) A grade should not be steeper than a team can safely descend with a load that it can handle for ten hours under normal conditions, exerting its normal tractive force;

(14) The amount of time necessary to descend a grade should be considered, making due allowance for the maximum speed that can safely be used on that grade;

(15) The highway engineer of to-day must remember that as time passes the motor traffic requirements of the public highway will be more and more exacting. Experiments as to gasoline consumption and its efficiency on difficult grades and materials are now being conducted near Uniontown, Pennsylvania, by Mr. R. O. Gill, Experimental Engineer for the Chalmers Motor Company of Detroit, Mich. In this connection we have but little data. Some recent experiments made by Mr. H. Kerr Thomas and Mr. D. Ferguson, of Buffalo, N.Y., for the Pierce-Arrow Motor Company, show that the class and kind of surface exert more influence upon the motor-driven truck than the percentage of grade and that it requires practically the same tractive force on a 1% grade in sand and loose stone to handle the same load as it does on a 27% grade on concrete, asphalt, new brick and first-class macadam. But observations lead to the conclusion that grades of any length exceeding 5 or 6% are not as satisfactory and as economical as lighter grades for motor traffic owing to the increased hazard, increased consumption of gasoline, and loss of power due to the resistance to gravity. Observation further concludes that in frozen or icy weather motor traffic is extremely hazardous on grades exceeding 10%, and entirely unsafe on grades exceeding 16%;

(16) Grades crossing a summit should merge into each other by some form of vertical curve. The writer has been accustomed to using the following formula which proves satisfactory and practicable. Take the summit grade at *e* and a grade point 100 feet on each side or any other desirable distance and by use of either one of the following formulas find the elevation at *f*, which will be half-way between *e* and *g*, then by use of the formula find the offset from the tangent at each of the ordinates. This subtracted from the elevation of the ordinate will give the true elevation of the grade.

By reference to Gillespie, whose work contains about all we have upon tractive power of a horse, which embraces the experiments of Sir John McNeil, Sir Henry Parnell, and Mr. Cayffier, some of whose works are quoted by nearly every writer, we find that a horse traveling at the rate of 2½ miles per hour can exert 10% of his weight, and traveling at the rate of 4 miles per hour, can exert 6% of his weight. These observations prior to 1850 and just before the advent of the steam road into our field of engineering embrace about all the experiments we have, excepting the work of Mr. E. B. McCormick, of Kansas State Agricultural College, and the works of Prof. J. H. Waters, of the University of Missouri, and other work by Mr. McCormick is now being done for the Office of Public Roads, at Washington. The writer's personal observations have shown that a horse for a limited period can exert ¼, and sometimes even greater percentage of his weight, this depending in a measure upon the kind of shoes on the horse and the foothold on the grade. A horse on a road material that offers safe footing can be safely trotted down a 5% grade, but cannot be trotted down this heavy a grade for any great length of time without injury by "jamming" or "stoving" him up. Therefore, the ruling grade should not exceed 5%, if for a horse-drawn vehicle over which speed must be made on the descending grade, because the average horse in walking down a grade will not make over 4 miles per hour, while he will trot 12 miles per hour; thus, from this standpoint, we can double the distance of the road and increase the time 33⅓%. The speed of 12 miles

Picking, 5c.; Plowing, 2c.; Steam Plowing, 1.5c. per cu. yd. Hauling by wagon, approximately 35c. per cu. yd.
Hauling by trucks and tram, 14c. per cu. yd.

Comparative cost per cubic yard for moving earth with

Distances hauled, feet.	Wheel-barrow.	Drag or slide scraper.	No. 1 wheel scraper.	No. 2 wheel scraper.	1-horse cart.	Wagon.	Tractor and trucks.	Grader.	Casting over bank.
100	$0.057	$0.090	$0.100	$0.100	$0.056	$0.095	$0.080	$0.022	
200	0.114	0.135	0.130	0.125	0.068	0.103	0.080		
300	0.170	0.180	0.160	0.150	0.080	0.111	0.080		
400	0.230	0.225	0.190	0.175	0.090	0.119	0.080		
500	0.285	0.270	0.220	0.200	0.101	0.127	0.080		
600	0.342	0.315	0.250	0.225	0.112	0.135	0.080		
800	0.457	0.405	0.310	0.275	0.135	0.151	0.080		
1000	0.570	0.495	0.370	0.325	0.160	0.167	0.090		
1500	0.857	0.720	0.520	0.450	0.214	0.207	0.090		
2000	1.143	0.945	0.670	0.575	0.271	0.247	0.100		
3000	1.713	1.395	0.970	0.825	0.388	0.327	0.100		
4000	2.280	1.845	1.270	1.075	0.500	0.407	0.100		
Loading by Hand.									
	$.050	$0.010	$0.010	$0.010	$0.130	$0.130			$0.100
Loading by Steam Shovel.									
					$0.060	$0.060			$0.060

per hour should not be undertaken down a grade of more than 3% with a vehicle bearing any kind of a load. In ascending a 5% grade the capacity of the team is about 4/10 of its capacity on level ground and about ¼ of its capacity on 10% grade, on a loading for the same tractive exertion, but a point here that should not be forgotten is that for a short duration a horse can exert from 25 to 40% of his weight, thus doubling and quadrupling its normal tractive force and in this connection it is often better economy, considering the financial condition of the community, to put in a short piece of 6 and even 7% grade, than to expend a large amount of money in making an exhaustive and expensive cut, especially so if the cut must be made at the expense of development in some other part of the community. One thing that should be borne in mind is that each year's development of our country makes the chances for changing of grades and their elimination less possible, and that while the improvement of the surface of a road increases its tractive efficiency about 200% on level ground it only increases about ¼ for a horse-drawn vehicle on a 10% grade, thus money expended in decreasing the grade within a reasonable amount of distance is the best possible investment.

Then, with these conclusions drawn and a decision as to the kind of surface that will possibly be placed upon the road at some future time, we are in position to determine what should be the maximum grade.

Methods and Costs of Grading and Excavating.—This is a machine age and wherever grading can be done by machinery it is usually more economical. The following table, based upon figures taken from different pieces of work, is approximately correct to a wage scale of 15 cents per hour and capable supervision.

By a glance at the figures it will be seen that at 22 cents per yd., or at the same cost for any given ratio, the ratio cost distances are: for wheelbarrow, 200 ft.; drag scraper, 400 ft.; wheel scrapers, 500 and 600 ft.; 1-horse cart, 1,500 ft.; wagon, 1,800 ft., while tractor and truck on track do not reach the amount within one mile. The cost of grading depends materially upon the class of material, the location and the management of the operation.

As to methods, the writer would suggest the use of machinery wherever possible under competent supervision and under proper direction. On work that is light and on which machinery can be employed the work should be done by day labor. On heavier work and large quantities the writer would recommend contracting, and to the contractor a systematic organization of his work so as to get the most efficient service from his men and equipment. There are volumes written covering the subject of cost data in heavier work, but my experience in highway work leads to the conclusion that there are many elements entering into the cost of highway construction that are often overlooked when comparing this class of work with heavier work. One point of deficiency that has been noticeable and should be emphasized here is the lack of organization in highway construction in the various sections of the country. In many instances 50% of the cost could be saved by an adequate organization.

Economical Considerations.—The economical phases of highways and highway construction are many, and call for more than the available space. The history of highways and highway economics can be divided into three periods: The Roman or Ancient Road; the Telford and Macadam period, extending from 1750 to about 1840, and our modern or twentieth century awakening. The Roman road, with its 3 feet of stone, was reduced about one-half in the days of Telford and Macadam, and now, with modern machinery, we are constructing macadamized roads at costs ranging from $1,000 to $4,000 per mile, concrete from $7,500 to $12,000 per mile, and brick from $9,000 to $20,000 per mile. It should be borne in mind that the cross-section of a road should be so as to permit the greater portion of the work to be done by machinery on ground where machinery can be operated, and that an extra width of the road on hillsides increases the cost. A road on hillsides should not be wider than is needed to care for the traffic. In country districts a 9-ft. concrete bituminous or brick or a 10-ft. macadam with 5 ft. of earth on each berm will meet all the requirements at much less cost.

On ground free from roots and stone, where a road machine can be used the material can be moved at a cost of less than 5 cents per yard, and on hillside grading, where the work is casting, a small steam shovel is an economical machine to use. With this should go a drilling outfit and attachments so it can be operated with the same power.

In conclusion, the most economical thing a community can do is to improve its roads so as to serve all its demands, and to do this it should employ a competent highway engineer to make a careful study of the needs of the territory, its financial ability to construct and maintain a road and to locate and superintend the construction of their road for them. When the road is constructed a competent patrolman should be placed on it to continually keep up the maintenance and repairs.

DOMINION GOVERNMENT ELEVATOR FOR VANCOUVER.

The Department of Public Works, Ottawa, purposes constructing a grain elevator with a capacity of 1,500,000 bushels on the government dock on Burrard Inlet, Vancouver. A site 578 x 352 feet with an additional wharfage 800 x 300 feet is being prepared.

The foundations of the plant are to be concrete piers carried down to concrete footings which shall rest on natural bedrock.

The buildings will be of reinforced concrete and will consist of a working house, track shed, storage house, sacking plant, transformer building, and conveyer galleries to handle bulk grain and grain in sacks from the elevator to the dock.

The whole of the work is to be furnished complete and ready for operation to receive, clean, and ship bulk and sacked grain on or before November 1, 1915.

The elevator will complete the chain of terminal and interior elevators erected by the government throughout the west from Port Arthur to the Pacific. The Vancouver elevator is intended to take care of the grain which will move westward from the prairie provinces for shipment via the Panama Canal.

Tenders close on November 30th.

In view of the fact that the war had cut off the supply of blocks formerly secured by England from Northern Europe, British Columbia millmen have forwarded to London samples of blocks made from British Columbia fir.

Division engineers of the New York State Highway Department have been directed in submitting estimates for construction to include hereafter an approximation of the number of working days required to complete each contract. This, it is expected, will enable the Highway Department to specify time limits on contracts more accurately, as the local engineers who work up the field notes are unquestionably in a better position to weigh carefully the elements which enter into the building of a piece of road than the office force are.

MUNICIPAL IMPROVEMENTS IN ALBERTA TOWNS AND CITIES.

SOME very interesting figures relating to the installation in 1913 of waterworks, sewerage and sewage disposal works in the Province of Alberta are presented in the report of R. B. Owens, B.A., B.E., Provincial Sanitary Engineer, in the recently issued report for last year of the Alberta Department of Agriculture. The following is a detailed list of new works or extensions, with estimated costs:

Waterworks.

Gleichen: Completion	$ 4,851.00
Blairmore: System	15,000.00
Tofield: System	14,000.00
Redcliff: Extension	120,000.00
Bassano: System	17,800.00
Athabasca Landing: System	127,440.00
Edmonton: Extension	311,600.00
Lethbridge: Extension	34,636.00
Medicine Hat: Waterworks plant	75,000.00
Extension	225,000.00
Extension	193,410.00
Calgary: Extension	378,000.00
Extension	643,200.00
Edson: System	90,000.00
Coronation: System	40,000.00
Total estimated cost for water	$2,289,937.00

Sewerage and Sewage Disposal Works.

Bassano: Sewage disposal system	$ 12,000.00
Extensions, sewerage system	1,500.00
Athabasca Landing: Sewerage system	70,000.00
Edmonton: Extension to sewerage system	569,500.00
Lethbridge: Extension to sewerage system	92,500.00
Extension to sewerage system	72,000.00
Extension to storm sewerage system	13,595.00
Extension to sanitary sewerage system	18,627.00
Medicine Hat: Extension to sewerage system	144,484.00
Main trunk sewer outlet and pumping station	105,000.00
System of storm sewer	50,000.00
Calgary: Extensions to sewerage system	348,750.00
Extension to sewerage system	43,731.00
Extension to sewerage system	30,628.00
Edson: Sewerage and sewage disposal system	55,000.00
Total estimated cost of sewerage and sewage disposal works	$1,627,315.00
Total estimated cost of waterworks, sewerage and sewage disposal works	$3,917,252.00

The present standing of the various cities and towns in Alberta, with respect to municipal improvements, with the exception of roads, streets, etc., is as follows:

Edmonton.—Population, 73,000; water supply, m.o. (municipally owned), pumped from Saskatchewan River; 2 intakes consisting of steel pipes with screens and cribbing protection. Water mains, 128.6 miles; 9,275 house services; 5,738 houses without services; 1,477 stopvalves; 648 hydrants, and 14 fountains. Daily consumption, 5,000,000 gal. Mechanical filtration plant (Roberts). Samples tested every other day in provincial laboratory.

Sewerage system, partly combined and partly separate; 117 miles of sewers, ventilated at man holes and vertical soil stacks; 9,275 house services; 8 gravity outfalls to be reduced to 3. Part of the sewage treated by sedimentation.

