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The Canadian Engineer

ESTABLISHED 1893.

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PRECISE LEVELLING.

The Department of Public Works, Ottawa, have just distributed a report on Precise Levelling. This report covers the years 1904 to 1907, and gives a description, the location and elevation of the most important permanent bench marks established by this department when running a line of levels from the United States Coast Survey bench mark at Rouse's Point, N.Y., to the mouth of the French River.

The officials of the department are to be commended for the enterprise and accuracy displayed in carrying out the survey and for the publicity they have given and detailed description furnished of this work.

With this survey as a nucleus lines of levels should be carried throughout Ontario and Quebec, so that all elevations could be referred to the same datum, i.e., mean sea level of the Atlantic ocean at New York.

Surveys of property, no matter by whom made, have a common base line, and the plans of different men, representing different interests can be readily compared and read.

But the reading of profiles is a different matter. Each man assumes a different elevation. 'Tis true we have, theoretically, a common plan of reference in the sea level, but in Canada the levels have not before been carried far enough inland to be of any value.

If the chief engineers of our railways and the city and county engineers throughout the Provinces become interested in this work it will not be long before the anomaly, of three railways and a municipality filing profiles, each of which has assumed different elevations for the datum plain, has passed.

Our city and county engineers along these lines of precise levels should be the first to adjust their B.M. to the new elevations. The Government party were generous in their distribution of permanent marks, and it would be a comparatively small matter for nearly all municipalities to adopt their elevations.

With the large railways it would be a difficult matter—but it will come in time.

INDEPENDENT TELEPHONE CONVENTION.

Conventions follow one another so quickly that one wonders what new interest can lay claim to public attention.

On September the 9th the Canadian Independent Telephone Association will hold in Toronto their third annual Convention. Matters of special interest to Independent lines will be discussed, as well as methods of organization, construction, and operation.

This convention will be a good place for directors, managers and superintendents to gather, forget their own little world, exchange bright ideas and grow. Such a convention should be a good place for a man to go to get out of a rut. It should help him to a more thorough mastery of his own system.

At the same time as the convention there will be an exhibition of telephone apparatus and equipment, improvements and new inventions, as well as the standard supplies—an exhibit of these will instruct the manager how he can run an exchange smoothly and get business.

FOR THE GOOD OF THE PROFESSION.

Speaking of one of the departments of our paper a contractor said: "I receive many valuable suggestions from the articles, but if I were to contribute I would feel I were giving away what was to me 'trade secrets.' That spirit of always receiving and never giving is hardly fair. We receive aid or suggestions from others, but do not care to give in return, assistance.

After all that is not the spirit of success. Success is better emphasized by co-operation and reciprocity. In endeavoring to ferret out and record new methods and new ideas in the world of engineering we are successful in only so far as we have the active sympathy of the man in actual practice. We endeavor to give practical suggestions and papers containing information of value to our readers. How many of our readers recognize any obligation to their fellow-readers in return?

TIMBER TESTING.

The effect of impact and variable loading upon beams and trusses has been very difficult to even approximate. To assist in solving this problem the United States Forestry Service are designing a special form of impact machine to be built and installed by the University of Washington at Seattle.

Engineers and designers will await with interest the results of experiments, for no satisfactory answer has yet been given to the question of the effect of repeated shocks on the strength of wood. Another question allied with this one, and which experiments with such a machine should assist in answering, is connected with the calculating of stresses in beams and trusses under repeated loadings.

This machine will be provided with a 1,500 pound hammer, which can be dropped upon the wood specimens under test from any height up to three feet. It is so constructed as to be both automatic and autographic.

EDITORIAL NOTES

Canada's canal traffic shows a steady increase for 1907. It aggregated 20,543,639 tons, or nearly double the tonnage for 1906.

* * * *

The Canadian National Exhibition is delighting her thousands this week. Next week the attendance will likely be larger than it is for the present week. The engineer may spend simply a holiday at an exhibition, or he may use it as a means of gathering information, and Toronto Exhibition is no exception.

* * * *

Toronto's city council has again shown their inability to recognize that their City Engineer knows "what he wants when he wants it." Mr. Rust recommended a certain location for the septic tanks in connection with the trunk sewer. The council refused to sanction the plan, and now the greatest improvement Toronto has ever undertaken bids fair to have its usefulness, in part at least, destroyed.

* * * *

The Governments, both Dominion and Provincial, grant aid to Agricultural Experimental Stations. The money so spent has brought forth large returns, both to the profession interested and for the general good. An Engineering Experimental Station in connection with our Faculties of Applied Science would be just as successful.

Most of the hard steel at the present time is made in the open-hearth furnace. Enormous quantities are used for car-springs and agricultural machinery, and both the acid and basic furnaces furnish a share.

VALUE OF IRRIGATION.*

Prof. Carpenter, Denver, Col.

Canadians have realized the value of irrigation to this country. They must have realized that without water their values were small, but with water there was no limit to what they could do. In fact, with irrigation it would be a venturesome act to try to set a value on the possibilities of this country.

For 25 years he had been connected with irrigation and had a chance to see something of its development. Twenty-five years ago men who made prophecies that land would reach certain values that seemed extreme were regarded as visionaries and lost caste, but in 25 years those forecasts had been more than made good. Water on the land had caused it to reach values that no one would have thought of.

There were people who supposed that the water supply would have been depleted years ago, but they had gone on building reservoirs and dams and there were no more signs of depletion now than then. Conditions were changing and enterprises which ten or fifteen years ago were not commercially feasible were feasible to-day. It was considered then that anyone who wanted to invest money would not consider irrigation, as the enterprise would not be worth the cost. In the meantime, however, land that was only worth $30 an acre had become worth $150 an acre, so that it paid to irrigate now where it would not have paid then. An enterprise he had reported against a few years ago, he had reported on favorably this summer, and an enterprise he might report against this year might pay to construct in a few years to come.

While it seemed that we have as much water as before, though more is being used, there has been no real increase. It is only that we are more saving with water now than we have been in the past.

As the value of land increases it pays to save it, and you build reservoirs and ditches because conditions demand it. When it will pay to do it, you will do it, but till it does pay you will not, and you would be foolish if you did. You may build a 10-foot dam to-day where you will build a dam of 100 feet in a few years, and you may even go as far as to conduct all the water in pipes.

Development is much the same in different countries. Even in Italy, I was struck by the similarity of their system to ours. It is true that they have been 600 years arriving at a condition which we have arrived at in a few years, but the stages were the same. I also find this country passing through exactly the same experience that Colorado passed through years ago.

Water the Prime Necessity.

In passing through British Columbia they knew the character of country they had here. It would develop as financial conditions changed. They had taken advantage of the streams as they found them, and had quarrelled about the water. They then found there was not enough water and began to seek means of storing it. For what was the value of land without water? In the States they could grow $60 an acre of root crops on irrigated land, so that it paid to spend $20 an acre on irrigation. They had there what they called the bonded system in which they put dams and ditches on condition that they could sell their bonds. The prices he had quoted were not in a fruit district such as this, where they had land selling at $500, $1,000 or $1,200 per acre. As conditions developed, the call on the water would be greater, and the greater the value of the water would become, so that it would justify more expense in getting and saving it, and the individual would take pains to see that none was lost, for where a community was economical the individual might be wasteful.

It did not take much irrigated land to make a great country, and he instanced Egypt, of which only a small portion was annually irrigated by the Nile and yet it maintained a dense population. In fact, it would be impossible to estimate the possibilities of these central valleys of British Columbia

* Abstract of an address at Vernon, B.C.

when the land became irrigated. There was a complaint sometimes of want of rain, and yet if they had the rain they would not have the bright sunny climate that ripened the fruit. In speaking to Colonel Mann a few years ago, he had said that he came from a country where they did not have to irrigate. "I told him he had my sympathy, and told him why. He wanted me to go through the country that his railway runs through. I have lately done so. It is a great country, but it does not take the place of the country where you can control the water and have such conditions as you have here."

The Storage Question.