There are two refuse destructors, a Heenan and Froud on the south side and a Decarie on the north.

The first town down stream is Fort Saskatchewan, 20 miles distant by river.

Calgary.—Pop., 80,000; water supply, m.o. Source, by gravity from Elbow River and by pumping from Bow River, both chlorinated. Bow River intake is a compound flume of reinforced concrete leading to pumps 600 ft. distant. Elbow River intake is a timber crib at the river bank. Water mains, 184 miles; 12,000 house services, and 400 houses supplied from 50 standpipes; 1,002 hydrants. Daily consumption, 11,750,000 gal. Samples tested regularly in municipal laboratory.

Sewerage system partly combined and partly separate; 188 miles of sewers, ventilated at every house service; 7,940 house services; 1,010 catch basin connections; 7 gravity outfalls into Bow and Elbow Rivers east of city, to be reduced by intercepting sewers built or under construction, to one main outfall. No part of sewerage treated. Plans under way for treatment system; packing plants and other trades deliver waste into sewers without preliminary treatment.

There are two refuse destructors, both Heenan and Froud.

Municipal gas supply, natural; obtained from Bow Island.

Medicine Hat.—Pop., 14,000; water supply, m.o.; source, South Saskatchewan River, by low-lift pumps to filters and high-lift pumps to reservoir and standpipe, with capacities 2,750,000 and 500,000 gal. respectively. Intake is a 36-inch cast iron pipe with concrete pier and a 20-ft. diameter well on the river bank. Water mains, 31 miles; 2,350 house services; 240 stop valves; 170 hydrants, and 6 fountains. Daily consumption, 3,000,000 gal. Mechanical filtration plant (New York Continental Jewell). Samples tested regularly in Medical Health Officer's laboratory.

Sewerage system, separate plan; 20.3 miles sanitary sewers ventilated through man-holes 94 yards apart, and vertical soil stacks; 3.2 miles storm sewers; 1,000 house services; 96 catch basin connections; three outfalls into South Saskatchewan River, each with a pumping station for discharge during high water. Daily discharge, over 1,000,000 gal. Sewage is not treated.

The first town down stream is Saskatoon, about 600 miles distant by river.

Municipal gas supply, natural, 1,050 B.t.u.; 38 miles of high and low pressure gas mains; 2,265 house services.

Lethbridge.—Pop., 11,000; water supply, m.o. Source, by pumping from Belly River; 38 miles of water mains; 2,000 house services and 120 houses without services. Daily consumption, 1,500,000 gal.; not filtered.

The first town up stream is Macleod, 30 miles distant by river; down stream, Diamond City, 6 miles distant.

Sewerage system, separate plan. One storm sewer with 100 catch basin connections. Two gravity outfalls; sewage treated in sedimentation tanks and filters.

Gas supply, natural; supplied by private company from Bow Island.

Macleod.—Pop., 2,500; water supply, m.o. Source, Old Man River; pumped by steam; 2 intakes, 16-inch wood pipe 700 ft. long and 20-inch wood pipe 2,300 ft. long, respectively. Water mains, 8.5 miles; 425 house services; 152 stop valves and 55 hydrants. Daily consumption, 450,000 gal.; mechanical filtration plant (Roberts).

Sewerage system, combined plan; 6 miles sewers with man holes 100 yards apart; 225 house services, catch basins trapped; 1 gravity outfall into Old Man River; disposal works to be constructed.

Wetaskiwin.—Pop., 3,500; water supply, m.o. Source, 3 wells each 250 ft. deep; pumped by compressed air to underground concrete reservoir, thence to elevated water tower with 227,000 gal. capacity. Supply ample. Water mains, 6.25 miles; 268 house services; 300 houses without services; 65 stop valves and 51 hydrants. Daily consumption, 100,000 gal.

Sewerage system, combined plan; 6.4 miles of city sewers and 3.5 of outfall sewers; ventilated at man holes and tops of house service stacks; 267 house services and 17 catch basin connections; 1 gravity outfall 3½ miles from city. Daily discharge, 120,000 gal.; treated in sedimentation tanks and effluent disinfected.

Municipal gas supply, natural, 975 B.t.u.

Red Deer.—Pop., 2,500; water supply, m.o. Source, Red Deer River by pumping; 1 intake, an 18-inch gravity flow pipe to two wells 18 ft. diam. and 20 ft. deep. Water mains, 7.25 miles; 305 house services; 102 stop valves; 34 hydrants, and 2 fountains. Daily capacity, 400,000 gal., filtered through 2 ft. of sand cylinders in each well.

Sewerage system, combined plan; 4.76 miles of sewers, ventilated at man holes 130 yards apart. 215 house services; 45 catch basin connections, untrapped; 1 gravity outfall into Red Deer River.

Redcliff.—Pop., 3,200; water supply, m.o. Source, South Saskatchewan River by pumping. Water mains, 15.5 miles; 308 house services, 108 houses without services; 106 stop valves, 33 hydrants. Daily consumption, 100,000 gal.; natural filtration.

Gas supply, natural, supplied by private company; 16 miles of mains and 430 house services.

Camrose.—Pop., 3,100; water supply, m.o. Source, 3 wells 130 ft. deep; pumped by compressed air to reservoir, thence by centrifugal pumps to water tower. Water mains, 2.5 miles; 90 house services; 23 stop valves, and 28 hydrants. Daily consumption, 37,500 gal.

Sewerage system, separate plan; 3 miles sewers and 90 house services; 1 gravity outfall discharging 33,000 gal. per day; treated on earth beds and effluent, disinfected by bleaching powder.

Athabasca.—Pop., 2,000; water supply, m.o. Source, Athabasca River by pumping; 1 intake, two 8-inch lines steel pipe to suction well; 4 miles water mains. No house services, system used entirely for fire protection. 22 stop valves and 24 hydrants.

Bassano.—Pop., 2,200; water supply, m.o. Source, Bow River, by pumping to a stand pipe; 1 tunnel intake, water gravatating to deep well. Water mains, 5½ miles; 40 house services and 250 houses without services. Daily consumption, 180,000 gal. to town and 150,000 to C.P.R.

The first town up stream is Calgary, 85 miles distant; down stream, Medicine Hat, 97 miles distant.

Sewerage system, combined plan; 3½ miles of sewers; 40 house services and 16 catch basin connections; 1 gravity outfall discharging into disposal works 2.5 miles from town.

Town has a Reid incinerator.

Claresholm.—Pop., 1,000; water supply, m.o. Source, Willow Creek; filters into gallery, gravitated to town and is pumped to increased pressure; 4 miles water mains. Daily consumption, 50,000 gal.

The town is supplied with natural gas by a private company.

High River.—Pop., 1,500; water supply, m.o. Source, Highwood River by pumping; infiltrates into concrete well at 600 gal. per min.; 1½ miles water mains; 43 house services; 34 hydrants.

Sewerage system commenced in 1913. Sewage to be discharged by pumping.

The first town down stream is Carmangay, 40 miles distant.

Blairmore.—Pop., 2,200; water supply, m.o. Source, York Creek by gravity; 4½ miles water mains; 200 house services; 8 stop valves and 38 hydrants.

Gleichen.—Pop., 80,000; water supply, m.o. Source, deep well by pumping; 1½ miles water mains; 22 stop valves; 6 hydrants. Daily consumption, 6,200 gal.

Sewerage system, combined plan; 1½ miles sewers, ventilated at man holes; 1 gravity outfall discharging 5,000 gal. per day. Sewage treated in sedimentation basin.

All these cities and towns have municipal engineers and staffs, with the exception of Red Deer and Comrose, where the municipal engineering is looked after by local firms of civil engineers.

THE GREATEST PRACTICAL TEST FOR THE MOTOR TRUCK.

IN *The Canadian Engineer* for October 8, editorial reference was made to the extensive use of the motor vehicle in the European war and to the policies of the belligerent powers toward the subsidization of manufacturers and users. Motorized military equipment extends beyond the main services of transportation of troops and commissariat to a host of auxiliary needs. The various services in which motor vehicles are employed receives a concise but comprehensive study by R. W. Hutchinson, Jr., in The Engineering Magazine for November. The following extracts will be found interesting:

Both light artillery and machine guns are being hauled on motor trucks. In the advance on Liège over a hundred motor trucks were used in carrying machine guns alone. In transporting field guns the cannon are generally placed on a trailer wagon, the carriage on another trailer, while the truck carries entrenching equipment, repair parts, tools, tanks of fuel and oil for itself, etc. Heavy siege guns and mortars are being moved, where road conditions permit, by two large tractor trucks in side-by-side fashion; but the 30-horse team is still being largely used for the heaviest siege guns. Trucks may serve as towing units, but they are too valuable for other services—provisioning the army, for instance. A close comparison of the speed and distances moved by the Germans and French in the war of 1870-1 will disclose the fact that to-day with motor transport the armies are operating at twice the distance from their base compared with the work 44 years ago.

Also without motor trucks, the immense armies now measured in millions instead of thousands would be difficult indeed to provision, as the battle lines have extended from 100 to 250 miles front, and have shifted so rapidly in position that if dependence were just on army mules supplying them with food, movements would be slow, the fighting efficiency of the men greatly impaired, and the slaughtering of the huge herds of cattle now necessary to victual the vast hosts would make sanitation impossible, leading to malignant disease and pestilence. Again, space where such prodigious numbers are now employed is valuable. A motor-transport train occupies only one-third of the space of the animal-drawn wagon, and being positioned much farther behind the army, causes less congestion between the main army and its auxiliaries and between the army and its base. Moreover, half of the load carried by animal-drawn army transports is a "non-paying" load, as it is food for the motive power—the mules; the efficiency is very low and the speed but a third that of motor transports.

The number of wounded in the present war is reported to be unexpectedly great, due to small-calibred, high-penetrating-power steel bullets; hence the carrying of wounded to hospitals in motor ambulances to save time and lives and to pick up the wounded rapidly is as important as motor supply trains. The usual form of motor ambulance in the service of both the French and German armies is in general appearance similar to the now more or less familiar automobile ambulances of city civilian service. Inasmuch as they are expected to do cross-country work, they are usually modified or standard passenger-car chassis of larger wheel base, arranged with stretchers in decks along the sides, and collapsible, removable seats for the less severely wounded. A number of army motor ambulances are, however, mounted on truck chassis and are veritable modern travelling hospitals, as for example, the Boulant type (named for its originator) field hospital of the French army. The body of this moving hospital (which, though of restricted capacity, adequately meets the surgeons' requirements) consists of three compartments—the forward one containing electrical apparatus, the middle one an operating room, and the rear division radium and X-ray equipment. The wide compartment bodies mounted on long-wheel-base chassis are lighted by roof windows and dome lights, with space enough in the operating room for tables, stands, and other absolute essentials. Electrical sterilizers in the front compartment sterilize 15,000 liters of water in 24 hours by the use of ultra-violet rays. Fitted alongside of the body are folding tents for hospital service, the interior of course, being too small to keep the patient permanently there. These Boulant field motor-hospitals are accompanying the troops in service, or are stationed at temporary convenient points. When mobile they can travel at a speed of 18 miles per hour. The number of these Boulant hospitals is small, however, and even the large number of standard motor ambulances are inadequate, so passenger cars and motor omnibuses of large carrying capacity are being requisitioned. When the veil of censorship is lifted and we get a detailed report of the frightful conflicts, the motor-vehicles' service in saving the lives of thousands of wounded will be a bright and comforting commentary.

In the aviation corps of the armies a two-wheeled trailer on which is mounted a canvas-covered frame constituting a portable hangar for aeroplanes is being pulled by a light truck at a speed of 18-25 miles per hour. These trucks carry, in addition to the renewal parts for themselves, extra parts for the aeroplanes, motor fuel, etc., and when a number are concentrated in one zone or section they are maintained in fit operating condition by a motor aeroplane-repair shop, consisting of a large, wide-bodied motor truck fitted up with an assortment of machine tools, small lathes, drills, a small forge and anvil, with tools power-driven by the truck's own engines through small electric motors. Skilled mechanics qualified to do repairs and adjustments on aeroplanes and motor vehicles accompany these ingenious portable machine shops. The French and German infantry are also equipped with a number of aeroplane destroyers, which are light, swift, armored motor trucks with superposed rapid-firing guns of 7-mile range, shooting a projectile of special type of 4.1 kilogrammes weight with a muzzle velocity of 670 meters and 93.8 meter-tons energy equivalent. Mounted in roofless steel towers and with a 45 degree inclination of muzzle of these aeroplane-destroying guns, the projectile has an ascent of 3,700 meters; with 75 degrees angle, 7,910 meters. The turret walls are such as to give a sweep of the gun a considerable distance above. Sighting of the gun is effected by means of a hand wheel working free of the pointing angle and the angle of the earth, final aiming being made by telescope with rigid eye-glass. Twisting reaction is arrested automatically. Armor plate protects gun and operator from light projectiles, as well as the vital mechanism of chassis and projectile receptacles along the sides of the truck.

Armored motor trucks operating both on railways by means of special flanged wheels and in regular manner, equipped with mitrailleuse, machine, and other forms of light guns or loopholes for sharpshooters, are being used to harass advance forces or cavalry. In addition, many hundreds of motorcycles carrying small quick-firing guns are being used to disperse advance scouts.

Quick and efficient communication between the tremendous forces of combatants with battle fronts of 50 to 250 miles is no longer possible by scouts, couriers, and heliographic devices. The long-range combat with terrible engines of destruction means radio or wireless communication, and every one of the Powers now at war is employing portable wireless telegraph plants carried on motor-truck chassis geared for speeds of 25 to 35 miles per hour. The truck motor drives an electrical dynamo which generates the primary current of the high-tension transformer necessary in radio transmission, and the complete paraphernalia of condensers, interrupters, collapsible antennæ, etc., are carried on the truck which is generally fitted with a protecting shield for the driver, and a special convertible body with sliding panelled sides which can be tightly closed in stormy weather. These motor-truck wireless outfits having an effective land range of 200 to 300 miles have enabled the armies of the "Dual Alliance" and the Triple Entente to keep in communication with their base, wings, and reinforcements—a task impossible in modern warfare without the radio telegraph and—most important—the motor truck on which to move swiftly the instruments and their relatively large space-requiring auxiliaries from position to position.

Numerous motor-searchlight outfits are being used by the armies of both sides. Like the wireless field outfits, the engine of the motor truck on which they are carried generates the electrical current for their operation. The searchlight is mounted on a four-wheel platform truck with rubber-tired wheels, which enable the auxiliary searchlight truck to be quickly and easily demounted and remounted and drawn independently by men or horses if required, and enable the motor truck to be utilized for other purposes. These portable searchlights, being thus self-contained, independent power plants, have permitted the dreadful night battles of which censors have undeleted enough to let our imagination portray in part the horror. These portable searchlights and their allied motorized aerial observation ladders have indirectly served as terrible allies of death and destruction. The aerial observation ladders are carried on long-wheel-base fast motor trucks and in general appearance are like the motorized hook and ladder outfits of modernized city fire departments.

The supplying of ammunition to the armies of 15,000,000 men now, or that probably will be, participating, will be a gigantic task—a task in feeding thousands of machine guns that use cartridges at 400 per minute, second to feeding the prodigious troops. only bigger-capacity motor trucks moving 3 to 4 times faster than horse-drawn ammunition wagons can be equal to the task.

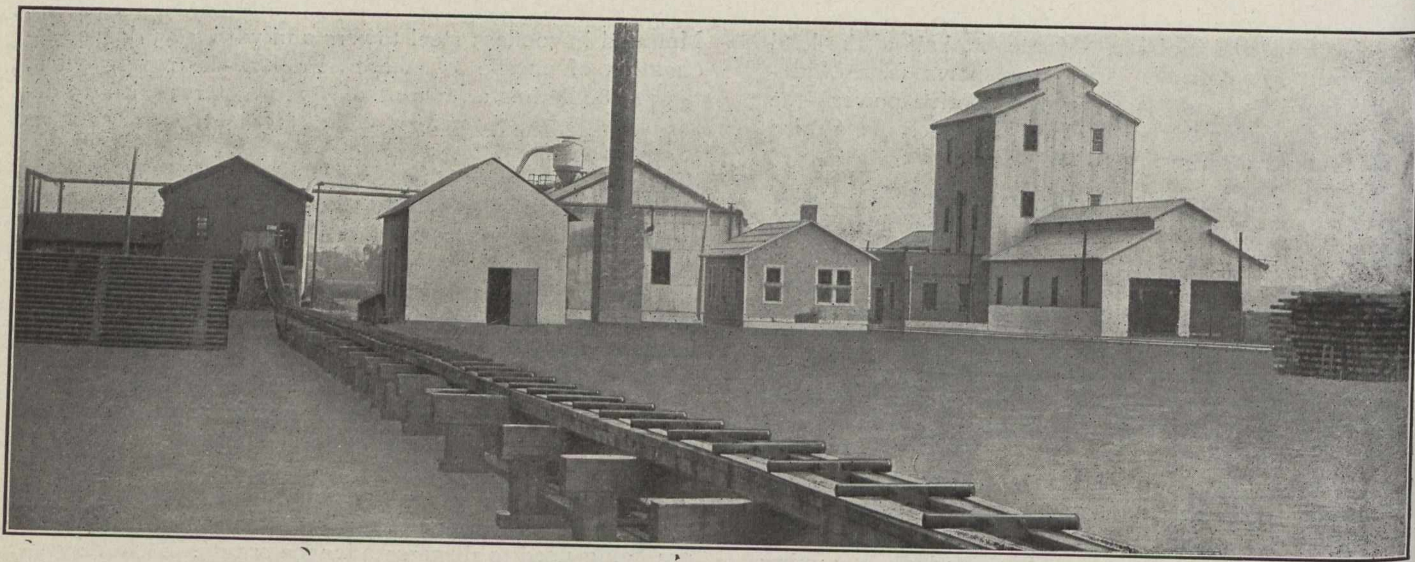


Fig. A.—Main buildings of a typical modern creosoting plant.

THE BATTLE AGAINST ROT

WHY CANADIAN RAILROADS AND MUNICIPALITIES ARE PREFERRING TREATED TO UNTREATED TIMBER — DESCRIPTION OF METHODS USED AND RESULTS OBTAINED — SOME NOTES ON THE WOOD PRESERVING INDUSTRY IN CANADA.

CANADA'S rapid railway growth—thirty thousand miles now, compared with half that amount twenty years ago—and the increasing cost and decreasing supply of good ties, has attracted the attention of the wood preserving industry to the Dominion. Forestry experts claim it takes sixty years to grow a tie, and that we place it in the track to rot out in from five to seven years, whereas it would give from eighteen to twenty-five years' service if preserved, or treated, before being used.

On this continent in 1885 only 120,000 ties were treated out of a total of 50,000,000 used, while in 1912 about 30,000,000 were treated out of about 150,000,000 used. In other words, only about 1/400th part of the ties were preserved in 1885, while in 1912 1/5th of all the ties used were treated. In Canada alone in 1910 practically no treated ties were used. In 1911, 200,000 ties were preserved before being placed in the roadbed. This was 1.4 per cent. of the total number used. Last year about 2,500,000 ties were treated, or 10 per cent. of the total number used. This shows that the Canadian railways have commenced the battle against rot.

Rot is the chief cause of failure of timbers such as ties, paving blocks, piles, etc. It is the breaking down of wood fibre that is caused by the growth of small plants organisms known as fungi. The spores or seeds of the fungi, which are usually carried by the wind, alight on timber and grow, sending microscopic threads or rootlets into the timber. These organisms live on the timber as food, causing the eating away or breaking down of the wood fibre.

Certain amounts of each of four things are absolutely essential to the existence of these fungi; namely, air, moisture, heat and food. Take away entirely any one of these four, and the fungi cannot live. The timber cannot be protected from air except in occasional instances, such as piles that are entirely submerged, in which case the timber needs no other protection from fungi, but may be exposed to teredo attacks.

It is also difficult, as a general rule, to protect the timber from moisture, but where it can be so protected the growth of the fungi is stopped. This is shown, for instance, by the excellent condition in which one often finds very old timber in interior construction.

If one could keep timber at or below the freezing point—say, in a cold storage plant—fungi could not live; but from the practical standpoint it is impossible to protect timber from heat.

Therefore, the only thing that can be affected to destroy the growth of the fungi—the only one of the four essential conditions that can be removed—is food. The fungi have only the wood fibre for food, and if that food can be rendered poisonous, the wood will be preserved against their attacks. This is done by treating the wood with a highly antiseptic fluid.

To properly treat a tie in order to preserve it against decay requires a modern treating plant of considerable cost and complexity. In 1885 there were only three of these plants in operation on the continent, while there are now over one hundred such plants in existence, with an aggregate capacity of over 100,000,000 ties a year. In Canada we have but five of these plants, all built within the last four years, with an aggregate capacity of approximately 4,500,000 ties per annum. These plants are located at Sydney, N.S.; Fort Francis, Ont.; Trenton, Ont.; Transcona, Man., and Vancouver, B.C.

Such plants consist of retorts, pressure pumps, vacuum pumps, proper gauges, storage tanks, measuring tanks, etc. Fig. B is an interior view of the retort house at the Trenton plant. The retort (1) is shown at the right of the photograph. It is 134 feet long, 7 feet in diameter, and has a net capacity of about 2,500 cubic feet of wood.

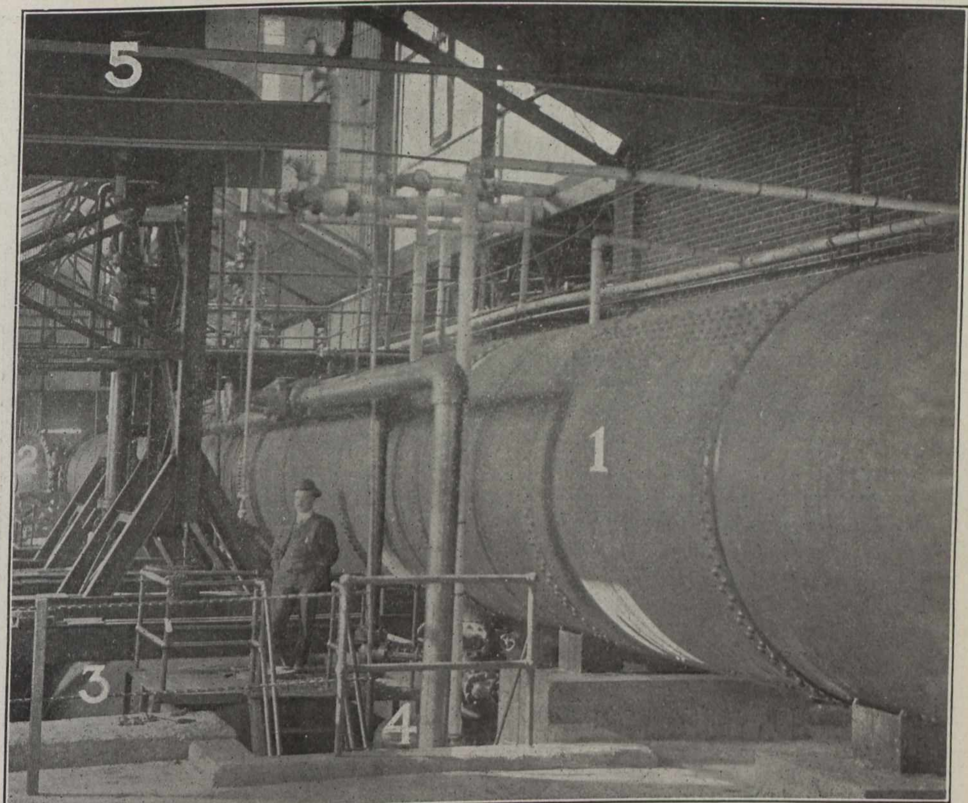


Fig. B.—Interior of retort house. 1, Retort. 2, Retort door. 3, Receiving tank. 4, Pump. 5, Overhead tank.

The retort is built of riveted boiler plate to withstand 225 pounds pressure per square inch. There is a door (2) at each end which is securely bolted and sealed after the retort has been charged. A receiving tank (3) holds the creosote oil that is drained from the retort after the finish of the pressure treatment, and also after the finish of the vacuum treatment. A centrifugal pump (4) forces this oil from the receiving tank to the overhead tank (5), from which the supply is drawn when the treatment is begun.

Steam coils run along the bottom of the retort for its entire length in order to regulate the temperature of the preservative during treatment. The end of these coils can be seen in Fig. E. At the operator's station is a board on which is mounted a number of gauges, both indicating and recording. One gauge indicates the pressure in the retort and one records it on a timed sheet. The amount of vacuum is indicated by another gauge and recorded, with the time, by still another. The temperature is indicated and recorded according to time.

Among the plant's equipment are several trains of tram cars, such as are shown in the centre of Fig. C. These are used to convey the ties and lumber into the retort for treatment. Sixteen tie lengths are used to make up a train; a tie length to each tram car; each tram car holding about 60 ties. The train is pushed by an electric locomotive right into the retort. Fig. E is a view of the end of the retort after a train has been pushed in and just before the door is closed. The stretch of track shown in the foreground of Fig. E is removable, the two rails simply forming a connecting link between the end of the track which runs from the yard and the track in the retort. These links, of course, must be taken up before the door is closed. The cars are not coupled, but are so constructed that they can push against each other without disturbing the load, a cast steel bumper being attached to each end of every car. A wire cable is fastened to the car farthest from the locomotive, so the train is easily drawn out.