You know the conditions in British Columbia better than I do. You have a series of rivers here that every irrigation State might envy, but they are nearly all in a position in which they are of no use to you. Take the Fraser, the Thompson and the Columbia. They are nearly all low down with high banks so that they are of no use to you for irrigation. Then your land is scattered about in patches so that the big ditches of the foothills are also impossible. This brings you down to irrigation by small ditches. The canal system of irrigation would not be possible. It does not seem that you will have any conflict between irrigation and navigation. You have many mountain streams and these are your source of supply. That is what you are using and your experience will be as in Colorado, where it takes from four to six acres of watershed to supply water for one acre below. Your streams have low heads and are subject to very rapid fluctuations. That brings up the extreme necessity of storage, which you have only begun to discuss here. The logic of events will drive you to consider these things more and more. The whole amount of your irrigable area needs to be dotted with dams and reservoirs.

It struck me last year that your local mountains were unexplored and there was a lack of information about your waterheads. The mountains are difficult to get through, but you must consider how valuable that water is. If some of your dams could be built on the other side they would be built at once.

Problems of Irrigation.

This increase in the value of water is going to have an important effect in many regards. Owing to conditions of gravitation you will have the problem of pumping, with plenty of water at a lower level needed at a higher level. Your problem is that of every other country, to get the greatest value out of the resources you have. Well, at times you will have many problems and difficulties, but they will not be such as to cause any Anglo-Saxon community to hesitate. If we expect to avoid troubles we ought not to be born. Every one who touches water will have troubles, but, fortunately, they come one at a time. In Colorado we have had a great deal of litigation. I like to speak of Colorado. It was a pioneer country with no experience to guide it, and it had to find its own way out. It is very difficult for human beings to adopt a new line of thought, and we were all the time trying to make our irrigation laws conform with riparian laws, and that country spent years in trying to find what should constitute the rights to irrigate and it led to litigation. When Mr. Dennis and Mr. Leach visited Colorado in 1902 it was about the end of that period of litigation, and since then there has been very little of it. We have gone through the development you are going through, but you will shorten up the process more than we and other States did. If you could produce to-day a code of laws that would meet your conditions, in 20 years it would not be adopted. You may be able to fix the main principles of legislation but not all the details.

It leads to this condition, that as affairs change, you will have to change your code. I have heard criticisms of the code in Colorado, as I heard criticisms of your Water Clauses Act. Yet when these laws were made they met conditions at the time, and credit is due to those who put them there.

There are so many things connected with irrigation that naturally only a few can be touched upon in an address like this. I want, however, to emphasize the value of your water. Your efforts will not be confined to this portion of the Province. You will have the same problems in the north, in the Peace River Valley and other places, though perhaps not for fruit culture, and it behooves your Government and you individuals to take steps to store the water, and bring, with the coming years all these valleys under cultivation."

ALLOWABLE LENGTH OF FLAT SPOTS ON CAR AND LOCOMOTIVE WHEELS.

E. L. Hancock.

The following analysis is the result of an attempt by the writer to develop formulæ showing the relation between velocity of train and the allowable length of flat spots on car and locomotive wheels. The flat spot, as is well-known, subjects the car and rails to considerable impact even at slow speeds. At high speeds, even very slight flat spots endanger both wheels and rails. There should be, then, some criterion that could be used as a guide by the inspector to enable him to decide whether or not any wheel is too flat to be continued in service. It is believed by the writer that the formulæ given below represent the relation between length of flat spot and velocity of train as nearly as this can be determined theoretically.

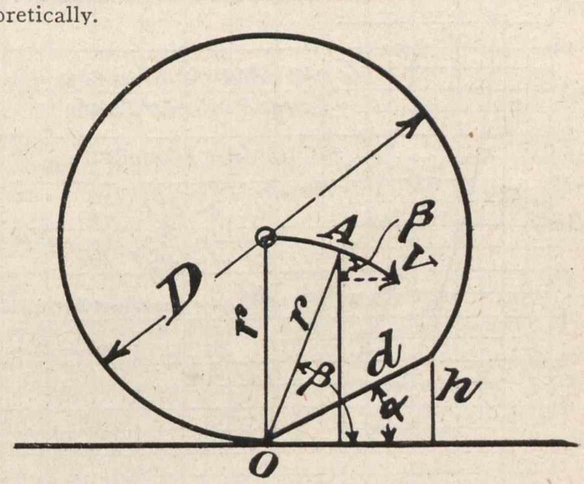


Fig. 1.

Let Fig. 1 represent the wheel of radius r and length of flat spot d. Represent the velocity of train by v. At any instant it may be considered that the kinetic energy of the wheel, with the weight it carries considered as rotating about the point O, is the same as if the mass supported by the wheel was concentrated at its center, that is, its kinetic energy is $Mv^2/2$. When the flat spot is in contact with the track the center of the wheel is at the point A, distant below the original position, approximately, h/4 equal to $d^2/4D$, where d is the length of the flat spot and D is the diameter of the wheel. At the point A the mass M has a downward velocity equal to v cos B*. But cos B* equals d/D, so that the kinetic energy with which M strikes the rail is

$$\frac{Mv^2 \cos^2 B^*}{2} = \frac{Mv^2d^2}{2D^2}$$

where v is the velocity of train in feet per second, d the length of flat spot in feet and D the diameter of the wheel in feet.

The allowable impact on a rail of any weight is given by the specifications of the Master Car Builders' Association, as that of a weight G^1 falling freely from rest through a distance h^1 upon the rail. The kinetic energy of the impact of the wheel should not be greater than that of G^1 falling through the distance h^1. We have, therefore,

$$\frac{Mv^2d^2}{2\,D^2} = G^1h^1$$

so that

$$(1) \qquad d = \left(\sqrt{\frac{2\,D^2\,G'h'}{M}}\right)\frac{1}{v}$$

If the diameter of the wheel is 33 inches, and the weight it carries, including its own weight, is 10,000 pounds, and if, in addition we assume G^1 as 2,000 pounds and h^1 as 19 feet, we have

$$d = \frac{43}{v}$$

this may be written, if v is expressed in miles per hour:

$$(2) \qquad d = \frac{29.4}{v}$$

This equation is shown graphically in Fig. 2 (a).

If we consider a locomotive drive wheel, 6 feet in diameter, carrying a weight of 25,000 pounds, the equation (1) becomes

$$(3) \qquad d = \frac{40.6}{v}$$

where v is in miles per hour and d is in feet. This equation is shown graphically in Fig. 2 (b).

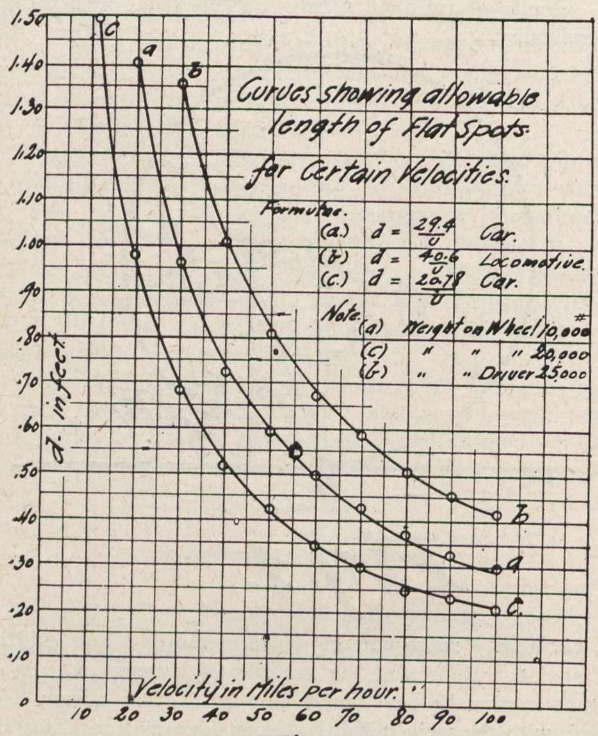


Fig. 2.