A different type of tram is used for treating paving blocks. A train of them is shown at the left of Fig. D. After these trams are filled with blocks, a perforated slide closes across the top of each tram, holding the blocks in place but allowing the creosote oil to flow through the perforations and fill the car.

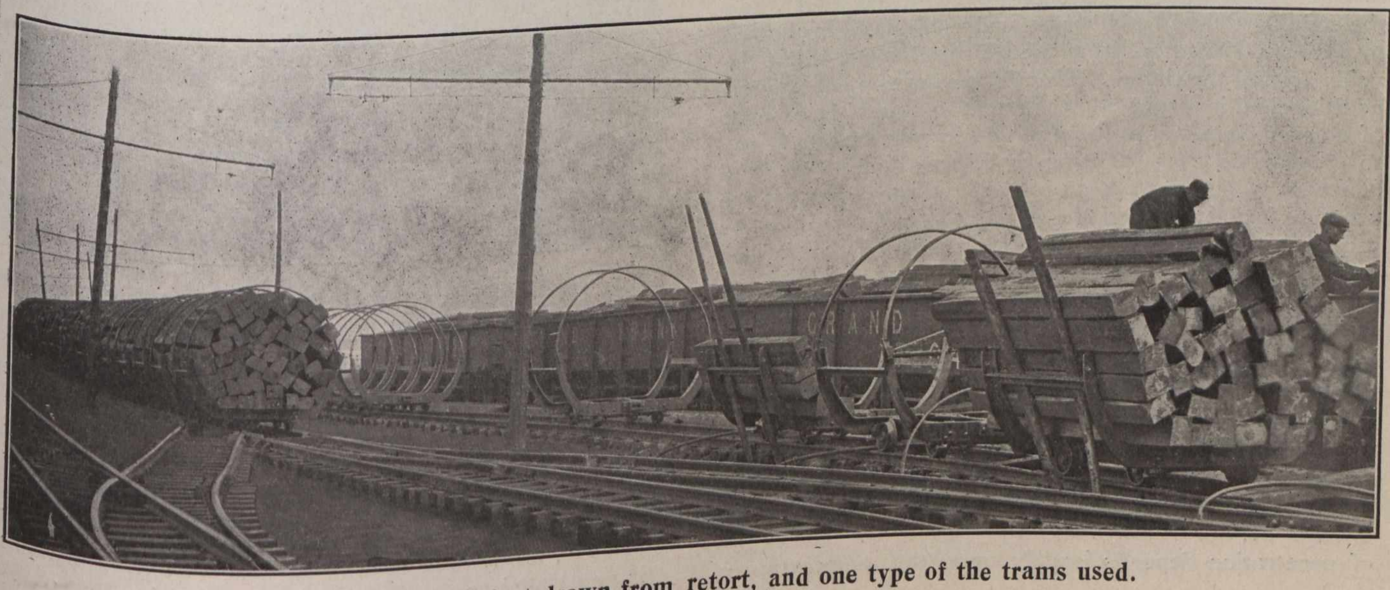


Fig. C.—Train of ties just drawn from retort, and one type of the trams used.

The paving block mill which operates in connection with the treating plant and manufactures the lumber into paving blocks, consists of a conveyer, a planing mill, saw tables with saws, etc. Seasoned lumber is loaded onto the conveyer, shown in the foreground of Fig. A, which carries it into the block mill. It passes on live rolls in a straight line through the planer and onto the saw table, on which it is fed into a mill of from sixteen to twenty saws which cut fifteen to nineteen blocks at a time. The sawn blocks drop onto another conveyer which carries them from the mill. As they pass out they are inspected and, from the conveyer shown in Fig. D, they are loaded into the cages, as the paving block trams are called. Sixteen of these cages are used to make up a train for each charge. Each cage contains about forty square yards of blocks.

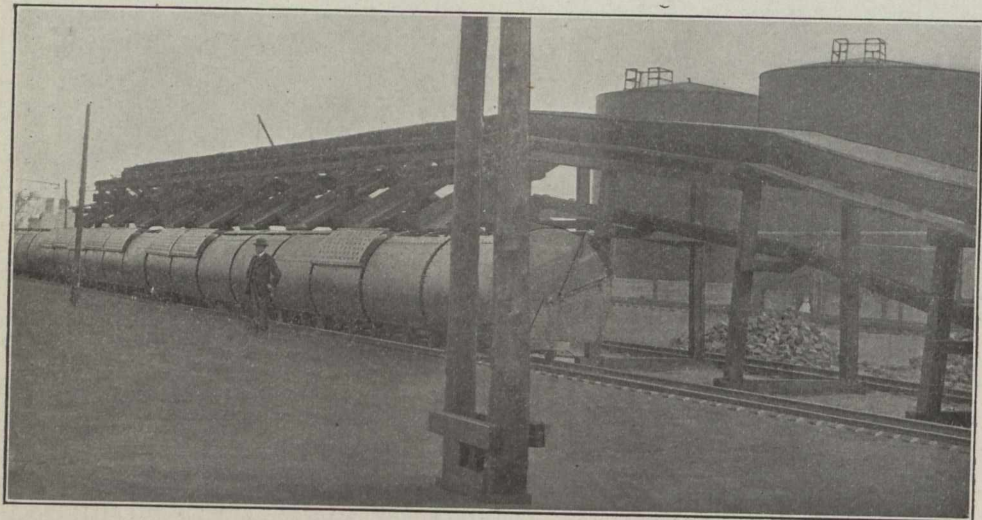


Fig. D.—Conveyer filling trams with paving blocks. Storage tanks in background.

Ties and timbers from the seasoning yard are loaded onto tram cars such as are shown in the centre of Fig. C and a number of trams placed together to make a train such as is shown at the left of Fig. C, ready to be pushed by the electric locomotive into the retort. The trains of block cages are made up at the conveyer at the end of the block mill, as shown in Fig. D, where they have been filled with blocks.

When the treatment is started after a train of paving blocks, ties or lumber has been placed in the retort, and the end doors closed and hermetically sealed, oil is allowed to flow into the retort from the overhead tank, filling the voids around the timber. Then by means of steam pumps additional oil is forced into the retort to obtain the amount of pressure required to thoroughly saturate the wood, 100 to 180 pounds pressure being used, according to the kind of wood. Upon completion of the pressure treatment the pressure is released and the oil is rapidly drawn into the receiving tank. A vacuum of from 23 to 27 inches is then quickly created in the retort by means of a special arrangement of vacuum pump and condenser. This vacuum is sustained from an hour to an hour and a half, and draws from the wood the surplus oil. After this surplus oil is drawn off, the doors of the retort can be opened and the train withdrawn.

During the treatment heat plays an important part as well as pressure and vacuum. The temperature during the pressure treatment is never allowed to drop below 150 degrees F., nor to rise above 190 degrees F. The degree of penetration depends largely upon the temperature of the oil; the higher the temperature, within certain limits, the freer the liquid will flow and the more easily it will enter the pores of the timber after the timber has become warm and the pores expanded by the heat. Some kinds of wood offer little resistance to the oil, while other kinds offer great resistance, depending on the size of the pores, the smoothness of the cell walls and the extent to which material obstructions are contained in the cells. The temperature, pressure, vacuum, etc., are readily regulated by the operator, all valves and the controlling apparatus being near the station from which he watches the process.

A complete record is kept so that any official of the creosoting company, or the customer's representatives, can check the operator's discretion and skill. These records are kept, and should it be desired to refer to them at any time for any reason, even after a lapse of many years, one can easily do so.

A clocklike device shows the amount of oil in the overhead tank, both before and after treatment. The difference, of course, is the net amount left in the charge. This method is remarkably accurate. It is checked up monthly by actual and precise measurements, and is also verified by weighing the timber before and after treatment. The whole process of treatment takes from three to five hours for ties and from four to eight hours for paving blocks. If the ties are well barked, in good condition and well seasoned, the treatment does not take so long as it does otherwise.

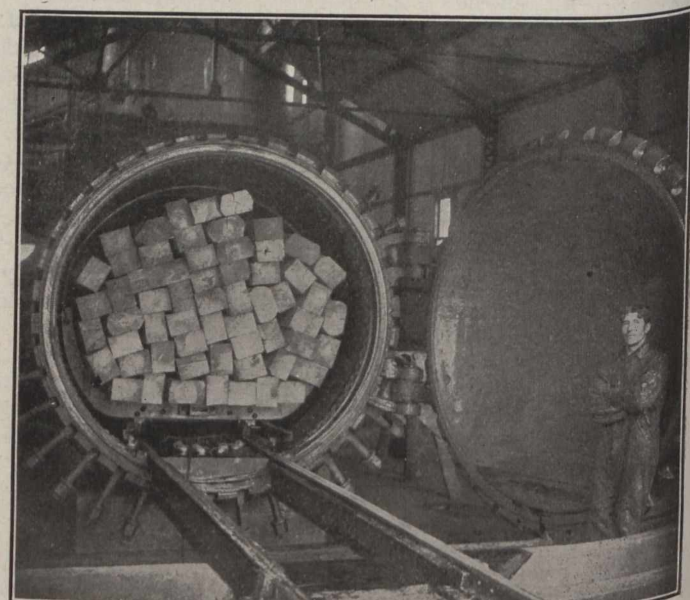


Fig. E.—End of retort after insertion of charge but before door is closed.

Various preservative fluids are employed, but that which is in most general use is creosote oil. Of the five plants in Canada equipped for preserving wood on a large scale, all except one use creosote oil. The plant at Fort Francis, Ont., uses chloride of zinc. Unless the timber is penetrated so deeply with the preservative that checks or openings cannot reach beyond the treated zone, the spores will find their way in through the checks to the untreated portion and cause interior rot, which is frequently misnamed "dry rot." The depth of penetration of the creosote oil depends on the amount of oil that is forced into the wood, yet it is not necessary for the preservation of the timber to leave so much oil in the timber as must be put into it in order to obtain the required penetration. Therefore, many plants use the process whereby a large quantity of oil is forced into the timber, thus insuring thorough penetration, but whereby a considerable portion of this oil is afterwards drawn from the timber by the creation of a high vacuum. This leaves in the timber only the amount of oil that is needed, and the oil is evenly distributed throughout the timber (except impenetrable heart wood), instead of simply being distributed densely at the surface. By this method proper penetration can be secured without adding so greatly to the cost as would be done if all the oil were left in the timber that had been put in to obtain the penetration.

Following is the record of a treatment recently given an order of Norway pine paving blocks, three inches wide by four inches deep, for the City of Toronto:

Creosote oil in each cubic foot of timber at end of pressure.	Net gallons remaining in each cubic foot at end of vacuum.
34.35	22.41
25.20	19.61
26.60	19.57
26.50	20.61
27.03	21.53
25.74	20.64
24.80	19.01

The objective was a twenty-pound treatment. It will be seen that the net average was 20.48 pounds. These blocks were treated at the plant of the Canada Creosoting Company, Limited, at Trenton, Ont.

After the blocks, ties or timbers have been treated, the penetration is inspected by the representatives of any inspection company who may be present on behalf of the purchasers of the materials, by cutting the blocks in two by means of a hatchet, or extracting small borings from the ties and timbers. These borings are made with a Swedish instrument which resembles a miniature core drill in its action. A perfect core several inches long and about 3/16ths of an inch in diameter is taken out of each timber that is bored. Examination of these cores shows the depth and uniformity of penetration.

The method of loading ties onto the railroad cars after treatment is shown at the right of Fig. C. The handling of large timbers, both before and after treatment, is all done mechanically.

Before ties and timbers are treated, or before lumber is cut into paving blocks, it is stacked on the seasoning yard for months, to become properly seasoned. The lumber is stacked in open piles, so as to permit the free circulation of air, for three to five months. The ties are piled in such a manner as will permit of good air circulation and at the same time not allow sufficient exposure to cause checking. It requires from 6 to 10 months to properly season ties. Fig. F shows the manner of piling ties.

Fig. A is a general view of the Trenton plant. The buildings, reading from the left to right, are the block mill, machine shop, boiler house, office and retort house. The company also owns its own tie camp, north of Trenton, which it organized in order to get hard wood ties.

The trestlelike structure in Fig. D is the conveyer running out from the block mill. The sawn blocks are carried out on this conveyer. Chutes will be noticed running from the conveyer to the cars, and when the cars are pulled into place under these chutes, trap doors are opened in the conveyer just over the chutes and the cars are filled. In the background of Fig. D can be seen large tanks for storing oil, holding 150,000 gallons each.

Creosote oil, the preservative used at the Trenton plant, is defined scientifically as any and all distillate oils boiling between 200° and 400° C. which are obtained by straight distillation from tars consisting principally of compounds belonging to the aromatic series and containing well-defined amounts of phenoloids. Or, to be less technical, creosote oil might be defined as a distillate from the tar which is produced as a by-product in the manufacture of coal gas from bituminous coal by the retort method; or a distillate from the tar which is produced as a by-product in the manufacture of coke from bituminous coal in by-product ovens; or a distillate obtained from a mixture of these two kinds of tar.