In working out the above relation between d and v no account has been taken of the action of gravity in bringing the mass down upon the rail with increased energy. The distance, equal to the distance of A below the center, approximately h/4, is so small that one might expect beforehand that the kinetic energy would be increased but little. Adding the term to account for this kinetic energy of the fall,

$\frac{M\,(2gh)}{2 \quad 4,}$ equal to $\frac{Mgd^2}{4D}$, equation (1) may be written,

$$(4) \qquad d^2 = \frac{4\,D^2G'h'}{M}\left(\frac{1}{2\,v^2+gD}\right)$$

Reducing as was done in obtaining equation (2) this becomes

$$(5) \qquad d = \frac{29.16}{\sqrt{v^2+20.77}}$$

Substituting values of v, from 10 miles per hour to 100 miles per hour, in equations (2) and (5) the following values of d are obtained:

*Beta.

TABLE I.

v in miles per h our	Value of d in feet. (2) Wt. on wheel 10,000 lbs.	(2) Wt. on wheel 20,000 lbs.	(5)	Approximate value of d in inches Using a factor of safety of 5 Weight 10000	Weight 20.000	Using a factor of safety of 10 Weight 10.000	Weigh't 20,000
10	2.90	2.07	2.67	6.96	4.92	3.48	2.46
20	1.42	.98	1.43	3.36	2.36	1.68	1.18
30	.96	.68	.97	2.30	1.64	1.15	.82
40	.73	.52	.72	1.75	1.24	.87	.62
50	.59	.42	.586	1.41	1.00	.70	.50
60	.49	.34	.49	1.17	.82	.58	.41
70	.42	.30	.42	1.00	.72	.50	.36
80	.36	.25	.36	.86	.60	.43	.30
90	.32	.23	.33	.76	.55	.38	.27
100	.29	.21	.29	.69	.50	.34	.25

It is evident from the results shown in the above table that the results obtained from equation (5) are not very different from those obtained from equation (2). In the case of Table II. a similar statement might be made regarding equations (3) and (6), so that it is shown that the added kinetic energy acquired in falling throught the distance h/4 may be neglected.

For the locomotive wheel the equation corresponding to (5) becomes, using the same values as those used in obtaining equation (3):

$$(6) \qquad d = \frac{40.62}{\sqrt{v^2+45.31}}$$

Substituting values of v in miles per hour in equations (3) and (6), the following values of d are obtained:

TABLE II.

V in Miles Per Hour.	Values of D in Feet. Equation (3)	Equation (6)	Approximate Values of D in Inches, Using a Factor of Safety of 10.
10	4.06	3.37	4.87
20	2.03	1.92	2.43
30	1.35	1.32	1.62
40	1.01	1.00	1.21
50	.81	.805	.97
60	.67	.67	.80
70	.58	.57	.69
80	.50	.50	.600
90	.45	.45	.540
100	.41	.44	.49

In the above discussion the probability of the wheel jumping from one corner of the flat spot to the other, without falling through the height h/4, has not been considered. Such action, due to the inertia of the car, could only take place at high velocities, and its effect would probably be to reduce the impact between wheel and rail. It should be added that flat spots are not likely to be found absolutely flat, as assumed in the analysis, but rounded or worn off at the corners. For such cases the distance of fall of the axle is less than h/4, so that the kinetic energy of the impact is less than that given by the analysis.

The wheels as rotating bodies have been considered as having their mass concentrated at the center and rotating instantaneously about the point of contact of wheel and rail. The wheel is, in fact, a compound pendulum and the radius at which the mass should be considered as being concentrated is a little greater than D/2. The additional kinetic energy introduced in equations (2) and (9) by such a consideration wou'd scarcely produce any difference in the estimated length of flat spot.

The writer is not aware that any analysis has ever been published that shows what is attempted in this paper. It is hoped that experimental data may soon be at hand to confirm or deny the results here given.

An electro-magnet has been successfully used in recovering a broken drill from the bottom of a borehole.

THE WROUGHT COMPRESSIVE MEMBER FOR BRIDGE TRUSSES.*

By H. E. Horton, M.W.S.E.

It is subtle and illusive and may side step.

It is composite, and not homogeneous.

No law written of proper relation and proportion of constituent parts.

Cannot deform without shear. Accept and fully provide for it, that is, the shear.

Applied science useful. Be sure you have the right basis in making application.

Successful practice the only sure instructor.

Mathematical investigation only safe when justified by practice.

Sound judgment and clear perception necessary to recognize proportion and relation.

The engineering profession has the ability to understand relations and proportion.