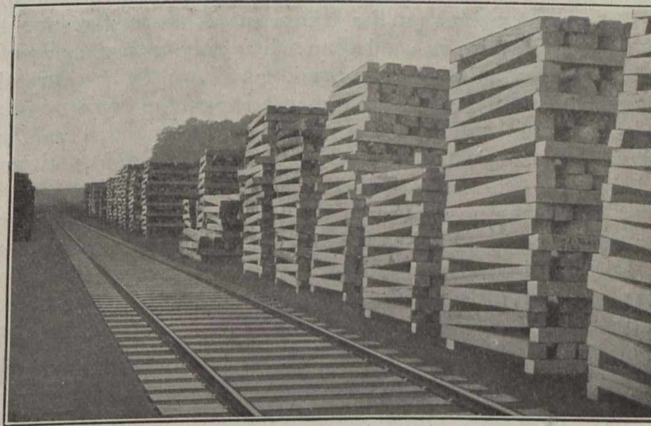


Fig. F.—Tie stacking yard.

Creosote oil is highly antiseptic and thoroughly protects the timber against fungus growths. For ties, eight to twelve pounds per cubic foot (about 2½ gallons per tie) is left in the timber, while for paving blocks from sixteen to twenty pounds per cubic foot is left in. Creosote oil may have a preservative value from physical properties as well as from its antiseptic or poisonous nature. This is especially true when applied to paving blocks. It may be capable of adhering to the cell walls and fibre of the wood with such permanency as to prevent conditions favorable for the development of elements destructive to timber. With the idea of obtaining the greatest prevention, both chemically and physically, pure coal-tar of low carbon content is frequently mixed with the creosote oil.

During the past few months there threatened to be a serious shortage of creosote oil on this continent owing to the war in Europe, but the release by the British government of a number of cargoes of creosote oil has helped the situation for the time being at least. England and Germany are the leading producers of creosote oil distilled from coke-oven coal-tar. When coke is manufactured in bee-hive ovens the coal-tar is burned in the process. On this continent most coke ovens are of the bee-hive type, while in Europe they are of the by-product type. Therefore we are largely dependent on Europe for our supply of coal-tar and creosote. The only by-product ovens in Canada are at Sydney, N.S., and Sault Ste. Marie, Ont. A bee-hive oven costs only about one-third or one-fourth as much as a by-product oven, which explains the popularity of the bee-hive ovens. The quality of coal for coking in Europe is not so good as on this continent, and requires the by-product oven in order to make the greatest quantity and best grade of coke. Therefore the use of the more expensive by-product oven is not altogether a matter of choice in Europe.

Creosote oil is one of the fractions of crude coal-tar obtained by its distillation. It is the fraction coming off between the benzol and carbolic acid compounds, which come off at low temperatures, and the pitch, which remains in the still at the highest temperatures. Coal-gas tar usually has a high percentage of free carbon which should be filtered out, or otherwise removed, before such tar is ever mixed with creosote oil. Refined coal-tar is often added to the creosote oil in preparing it for use in wood preservation, as the treatment is more permanent when the mixture is used than when only creosote oils of low specific gravity are used, as there is a marked evaporation of the low-boiling fraction of the creosote oil. The coal-tar and the creosote oil, when mixed, combine thoroughly, and cannot be separated again, either physically or chemically.

Up to the present only wood block and ties have been treated at Trenton, but it is expected to treat timber for station and outdoor platforms; switch ties; dimension timbers; decking; flooring for docks, bridges, fire halls, warehouses and heavy manufacturing plants; crossing planks; fence posts; signal poles; snow fences; piling; mine props; telegraph and telephone poles; cross arms; mine timbers; tie plugs; wooden pipe; and all material for breakwater and marine work.

The first ties ever treated in eastern Canada from Canadian timber were creosoted at the Trenton plant last month for the Toronto, Hamilton and Buffalo Railway. The only woods used so far have been beech, birch and maple for ties, and southern yellow pine and Norway pine for wood block, but spruce, tamarack, fir, hemlock and other woods will probably be treated later on.

Special attention will be given to the treatment of mine props, as timbers for use in mines decay very readily, owing to ideal conditions of moisture and temperature for fungus growth. Much of the failure of mine props now attributed to breaking and splitting is due primarily to rot. This can be prevented, and the original strength of the timber maintained, by creosoting or otherwise preserving it. The creosoting of mine timbers is not so expensive as come other forms of creosoting, because it is not necessary to obtain such great penetration. The uniformity of temperature and moisture in mines, and the lack of exposure to the direct rays of the sun, result in no checking taking place, so that it is not necessary to get such deep penetration. A much lighter treatment than is given other timbers will therefore prove satisfactory. But this does not necessarily mean that any merely superficial treatment is sufficient.

The difference in strength between untreated and treated ties and timbers, except in the case of those treated with heavy oils which protect the timber from excessive moisture and add to its strength, is so slight as to be of no importance. This assumes that ties and timbers are properly treated and not injured by steaming or excessive heat during treatment. The drier that wood is kept, in ties and timbers, the stronger and better service they render.

The very great value derived from the treatment of wood is not only the prevention of the rot which makes the wood useless. The treatment maintains the original strength of the timber, especially in the case of ties treated with oil, and causes it to resist mechanical abrasion and wear longer. Furthermore, when ties are properly seasoned before treatment and preserved with creosote oil, the oil resists moisture and prevents the ties from becoming soft and spongy.

The added life due to creosoting depends upon the quality of treatment, and upon the kind of timber and the manner in which it is used. It is only fair to say, however, that creosoted ties will last from three to five times as long as untreated ties, while the cost of treatment does not double the cost of the tie. Therefore the great saving in the use of treated instead of untreated ties is apparent. This saving is even more pronounced in the case of other timbers.

NEW SAFETY AND DETONATING FUSE.

In a paper presented at the Pittsburg meeting in October of the American Institute of Mining Engineers, Mr. Harrison Souder, of Cornwall, Pa., directs attention to a safety detonating fuse by the use of which he claims misfires in blasting may be eliminated and safety in blasting operations provided. The detonator, which is known as the Cordeau detonant, is sold under the name of Cordeau-Bickford, and consists of a lead tube 5 to 6 mm. in diameter, filled with trinitrotoluene. It is applicable to all classes of mining, but is of especial value in connection with deep-hole blasting in open-cut mine or quarries, or any operations where a large number of holes are to be shot at one time. After detailing the superior results obtained with the use of this fuse in actual practice, the author summarizes its peculiar advantages as follows:

(1) There is no danger in handling or storage of the fuse. It cannot be exploded by friction, fire, or ordinary shock. It requires the use of a strong blasting cap properly attached to explode it. In blasting charged holes, the cap or exploder can be applied outside the hole, thus avoiding the danger of burned powder caused by side spit from ordinary fuse; also any risk of accident while tamping and the risk from a portion of an unexploded charge accompanied by a cap remaining in the debris from a blast is entirely obviated.

(2) The average rate of speed of this fuse is estimated to be close to 17,000 feet per second, so that when it is used, the explosion charge is detonated instantly throughout its entire length, instead of at one point as is the case with the blasting cap or electric exploder.

(3) It is known that the speed of an explosive decreases as the explosion wave travels away from the detonator. That the powder in a hole has the strongest explosive effect around the exploder is evident from an examination of the face of the bank after a shot. This can be demonstrated also by placing sticks of dynamite on the ground end for end, about 6 inches apart, with the cap in the first stick. The explosive force gradually lessens until it finally ceases to progress, leaving the farthest stick unexploded.

By using this fuse, the charge is detonated instantaneously throughout its entire length. This results in a saving of about 10 per cent. of explosives as determined by results obtained at Cornwall and elsewhere. It is not affected by heat, cold, or moisture, and lasts indefinitely without deterioration.

It is wound in continuous lengths on spools containing 100, 200, or 300 feet each, and weighs about 7 pounds per 100 feet. It is accepted by transportation companies without restrictions except that it shall not be packed with other high explosives.

THE COST OF POWER AS A FACTOR IN LOCATING INDUSTRIES.

By H. E. M. Kensit, M.Can.Soc.C.E.

THE above title implies a subject that is of interest to every progressive city in Canada. There is a very general impression that the cost of power is a largely determining factor in inducing most industries to select a location, and constant repetition of this claim has caused its general acceptance. Little investigation appears to be made, however, as to the basis of this belief, in which industries the cost of power is an important item and as to what proportion the cost of power bears to the total cost of production or total expenses.

This impression leads cities, which means the councillors in power in any particular year, to embark on expensive and in many cases doubtful projects for providing cheap power, without having any definite knowledge as to what industries the general local conditions will make it possible to locate, or of the relative importance of cheap power to such industries.

The questions of distribution facilities, proximity of raw materials, extent of labor market, etc., are awkward matters that cannot be controlled by that year's council, and they are, therefore, left in the background, while it is decided to enter on some extensive project to provide cheap power in the hope that this will make everything all right and produce a rush of industries anxious to take advantage of it.

The fallacy of this view has been impressed upon the writer by various personal experiences and has led him to collect a large amount of data on the cost of power in different industries. A large amount of manufacturing data has also recently become available in the statistics issued by the United States and Canadian census bureaus, the Ontario Bureau of Labor and other sources, and it is, therefore, possible to tabulate the average proportionate costs of many different industries in a manner to give an approximate idea of their relative importance.

A comparison of these statistics by such factors as the per cent. of wages to gross value of product and the ratio of the value of the product to the capital employed shows that, while the figures vary appreciably in the two countries in some individual industries, if the average is taken over a considerable number of miscellaneous industries they are in very close agreement and that, therefore, the conditions are not widely different. On the whole, the United States statistics are the most satisfactory to work to, because the explanation given of the meanings of the terms, the precautions taken and exactly what the headings include, is much more complete and specific than in the others. It involves some little labor to dig out the figures and give them in the form shown, but the tables that follow are deduced direct from the census figures, the only assumptions being the rate for interest and depreciation on the stated capital and an assumed price per h.p.-year for the stated horse-power employed.

A certain number and class of industries will attach themselves to every town in proportion to its population and other local conditions, entirely irrespective of the cost of power.

Such industries in a town of 5,000 population would be, say, a brick-yard, steam laundry, machine shop, flour and grist mill, planing mill, mineral water factory, elevators, etc. When it reaches 12,000 or 15,000 there may be added, still without regard to cost of power, further factories of the same class and in addition a foundry, brewery, sash and door factory, tent and mattress factory, etc. At 50,000 population, and still without regard to cost of power, there would probably be, in addition to the foregoing, some or all of the following: box-works; abattoir and cold storage, harness factory, soap works, creamery, show-case factory, etc.

The results are so general that a little investigation will satisfy anyone that they are obtained under normal conditions irrespective of the cost of power.

The reason can be clearly seen from Table I. on consideration of the percentage cost of power, compared to other items of expense incurred by miscellaneous medium sized industries. It will be seen that at the assumed figure of $50 per h.p. year the highest figure for the cost of power in per cent. of total costs is under 6% and the average is 3%.

The intention in this and the following tables is to give a fairly approximate idea of the proportion that the cost of power bears to the other items of expense, not to attempt to give an exact figure of the cost of the power itself, which must vary in each case in each industry.

Before proceeding further it will be well to explain the basis on which this table is constructed, so that those interested can make any allowances they see fit.

The total capital employed is given in the census reports for each group of industries and it is specified that the expenses given do not include interest and depreciation.

"Materials" include all raw materials, mill supplies and containers. It also includes (as given in the census reports) fuel, rent of power and heat; and fuel includes all fuel used whether for heat, light or power or for process of manufacture.

Salaries and wages include labor for power and this latter cannot be given separately.

Power. The census returns show the primary power employed in each industry, but do not give the cost of power separately, this being included in "materials" and in wages, as above stated. The cost assumed for power has, therefore, been deducted from the amount given in the census reports for materials and the amount so deducted represents only fuel, oil, stores and water and rented power, or the equivalents. The writer finds that the average proportion of costs of producing power in factories, from a large number of individual cases where the costs were accurately kept, is as follows:

Fuel	50.00%
Oil, stores and water	4.25%
Wages	17.00%
Repairs	4.25%
Interest and depreciation on power plant at 10% on investment	25.00%
	100.00%

To correctly show the percentage cost of power it would therefore be necessary to correct the interest and depreciation column and the salaries and wages column shown in the tables. This can be easily done for any particular case but to do it to the whole of the table on an assumed cost of power would diminish the value of the original figures. Furthermore, it is not necessary to do so to support the contention as to the low percentage cost of power in miscellaneous industries.

If, for instance, taking the averages of the columns, power at $50 represents 3% of the total costs and we assume that power costs 25% more or less than $50, this will only be 25% of 3% or 0.75% on the total cost taken as 100%, but 25% on wages or materials would be 5.7% and 13.5% respectively on the total costs.