With understanding of relation and proportions, wrought compressive members may be so designed and built of any size with all the certainty of satisfactory result, as of any physical thing designed and built by man.

A leading engineering journal of international reputation in a recent issue has made the broad statement that failures in wrought metal frame structures have all developed from buckling of the compression members, proving the general rule, by noting only one exception where tension members had failed and that due to deterioration by rust. As this was a review of a large number of cases, it is surely evidence that research as to the compression member is not only desirable but necessary. We also have at this time in the columns of the technical press, by correspondence, evidence of a renaissance in the mathematical investigation of compression members and nothing as to the proportion of the elements from which a compressive member is built up.

The design and proportion of compressive members for an open frame structure, like a bridge span, is one of compromise and concession. If the conditions demand only the ability to support weight like an individual column supporting a girder, with uniform distribution of load over the entire area of the column, it is well established that a section of uniform thickness of material in a triangle, in a circle or a square figure, are the most efficient; provided that we can produce by process of manufacture such a figure of homogenous material. However, it is idle to speculate on the efficiency of any exact form of column when the conditions demand that the compressive member must be built up of sections or segments, in practice generally riveted together.

Further the difficulties of making panel connections in truss work are such as to suggest the compressive members, open on one or more sides. This open or lattice member is always made with a material loss of efficiency as to the total weight of material in the member. A typical case will represent a direct loss of full 30 per cent. when two channels or similar sections are used, laced on two sides and will generally reach 100 per cent. when four angles or similar sections are used, laced on four sides; illustrating the good engineering maxim that you cannot "eat your cake and keep it."

We cannot economically connect to an enclosed triangular or circular section; in fact the cost of such connections to either of these figures will generally represent more cost than the percentage lost, as indicated above, in developing the open figure.

The enclosed box section presents greater possibilities of connection and lacks but a trifle in efficiency as compared with the triangle, which is greatest, and circle next; these differences can readily be ignored. It may, and probably will develop that such box figures, in the evolution of design, will find its place when maximum sections are required.

Flanged plates with riveted connections were used 30 years ago to form triangular sections. More recent years we have seen circular columns built up of longitudinal sections generally with projecting flanges through which the rivet connections were made. This section was popular and in very extensive use for many years. Box sections have been in use through all periods and with favorable conditions are at the present day.

We have little experimental and definite knowledge of the action of steel in built up compression members. Specimen tests have been carried out on solids and small pipes through many years. Our experience shows full sized members, tested to destruction, fail at less than the computed strength. It is a case of the strength of the composite member being determined by the weakest elementary unit and the further fact of want of cohesion of the parts.

It is quite usual practice in building a structure of any considerable importance to have tests to destruction of tension members, while with the compression members tests are only made on samples to be certain as to the character of the material used. An individual tension member, maximum eye bar, will scarcely cost $200, while we see in practice compression members of size to require a testing machine of 15,000 tons' capacity and one such column would cost $10,000. It is scarcely to be hoped that comprehensive tests of such sizes will be undertaken.

It is in fragments only that we have knowledge of such tests as have been made. It seems reasonable to hope that the records of tests of steel that have been made in compression, both in individual pieces and combined members, might be gathered together, edited and published.

Our understanding is that steel of the character used in construction of a composite column or in rolled sections of 100 "radii" yields by bending at somewhere from 30,000 to 35,000 pounds per square inch; that the elastic limit and ultimate strength are essentially the same, that is, the column yields and fails at once under the same load and at the same time.

Our experience and tests as to the reliability and strength of full sized members has been limited generally to pieces not ever 30 ft. long and 25 square in. of section. In fact our knowledge of the action of such members in the testing machine is very slight, but our knowledge from practice shows rectangular compression members very reliable when designed to standard specifications and sizes within our usual experience in all the well-known forms. That we have scarcely more than practice to direct us, is to be regretted.

Length, divided by least Radius of Gyration (expressed herein as "Radii"), is accepted by engineers as an indication of unit value in a compressive member, the application being made by formulæ with somewhat varying constants. The least "radii" in all cases showing the largest compressive unit value for material, and here the fact is apparent that the thinner the material the larger the radius. To illustrate:

Member	Section Sq. in.	Radius of Gyration	8 ft. 4-in. equal to	100 "Radii" equal to
4-in. Solid Round	12.5	1	100 Radii	8 ft. 4-in. long
8-in. Pipe, ½-in. thick	12.5	2.5	40 Radii	20.66 ft. long
16-in. Pipe, ¼-in. thick	12.5	5.5	18 Radii	45.8 ft. long
32-in. Pipe, ⅛-in. thick	12.5	11.3	8.8 Radii	94.1 ft. long
64-in. Pipe, 1-16-in. thick	12.5	24.0	4.1 Radii	200 ft. long

These illustrations clearly indicate the necessity for a definite and clear limitation or thickness of material forming a composite column. We recognize the fact that a 4-in. solid round 8 ft. 4 in. long, 100 "radii," is safe to carry 11,000 pounds per square inch; that an 8-in. pipe ½-in. thick at 40 "radii" is safe to carry 16,000 pounds per square inch. In the circular form we can readily believe that a 16-in. pipe ¼-in. thick, at 18 "radii" will also safely carry 16,000 pounds per square inch. But a pipe 32 in. in diameter ⅛-in. thick, 8.8 "radii" will also carry a goodly load per square inch, but I doubt if anyone would expect to load it to 16,000 pounds per square inch. A 64-in. pipe 1-16-in. thick 4.1 "radii" we have reason to believe will collapse and fail at less than the load per square inch that the 4-in. solid round at 100 "radii" will sustain.

Let me cite the following as an illustration of the necessity of recognizing some rational thickness of material to radius of gyration: developed in personal practice, a circular section 20 ft. in diameter ¼-in. thick, radius of gyration 85, "radii" 13½, to support a compression of 5,000 pounds per

* Paper read before the Western Society of Engineers.

square inch. Inquiry among engineers and a review of practically all the literature on the subject availed me nothing; therefore I made a test on a circular figure of 1-20 size, height and thickness; that is, thickness was 1-80 in., diameter 16 in., height 57 in., and was agreeably surprised to note that the material in this form developed 7,000 pounds per inch ultimate strength. (See Fig. 1.)

These examples are on circular figures where the circular element has to do with the ability of very thin material to resist compression. What of the plate in a rectangular compressive member? Someone has specified that it must be 1-30 as thick as wide. For want of other basis it has generally been accepted. The radius of gyration will modify and hold in check any disposition to use material of undue thickness, but what of thin plates? They are frequently used and surely of some value. Also thin plates in multiple with more or less efficient riveting, however, in no way forming a homogeneous whole.

As to the value of flat plates in compression, one or in multiple and the relation of thickness to width, we have no definite knowledge.

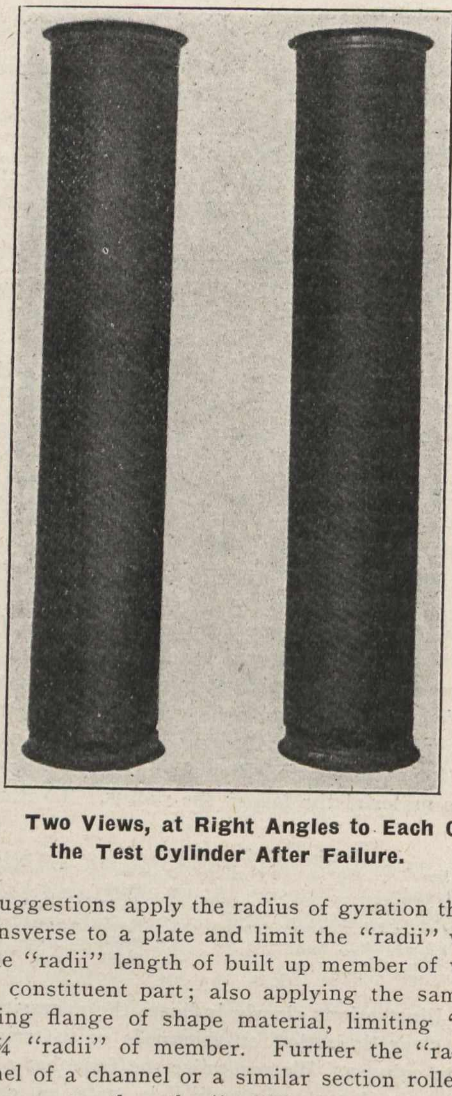


Fig. 1. Two Views, at Right Angles to Each Other, of the Test Cylinder After Failure.