The method by which Table I. is figured is shown by the following sample calculation:

Census Figures for Totals per Establishment.

Primary horse-power		69.5
Capital invested		$68,500
Expenses—		
Salaries and wages		16,250
Materials (including power)		45,200
Miscellaneous		7,240
From which the following is deduced:		
Interest and depreciation, say 12%	$ 8,220	10.7%
Salaries and wages	16,250	21.2%
Power: 69.5 h.p. @ $50 per h.p.-year	3,475	4.6%
Raw material and general supplies	41,378	54.0%
Miscellaneous	7,240	9.5%
	$76,563	100.0%

The relative position of industries as power users can be obtained in a different manner and is shown in Table II. Columns 1, 2 and 3 are calculated direct from the census figures. The last or fourth column is an arbitrary attempt to establish a numerical rating, and while objections may be made to the method, it does establish clearly which industries may be classed as using a relatively large amount of power on the three principal bases. For instance, it is obvious that the cost of power must be a more serious consideration to numbers 27 and 28 than to numbers 3 and 4.

Some of these industries using relatively large amounts of power are shown in Table III. in a similar manner to those in Table I. It would not do to assume a figure of $50 per h.p. year for all these because in some cases this would be prohibitively expensive power.

Steam power for blast furnaces costs about $70, with gas engines using blast furnace gas from $30 to $40. In cement mills the power required is relatively very large but their large plants and good load factor give them low costs and several concerns buy hydro-electric power at cheap rates. Pulp mills are usually in districts where water power is available at $18 to $30 per h.p.-year. The figures for cost of power have therefore been chosen accordingly to give an approximate idea of the relative cost of power in each case.

Looking at these large power-using industries from the location point of view, it will readily be seen that while the cost of power is a serious consideration, matters of raw material, labor market and distribution facilities are still more serious and that it would require a good deal in addition to cheap power to determine their location.

Table I.—Percentage Cost of Power in Miscellaneous Industries. Power Assumed at $50 per h.p.-year.

	Interest and deprecia-tion at 12% on capital.	Salaries and wages.	Power at $50 per h.p.-year.	Raw materials, etc.	Miscel-laneous.
	%	%	%	%	%
Boots and shoes	9.8	43.3	1.8	41.4	3.7
Breweries	21.7	16.7	4.5	20.7	36.4
Canning and preserving	9.2	17.3	2.6	62.7	8.2
Carriages, wagons	13.0	28.2	2.5	49.1	7.2
Clothing	5.4	24.8	0.4	56.5	12.9
Creameries	3.2	5.5	1.9	86.2	3.2
Farm implements	20.7	26.0	3.4	37.2	12.7
Flour & grist mills	4.8	3.9	4.9	83.4	3.0
Foundry and machine shops	14.4	33.0	3.4	39.4	9.8
Furniture	9.5	43.8	3.9	34.6	8.2
Lumber, saw and planing mills	5.9	34.5	5.9	42.3	11.4
Meat packing	3.4	5.3	0.3	87.8	3.2
Paints and varnish	10.0	15.1	2.2	61.6	11.0
Woollen goods	11.8	18.8	4.1	60.2	5.1
	10.2	22.6	3.0	54.5	9.7

Table II.—Relative Position of Industries as Power Users.

Industry.	Horse Power. 1. Per Capita.	2. Per $1000 Capital.	3. Per $1000 Value of Product.	Relative Use of Power. Average of 1, 2 & 3.
1. Clothing	0.14	0.16	0.07	0.12
2. Boots and shoes	0.45	0.43	0.19	0.36
3. Canning and preserving	1.13	0.68	0.52	0.78
4. Meat packing	1.92	0.55	0.02	0.82
5. Foundries and machine shops	1.40	0.57	0.71	0.89
6. Farm implements	1.66	0.39	0.68	0.91
7. Car-shops, railroad	0.98	1.23	0.72	0.98
8. Carriages & wagons	1.52	0.72	0.79	1.01
9. Paints & varnishes	2.55	0.56	0.45	1.13
10. Furniture	1.54	0.98	0.93	1.15
11. Electrical machinery and apparatus	1.51	0.60	1.41	1.17
12. Woollen mills	2.07	0.84	0.83	1.25
13. Smelting, lead	3.45	0.20	0.16	1.33
14. Creameries	3.22	1.42	0.37	1.67
15. Petroleum refining	5.45	0.50	0.38	2.11
16. Breweries	5.20	0.56	0.93	2.23
17. Cotton mills	3.35	1.58	2.06	2.33
18. Grindstones	3.72	1.16	3.38	2.75
19. Lumber, sawing and planing mills	3.62	2.51	2.46	2.86
20. Bricks and tiles	3.99	1.95	3.68	3.21
21. Chemicals	7.50	1.34	1.77	3.54
22. Smelting, copper	9.40	1.42	0.42	3.75
23. Iron and steel rolling mills	8.1	2.09	2.13	4.11
24. Sugar and molasses	10.70	1.05	0.58	4.11
25. Oil and cotton seed	9.00	2.11	1.30	4.14
26. Flour & grist mills	12.90	2.44	0.97	5.68
27. Portland cement	12.6	1.98	5.9	6.83
28. Paper & wood pulp	16.0	3.19	4.86	8.02
29. Blast furnaces	27.2	2.41	3.00	10.87
30. Carbide of calcium	37.4	12.1	14.5	21.3

In this connection it is of interest to consider the proportion of power owned by and the proportion purchased by industries. The census summaries of the total power used in all industries show that the percentage owned by the establishments using it is 97% in Canada and 90% in the United States, so that the proportion of purchased power is still quite small in relation to the whole and there must still be a very wide field for central station power.

It is also of interest to observe the large proportion of power, other than water power, used in both Canada and the United States, by industries that are essentially large users of power. This is shown in Table IV., which gives the total primary power owned by the establishments and excludes electric motors driven by that primary power.

The above particulars appear to indicate clearly that in ordinary miscellaneous industries the cost of power is a comparatively small consideration, that even in industries where the cost of power is a large proportion of the total costs, other considerations of raw material, distribution facilities and labor market are of even greater importance.

Table III.—Percentage Costs in Industries Using Large Amounts of Power.

	Interest and Depreciation at 12% on Capital.	Salaries and Wages	Power. Per H.P. Year.	Power. Per Cent.	Raw Materials, etc.	Miscellaneous.
	%	%	$	%	%	%
Blast furnaces.	13.9	7.4	35	9.8	66.3	2.6
Chemicals	16.5	18.0	50	9.3	47.6	8.6
Cotton mills ...	13.8	20.5	50	9.0	51.7	5.0
Portland cement	30.2	25.4	35	17.4	21.9	5.1
Rolling mills ..	11.9	18.7	50	10.3	54.7	4.4
Wood pulp and paper	17.1	17.6	25	11.4	46.4	7.5

Table IV.—Class of Power Used in Large Industries.

Industry.	Canada, Census 1911. Water Power.	Canada, Census 1911. Other Power.	U. S. Census 1909. Water Power.	U. S. Census 1909. Other Power.
	%	%	%	%
Wood pulp and paper..	94.0	6.0	60.0	40.0
Portland cement	2.3	97.7	....	....
Carbide of calcium	3.2	96.8	....	....
Smelting	2.0	98.0	6.9	93.1
Iron and steel products	0.8	99.2	0.05	100
Cotton	48.5	51.5	24.4	75.6
Flour and grist mills...	52.0	48.0	31.0	69.0
Lumber products	19.3	80.7	5.0	95.0

There is no question that very cheap power has located industries at certain points *where the other conditions were also favorable*, but it is extremely doubtful whether the large sums spent by municipalities in competitive efforts to attract industries by the offer of cheap power produce any tangible results, except where the other essentials predominate and really form the deciding factors in locating the industry.

BRITISH LOCOMOTIVE EXPORTS.

Notwithstanding the war, the British locomotive shipments exhibit, upon the whole, satisfactory results for the nine months ended September 30th, the value of the engines exported to that date having been £2,929,502, as compared with £2,067,316 in the corresponding period of 1913, and £1,430,977 in the corresponding period of 1912. Argentina took British locomotives in the first nine months of this year to the value of £603,766, as compared with £499,254 and £313,432. This result must be regarded as favorable in view of the current disorganization of the Argentina railway interest. It is, however, in British India that the greatest progress in the demand is observable, the value of the Colonial imports having been as follows to September 30th, this year, as compared with the corresponding periods of 1913 and 1912:—

Colonial Group.	1914.	1913.	1912.
British South Africa	£ 64,099	£ 96,831	£148,442
British India	1,322,082	711,910	298,996
Australia	430,950	338,861	237,919

It will be seen that purchases of locomotives upon Australian account have been good this year. The war may exert an unfavorable influence upon Australian development, but thus far it has not had much effect.—Engineering, London.

THE ROYAL ENGINEERS OF THE BRITISH ARMY.

By Geo. Laidler.

FROM the earliest times, engineers have been employed in the field of war on the construction of fortifications, earthworks and batteries for besieging defences. In modern times, however, the application of scientific devices to warfare has given rise to many minor branches of military engineering in addition to the primary duties of fortification and siegecraft, such as the field telegraph service, the flying corps, the construction of temporary roads and bridges for the transport of an army; also works which more properly belong to the realm of civil engineering, such as surveying, the construction of permanent military buildings, railways, piers, etc. All these branches require special knowledge, and consequently the "field companies" and "fortress companies" represent the application of their arm to works of offence and defence in field and siege warfare.

It is difficult to distinguish between military and civil engineers in early modern history, for all engineers acted as builders of defensible strongholds, as well as makers and manipulators of engines of war for attacking and defending them. The annals of the science of glorification record artists, architects and soldiers as being responsible for the design and construction of the various systems. Artillery naturally became just one branch of military engineering; in fact, the word "engine" which, at the time of Chaucer meant "natural talent," or "invention," (corresponding to the latin "engenium" from which it is derived) was formerly used especially to denote a weapon of war, such as the catapult or battering-ram.

By the middle of the thirteenth century there was in England an organized military body of skilled workmen controlled by a "chief engineer." At the siege of Calais in 1347 this corps consisted of masons, carpenters, smiths, tentmakers, miners, armourers, gunners and artillerymen. When Harfleur was besieged in 1415 the chief engineer was designated "master of the King's works, guns and ordnance," and his men numbered 500, including 21 foot archers. About 1450 the engineer branch had developed into the Office of Ordnance, whose duty was to administer all matters connected with fortifications, artillery and ordnance stores.

Henry VIII. employed many engineers to construct coast defences around England, and also added to the organization a body of pioneers under trenchmasters, to clear and repair roads and to remove obstacles to the march of troops. Up to 1715 the commander of an ordnance train was nearly always an engineer, but after that date it was decided to separate the artillery from the engineers. It afterwards became common for the officers of engineers to hold commissions in foot regiments in addition to their rank in the corps of engineers.

In 1757 all engineer officers were gazetted to army as well as engineer rank—chief engineer as colonel of foot and so down the scale to practitioners as ensigns (second lieutenants). In 1782 the engineer grades except that of chief engineer were abolished. Ten years later a small corps was formed, and in 1787 the designation "Royal" was conferred upon it.

In 1802 the title of Chief Engineer was changed to Inspector-General of Fortifications, and from this time up to the conclusion of the Crimean War many augmentations took place on account of the widely increasing duties which devolved upon the officers.

In 1772 the formation at Gibraltar of the "Company of Soldier Artificers," officered by Royal Engineers, was authorized, and in 1787 the "Corps of Royal Military Artificers" was established at home. In 1813 its title was changed to the "Royal Sappers and Miners," doubtless on account of the intrenching and subterranean nature of much of its work. In 1856, after the Crimean War, it was incorporated with the "Corps of Royal Engineers," by whom it had always been officered. There is a School of Military Engineering at Chatham, England, (the headquarters of the corps) where officers are trained, and where the official textbooks on military engineering are compiled.

The ordinary strength of the regular Royal Engineers of the British Army is about 10,000 officers and men, with mounted and dismounted sections. The territorial and overseas forces also include a proportional complement of Engineers. The privates (called "sappers") in the regular Royal Engineers are generally skilled artisans. They are trained in tactics and the use of the rifle and are paid at a higher rate than infantrymen. The utility of this important branch of the service has frequently been shown in the course of the present war, especially on demolitions, entanglements and bridges.

DRAINAGE STRUCTURES.*

By W. E. Atkinson,
State Highway Engineer of Louisiana.

In determining the length of bridges and spans between bents and piers and the size of culverts, consideration is given to the maximum rainfall, amount of run-off, average slope of ground of drainage area, seepage, etc., as included in the same factors governing similar structures under railroad construction. After determining the required opening for waterway, the factor governing the required strength or carrying power of the structure is determined, so far as it is possible, upon the maximum load the structure is likely to be subjected during its bonded life. As to the bonded life of structures of this character, it is figured that they should last until bonds or taxes voted for the construction of same are retired, all structures being computed, however, to safely carry a minimum live load of not less than ten tons, plus 50 per cent. impact and a factor of safety of four.

Standard Plans.—It has been the policy of the highway commission of Louisiana to construct, wherever funds and conditions will permit, permanent structures and adopt uniform and standard plans for bridges and culverts for any particular highway project. However, oftentimes different designs are necessary to meet existing conditions. The type and design of bridges, whether they be of wood, concrete, or masonry, etc., are determined largely by the amount of funds available, and the character and nature of soil for foundation.

Due to the alluvial character of the soil, with the exception of some sections in the northern part of the State, there are instances where it is not safe nor economical to construct the arch type of concrete bridges; even with some of our girder and slab bridges, it oftentimes becomes necessary to provide pile foundations for the piers, abutments and wing walls. In some places it is necessary for these piles to be of concrete instead of wood on account of many reclamation projects, now under way, lowering the ground water which would become detrimental to the latter type of construction.

Uniform Design.—We have found it advantageous and economical to provide, where conditions will permit, a uniform design for all drainage structures, especially for those of concrete construction, that the contractor may use the same drainage forms over and over, permitting thereby much lower bids per cubic yard on such work than otherwise under a system of non-uniform standard designs for such structures, and in addition, many times permitting, without greater cost, greater waterway opening than theoretically computed, resulting in a larger factor of safety, and often providing for some unprecedented rainfall or cloudburst not anticipated. In addition to concrete bridges, the department is building many wooden bridges, both of creosoted and uncreosoted materials; this character of construction predominating in some parishes due to lack of funds for more permanent construction.

Types of Culverts.—The department has installed several types of culverts, that of vitrified clay, cement, concrete, cast iron, wood, corrugated galvanized iron, etc., the type of construction being governed by the available funds and topographical features together with character of soil encountered in foundation. However, where practicable, concrete has always been recommended.

At many places, however, we have found it impracticable and not economical to use concrete culverts and others of a monolithic character, especially in some of the bayous and coulees. In one place in particular, it is recalled, where the foundation in one bayou was so poor that a strip 2 in. x 2 in. x 16 ft. was pushed down its full length in the bottom of the bayou, and could have been pushed farther if the strip had been longer. This bayou was 250 ft. wide across the top and 25 ft. deep, and the only opening necessary was that of an equalizer with an area of some 28 sq. ft. to be filled over with earth, thereby making a bridge of earth and of an equalizer. The equalizer installed at this particular location was a 10-gauge 6-ft. diam. corrugated galvanized iron pipe culvert. The entire cost of this combination bridge, if it may be so termed, amounted to $2,059.27, including an item of $215.73 for riprap, whereas to have bridged the bayou with concrete, or to have attempted to build a concrete culvert, would have made the cost very much in excess of this amount.

Due to debris, drift wood, and other extraneous matter, our highway department has adopted a policy not to install any culverts of less than 18 in. in diam. where possible, it preferring that they should be not less than 24 in. in diam. Experience has shown that culverts of these sizes have proven more satisfactory and given better service, requiring less maintenance both for road and culvert at such places than when culverts of smaller diameter are used, even though the smaller culverts are ample to carry the water, due to the ineffectiveness of the latter from drift choking and filling them up.

* From a paper read at the Fourth American Road Congress, Atlanta, Ga., Nov. 9 to 14, 1914.

PACIFIC GREAT EASTERN RAILWAY CONSTRUCTION.

The British Columbia Government has decided to guarantee bonds to enable the Pacific Great Eastern Railway Company to float a loan of $5,000,000, to provide for further construction.

The American Society for Testing Material has added to its specifications for reinforcing steel rolled from billets, an intermediate grade between the structural and hard grades. The new grade has a yield-point of 40,000 lbs., and an ultimate tensile strength of from 70,000 to 85,000 lbs.

Editorial

THE ROYAL CANADIAN INSTITUTE AND SCIENTIFIC RESEARCH.

Mr. Frank Arnoldi, K.C., President of the Royal Canadian Institute, has announced that the Institute, with a mature and comprehensive knowledge of the fact that the necessities and welfare of every member of the community and the attainment of efficiency are bound up with the advancement of the scheme of co-operation of science with industry, is about to undertake to promote the establishment within itself of a Bureau of Scientific and Industrial Research. As Professor Haultain observes, in his open letter commending the procedure, it marks the return of the Institute to the channel molded for it in the minds of its founders over half a century ago.

Science and Industry must co-operate if Canada is to make any material advance in the readjustment of industrial greatness, of which this war is the curtain-raiser. The universities have long realized this, and have not hesitated to extend offers to co-operate with the Institute in its move. But, in Canada, as previously in England, there has been some disinclination on the part of the industrial and business man to embrace the advantages which Science has proffered. On the other hand, it has not been the enemy's militarism but the co-operation of Science with German industry that has placed that country where it is industrially. Enemy though it is, the German nation has given the world a great lesson.

Down in the University of Pittsburg, there is nearing completion a home for the Mellen Institute of Industrial Research and School of Specific Industries. It will provide ample accommodation for seventy researchers besides accommodation for graduate courses. Industrial fellowships constitute the basis of the system, and these are constantly increasing in amounts subscribed for their maintenance by industrialists. We have not the space here to describe the system as fully as we would like; for although in its infancy the Institute has gained world-wide fame through its investigation of the Smoke Problem. Suffice it to state at this juncture that there is every indication of a successful start on the road to the ideal for which it is striving. This ideal may be read from the inscription on the door:

> "This building is dedicated to the service of American Industry and to young men who destine their life-work to the Industries; the goal being Ideal Industry, which will give to all broader opportunities for purposeful lives."

In a quiet way the graduates of the Faculty of Applied Science and Engineering of the University of Toronto raised a fund among themselves and have financed a considerable amount of engineering research. The movement has had the closest co-operation of the the University of Toronto, and the results obtained in a recently completed fellowship will, when published, be found very valuable.

The Royal Canadian Institute, in its revival of scientific investigation in relation to Industry, will receive warm support from the scientific world, and there is little doubt that the organization will make a creditable showing in making Canadian industry more efficient in its manufacturing practices.

LAYING CONCRETE ON THE LEVEL.

Mr. Geo. H. Gooderham, chairman of the Toronto-Hamilton Highway Commission, is quoted in the daily press as having answered in the following way some criticisms directed against his action in appointing as chief engineer of the proposed highway, an engineer who is not a Canadian:

> "I received no less than three hundred applications for the position, some from engineers from Toronto and Hamilton; but there was not one among them who had the necessary qualifications for the work. Some were capable of building a 20-story building, but none were capable of laying concrete on the level."

The layman's intelligence and knowledge of present conditions is no doubt responsible for his belief that of those 300 applications the majority at least were from Canadian engineers; that the applicants felt qualified in technical ability and practical experience to undertake the responsibility of laying a concrete road, and that, considering the present prostration of engineering work, the proposed piece of construction must have attracted the attention of many of our engineers, of broad engineering experience and careful training.

It is painful, in view of the wide publicity and endorsation that has been given the whole project in the technical, trade and daily press, since its inception, that engineers of this country should be the objects of such a remark from an individual who, by virtue of his position, should know better. It points once more to the questionable silence on the part of the engineer respecting his profession and his achievements therein. His ability to lay concrete on the level should not be so conscientiously shielded from the gentle gaze of the interested public.

As for the appointee, who is also a capable engineer, it is no doubt of some little concern to him if the chairman of the commission knows as little about engineering and engineers in their relation to concrete road building as the above quotation implies.

REINFORCED-CONCRETE FACTORY BUILDINGS.

A paper to be read by F. W. Dean at the coming convention of the American Society of Mechanical Engineers (Dec. 1 to 4) presents the advantages of the use of reinforced concrete for the use of factory buildings, such as fire-resisting qualities, great window area, and good lighting, and also some of the disadvantages. It also points out that regular mill construction buildings have shown their fire-resisting qualities when properly designed. The best methods of finishing the floors are discussed and also the application of wood as a wearing floor above the concrete. The difficulties of fastening shafting hangers and machinery are brought out and the extra cost of drafting in consequence of this, as well as the great care required in making provision for everything to be installed. The different methods of constructing floors and the different forms of ceilings are taken up and also the relative costs of concrete and regular mill construction buildings.

"CO-OPERATION BETWEEN SCIENCE AND INDUSTRY."

An Open Letter to Frank Arnoldi, Esq., K.C., President of the Royal Canadian Institute.

Congratulations, sir, not so much on the addition of the word "Royal" to the title of the Institute, which in itself is no small thing, but on the goal towards which, as we now recognize, that was but a step.

"Co-operation Between Science and Industry in Canada," recently issued over your signature, will be read with interest by engineers everywhere and they will recognize and appreciate the partial return of the Institute to its old love.

The study of nature to woo from her the knowledge of her secrets is one thing and this knowledge may be called Science, or Pure Science, or Exact Science. To convert this knowledge to the use and convenience of man is another thing. It is sometimes called Applied Science, but it is really Engineering. It is the new form of the old struggle with nature to make her work for man. This struggle has been aided, has been entirely changed by the knowledge supplied by the sciences, but the knowledge is but a weapon and much lies in the wielding of it before nature is compelled to yield in usefulness. This wielding for the community is Engineering. The methods of the Engineer are scientific methods, but they are very different from the scientific methods that produced the weapons. It is Engineering that makes the weapons useful.

You are seeking methods of developing this Engineering aid. You are pleased to consider yourself neither a scientist nor an Engineer, but you belong to that profession which has a broader and at the same time a more intimate view of the real needs of the community than any other other, and you have chosen to lead back the Institute to the lines favored by its founders. The Royal Charter of 1851 stated the objects of its incorporation to be "more particularly for promoting the acquisition of those branches of knowledge which are connected with the professions of surveying, engineering and architecture." The aims of the Institute show the conventionalized symbols of Engineering and its founder was an Engineer, but for more than a generation the Institute has departed from the lines laid down for it, and the tangible results have been meagre compared with the promise of the future. Our congratulations on the return to the original trail.

Yours faithfully,

H. E. T. HAULTAIN.

C.N.R. SHOPS AT PORT MANN, B.C.

The buildings for the proposed machine shops and repair plant of the Canadian Northern Railway at Port Mann, about 16 miles from Vancouver, were completed some months ago and equipment is now being installed. The buildings are practically all of reinforced concrete construction with wood and steel roof trusses. The main erection and repair shop is 276 x 143 ft. and is laid out with two main bays. The other buildings include a 15-stall round house, a large storehouse, an 80-ft. turntable, an 80,000-gallon steel water tank mounted on a steel tower, and housing and boarding accommodation for about 150 men. The bay of the main structure devoted to repair shop has a 30-ft. elevated platform running the full length of the building to be used for purposes of light repair. Both bays are served by 10-ton travelling cranes. An electrically operated pair of jacks with spacing capacity of 25 to 45 ft. is being installed for the manipulation of locomotives. The drill, lathe and other equipment are of the most modern types.

SANITATION AND THE WAR.

At a recent meeting of the Canadian Club of Toronto, Dr. John A. Amyot, director of the Provincial Board of Health, pronounced sanitation as the most vital factor in a modern military campaign and corroborated his statement by reference to war fatalities in the past. Where efficient precautionary measures against disease had not existed, fatalities had been overwhelmingly more numerous as the result of epidemics of sickness than from the destructive forces of the enemy.

It was stated that in the South African war 12,669 men and non-commissioned officers had died from disease, while only 7,000 had died from wounds. In the American Civil War the northern army lost 102,000 men, and 20,000 of that number died from disease. Going back to the Crimean War, during 6 months, from October, 1854, to March, 1855, there were 52,000 men in the hospitals and only 3,800 of that number had been disabled by wounds.

The Russo-Japanese War very stoutly emphasized what sanitation in war meant. By rigid measures, conditions as outlined above were reversed and less than 25% of those who met death, died from disease.

The speaker pointed out the work of the Army Medical Service Corps—to keep men fit and to return as many sick and disabled persons as possible to the firing line. It was stated that before the time of antiseptic surgery the mortality in cases of amputation and injuries to lower extremities on the field of battle was as high as 90%, and that it has now been reduced to as low as 5%.

He expressed the great difficulty in the present war to be that the armies were of such a mixed nature that the difficulties attending complete sanitation on such a gigantic scale are enormous.

Dr. Amyot paid due attention to the problem of water supply and remarked that in war the army always assumed water in a new district to be impure, until it had been proved to be otherwise.

GOVERNMENT DRY DOCK AT SELKIRK, MANITOBA.

Late in October the Department of Public Works, Ottawa, completed at Selkirk, Man., the construction of a $100,000 dry dock. The capacity of the dock is 1,500 tons, and it is of sufficient size to handle a vessel 250 ft. in length. The cradle is 192 ft. long in itself, and 208 ft. over all. Its width is 52 ft. It has been constructed in two parts in order to provide for repairing two small vessels simultaneously.

The dry dock is operated by a 150 h.p. motor. By it the dock cradle is raised or lowered on a track extending 525 ft., or to any depth necessary for hoisting the craft to be repaired. The hoisting is accomplished by chains. The cradle is chiefly of steel construction, while the dock walls are both of concrete. The Crandle Engineering Co., of Boston, were the contractors. Inspection work was carried out by the Canadian Inspection Co.

Coast to Coast

Lethbridge, Alta.—The Lethbridge-Weyburn line of the C.P.R. has about 67 miles of steel still to be laid.

Woodstock, N.B.—Mr. F. T. Gutelius, general manager of the Intercolonial Railway, states that the finished portion of the Valley Railway will likely be taken over by the Intercolonial before the end of the month.

West Vancouver, B.C.—Work is progressing rapidly on the new Capilano bridge. Naylor Bros. are the contractors, and expect to have it completed early in December. This firm is also rushing to completion a new wharf at Dundarave.

Vancouver, B.C.—A large suction dredge of the Pacific Coast Dredging Co. is doing a large amount of reclamation work at Pitsilano beach. The fill, which varies from 3 to 10 ft. in depth, will aggregate about 100,000 cubic yards, and is being placed at the rate of about 3,500 cubic yards per day.

Toronto, Ont.—During the season Mr. Frank Barber, engineer for the county of York, has constructed two bridges south of Brownhill, one at Newmarket, one at Schomberg, one at Willowdale, and another on the Dawes Road, while there is one still under construction between Scarboro and Markham.

London, Ont.—Complete estimates have been prepared by engineers of the Hydro-Electric Power Commission for five different schemes of radials to connect the municipalities of Tillsonburg, Brownsville, Springfield, Port Burwell, Aylmer and Belmont with St. Thomas and London. They include buildings, equipment, and all data as to probable revenue and cost of operation.

Revelstoke, B.C.—The double track of the C.P.R. between Revelstoke and Taft, and also between Kamloops and Hapgood, each about 25 miles in length, will soon be in operation. The double-track system over the new bridges crossing the Harrison and Pitt Rivers is now in operation, giving continuous double trackage from Vancouver to Ruby Creek, a distance of 83 miles.

Edmonton, Alta.—It is stated that before the war the Alberta government acquired over $12,000,000 for use in railway construction. This sum had been received from guaranteed railway securities and had not been paid up. It is to be applied to the Canadian Northern. Canadian Northwestern, Edmonton, Dunvegan and British Columbia, Alberta and Great Waterways, and the Lacombe and Blindman Valley Railways.

Vancouver, B.C.—As announced in August 27th issue of *The Canadian Engineer* in connection with an article descriptive of the proposed Second Narrows Bridge at Vancouver, Mr. Ralph Modjeski, consulting engineer, Chicago, has been retained by the Burrard Inlet Tunnel and Bridge Co. to report on the three designs and tenders for its construction. It is expected that this report will be in the hands of the company in the course of a few days.

Winnipeg, Man.—Grading for the construction railway in connection with the Shoal Lake aqueduct was completed on November 4th to mile 9, and the remainder of the line is 75 per cent completed. Track-laying is completed for over 70 miles and ballasting for over 60 miles. In the Brokenhead River ditch 4,400 lineal feet has been constructed, resulting in considerably lowering the water level at the railway crossing. The telephone line over the entire system has been completed.

Montreal, Que.—The newly-opened Montreal branch of the Ford Motor Co. of Canada, Limited, will give employment to about 200 men. The factory has been erected at a cost of about $300,000, and covers an area of 150 x 160 ft. It is four stories in height, but has been designed to add six more stories, should the business demand it. A novel feature of the plant is the flat concrete roof, surrounded by a parapet, and to be used for testing cars after they have been assembled. The building has been designed with the view of obtaining a maximum of light for the workers.

Winnipeg, Man.—In connection with the Shoal Lake aqueduct scheme of the Greater Winnipeg Water District, a dyke 5,070 ft. in length has been constructed to divert a considerable quantity of water from the Falcon River, because of its dark color owing to muskeg effluent (see *The Canadian Engineer*, October 23rd, 1913, page 606). Since its construction the color density of the water in this section has been very noticeably reduced. On October 9th tests gave the water a color density of 186. Recently similar tests gave it a color density of 9, quite unnoticeable in a glass of water.

Vancouver, B.C.—The Pacific Great Eastern Railroad, under construction from Vancouver to Prince George, 480 miles, is in operation from North Vancouver to Whitecliffe, 12.7 miles. The line is under construction from this point to Squamish, at the head of Howe Sound, and is in operaion north of Squamish, via Cheakamus, on about 20 miles. The grading work is finished to Lillooet, 100 miles from Vancouver, and track-laying is now under way. It is expected that track-laying and ballasting on this section will be finished this year. The remaining section from Lillooet north to Prince George on the Grand Trunk Pacific is all under contract.

Pitt River, B.C.—A large reclamation scheme is now nearing completion at Pitt Meadows, in the Fraser Valley, at an expenditure of approximately $200,000. The scheme, inaugurated for agricultural and market-garden purposes, has entailed a large amount of dyking and drainage, the former necessitated by the tides which flowed over the land, and the latter by its extremely level surface. A dyke 12 miles in length, 10 ft. in height and 6 ft. wide at the top, equipped with flood-gates, key-ditch and pumping equipment, was constructed at a cost of about $100,000. The drainage work has included about 40 miles of ditching. The era of systematic dyking and drainage is beginning in British Columbia. Another scheme is under way in the municipality of Richmond, as noted in last week's issue. The lands already dyked in the Fraser River Valley are the most productive in British Columbia.

North Vancouver, B.C.—North Vancouver gets its main supply from Lynn Creek, to the north-east of the city. This supply is abundant at present, but is not absolutely reliable, fears being occasionally expressed that an exceptionally dry year or a devasting forest fire might produce a shortage in the watershed. To overcome this, the city decided upon a scheme three years ago to increase the supply by the construction of a storage reservoir at Rice Lake, the work entailing the deepening of the lake and the clearing of its banks. When finished it will have a storage capacity of about 150,000 million gallons of water. The cost is estimated at about $175,000.

At the present time the water supply from Lynn Creek comes through an intake pipe 16 in. diam., with a fall of 180 ft. to Rice Lake below it. This pipe delivers some 6½ millions of gallons of water daily. From the lake a shaft is driven through the mountain 1,000 ft. long to connect the lake with the city system. This shaft is 6 ft. wide by 7 ft. high and has cost approximately $25,000, and through this the necessary pipes are laid, while a flume has also been constructed therein to carry away the debris from the bottom of the lake, which is being sluiced out. When a survey was taken of the lake some four years ago it was found that the bottom was covered with silt, logs and other debris to a depth of from 5 to 10 ft.

PERSONAL.

W. S. DINGMAN has been appointed water commissioner of Stratford, Ont., to succeed J. D. Barnett, resigned.

J. L. McKEE has been appointed superintendent of the St. Thomas (Ontario) division of the Michigan Central Railway.

G. C. BATEMAN, Toronto, has been appointed consulting mining engineer to the Long Lake Gold Mines, near Sudbury, Ont.

W. A. McLEAN, Engineer of Highways for Ontario, will be a speaker at the coming convention of the Union of Manitoba Municipalities, to be held at St. Boniface, November 24th, 25th and 26th.

FRANK E. LATHE, B.A., B.Sc., has been appointed lecturer in metallurgy at the University of Toronto. Mr. Lathe, who is a graduate of McGill University, Montreal, resigned a position on the technical staff of the Granby Smelter (B.C.) to accept the appointment.

J. H. BILLINGS, B.A.Sc., a graduate in mechanical engineering of the University of Toronto, was, at the outbreak of the war, on his way to Germany to take a course of study at the University of Berlin. He is now at the Massachusetts Institute of Technology taking a course for a master's degree in mechanical engineering.

A. G. CHRISTIE, B.A. Sc., has resigned his position as assistant professor of steam engineering in the University of Wisconsin to accept a similar professorship in the engineering department of Johns Hopkins University. Prof. Christie is a graduate in engineering of the University of Toronto, and is the author of a valuable series of articles on the design of central heating systems, appearing in *The Canadian Engineer* in July, 1913.

T. C. KEEFER, C.E., C.M.G., LL.D., twice president of the Canadian Society of Civil Engineers, an honorary member of the Canadian Society and the American Society of Civil Engineers and of the Institution of Civil Engineers of Great Britain, celebrated his ninety-fourth birthday on November 4th. Mr. Keefer was born in Thorold, Ontario, educated at Upper Canada College, and has had a notable and distinguished engineering career.

J. VIPOND DAVIES, Vice-President of Jacobs and Davies, Inc., Consulting Engineers of Montreal and New York, was awarded on November 3rd, by the Institution of Civil Engineers, London, England, the Telford gold medal of that Institution for his paper on the "Extensions of the Hudson River Tunnels of the Hudson and Manhattan Railroad." The Telford medal dates back to the year 1835, funds for it having been bequeathed to the Institution by the celebrated engineer, Thomas Telford, its first president (1820-1935).

AMERICAN CONCRETE INSTITUTE.

The 11th annual convention of the Institute will be held in Chicago, Ill., February 9th to 12th, 1915. This convention will mark the completion of the tenth year of the existence of the Institute, and an especially interesting and profitable program is being arranged. The sessions will be at 10 a.m., 3 p.m. and 8 p.m. The following is a summary of the program:—

Concrete Roads, Sidewalks and Bridges.—Important papers and discussions relating to the status of concrete road construction will be presented, and special attention given to costs, repairs and maintenance. (Tuesday, Feb. 9th.)

Concrete and Reinforced Concrete Tests and Design.—Discussion of the very important column tests made by the Institute at Pittsburgh, tests of buildings, and other matters of current special interest. (Wednesday, Feb. 10th.)

Concrete in Art and Architecture.—Discussion of architectural design in concrete, dimension and art concrete stone, treatment of surfaces, etc. (Thursday, Feb. 11th.)

Plant Management and Costs.—This day will be devoted to concreting plants, covering plant management and costs, the design and cost of wood and metal forms, and the methods of placing, proportioning and selection of concrete materials. (Friday, Feb. 12th.)

CHANGE IN A PROMINENT CONSULTING ENGINEERING FIRM.

Dr. J. A. L. Waddell and Mr. John Lyle Harrington announce the dissolution of the firm of Waddell and Harrington. The firm's business will be conducted as usual till the conclusion of its affairs in July, 1915, except that it is accepting no new commissions. Dr. Waddell will give his attention to special engineering and financial matters and to important advisory work. Mr. Harrington will be joined by the firm's Associate Engineers, Mr. E. E. Howard and Mr. Louis R. Ash, in the establishment of the firm of Harrington, Howard and Ash, Kansas City, Mo.

INTERNATIONAL IRRIGATION CONGRESS.

The new officers of the International Irrigation Congress are: J. B. Case, Abilene, Kan., president; Arthur Hooker, Spokane, Wash., secretary; J. S. Dennis, of Calgary, first vice-president; Richard Burges, of El Paso, Tex., second vice-president; J. F. Hinkle, of Permiston, Cal., third vice-president; Kert Grunwald, of Denver, fourth vice-president; and George A. Smith, of Salt Lake City, fifth vice-president.

COMING MEETINGS.

WASHINGTON STATE GOOD ROADS ASSOCIATION.—Convention to be held at Spokane, Wash., November 18th, 19th, and 20th. Secretary, M. D. Lechey, Alaska Building, Seattle, Wash.

ANNUAL MEETING, AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The annual meeting of the American Society of Mechanical Engineers will be held in New York, December 1st to 4th, 1914. Secretary, Calvin W. Rice, 29 West 39th Street, New York.

AMERICAN ROAD BUILDERS ASSOCIATION.—Eleventh Annual Convention; fifth American Good Roads Congress, and 6th Annual Exhibition of Machinery and Materials. International Amphitheatre, Chicago, Ill., December 14th to 18th, 1914. Secretary, E. L. Powers, 150 Nassau Street, New York, N.Y.

CANADIAN NATIONAL CLAY PRODUCTS ASSOCIATION.—Annual Convention to be held at the King Edward Hotel in Toronto, January 26, 27, and 28, 1915. Secretary, G. C. Keith, 32 Colborne Street, Toronto.

EIGHTH CHICAGO CEMENT SHOW.—To be held in the Coliseum, Chicago, Ill., from February 10th to 17th, 1915. Cement Products Exhibition Co., J. P. Beck, General Manager, 208 La Salle Street, Chicago.

AMERICAN WATERWORKS ASSOCIATION.—The 35th annual convention, to be held in Cincinnati, Ohio, May 10th to 14th, 1915. Secretary, J. M. Diven, 47 State Street, Troy, N.Y.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—Annual meeting to be held at the Iowa State College, Ames, Iowa, June 22nd to 25th, 1915. Secretary, F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.