The suggestions apply the radius of gyration through the center transverse to a plate and limit the "radii" width of a plate to the "radii" length of built up member of which the plate is a constituent part; also applying the same method to projecting flange of shape material, limiting "radii" of same to ¼ "radii" of member. Further the "radii" of a lattice panel of a channel or a similar section rolled or built shall be no greater than the "radii" of the entire member.

These applications of the radius of gyration will produce results not materially different from practice in the average and usual member, but will allow thinner material as the "radii" of the member increase. The compressive formula presented in the suggestions, only works a reduction of compressive unit value when over 71 "radii"; hence the application of "radii" as indicating thickness of plate material will only apply as member is 71 or more "radii" in length. In members 71 "radii" and less plates will be 1-24 thickness of width.

Of proportion or percentage of shapes necessary to properly combine with plates, we have only suggestion from practice.

Columns of 100 "radii" will, under compression, yield by bending. The same column under a transverse load will also yield by bending and here we have evidence that compression and transverse load will develop shear, termed eccentricity by many writers, in all cases, however, it will be noticed that the eccentricity is arbitrarily arrived at. Of shear or proportion and relation of shear to compression, acting through the member, specifications are absolutely silent.

Practice shows shear to be well provided for by cover plates, tie plates and lattice as used on typical columns of medium size in box or laced members and does in all cases provide for 5 per cent. at each end of the compressive force acting through the column. This is the basis of analysis of both cover plates, stay plates or lattice as used on rectangular compressive members.

Many specifications in general use, have specified an ability in tie plates at the end of open lattice column to transfer 25 per cent. of the load across the column and is safe practice; this carried into the lattice would seem excessive, but surely somewhere between 5 per cent. and 25 per cent. will give safe results.

The proportions of shapes and plates and thickness, to width of plates and shapes in connection with shear, are vital ones in designing a safe compressive member, and undoubtedly have as much importance as the "radii" in determining the unit value of the material used.

It is hoped that investigation and research may be undertaken on the immediate relation of parts similar to those used in composite rectangular compressive members. We surely can gain knowledge from models at even 1-16 size tested to destruction at comparatively small cost.

To design to the accompanying suggestions, will show us difficulties in making a latticed compressive member of excessive size, both in the size of lattice and the connection of the lattice with the flanges. This leads to the very natural conclusion that when an extraordinary large section is to be built, box members will be used for the same reason that practice has forced the use of plate or box girder under somewhat similar conditions; that is, where considerable shear exists and a very shallow girder is a necessity.

The compression formula presented herewith does not limit the "radii" length a member may be built, but does reduce for increased "radii" very much more rapidly than formulæ as usually written. It also limits maximum compression to ¾ tension. The particular formula was arrived at because it fairly fits, using 20,000 dead load unit stress, and the standard straight line formulæ of the day, in its application to chord members and also for posts with modified unit stress.

Accompanying is an extension of the formula showing the relative position with the straight line formulæ referred to, and Pin Bearing Formula on page 143 of the Carnegie Hand Book for 1903, and the further fact of having knowledge of tests on solid rounds 300 "radii," which also justifies the form of the formula. It is proposed to use this formula in all compressive members, because compressive members in a truss structure are only fixed by other compressive members subject to flexure from the same load.

I have noticed a tendency to use excessive unit stress in compression members of small "radii;" while it is a fact, tests of homogeneous steel in short lengths show an ability to resist compression equal to its ability to resist tension. It must not be overlooked that a compression member, however short, of any form used in construction, is a composite and not homogeneous body. It is entirely impossible to be certain of a reasonable uniform distribution of force over the entire section of a short member. Undoubtedly a member 100 "radii" is as reliable as one 5 with same load, because of want of ability to distribute the load uniformly over the short section and the further fact that a member 5 "radii" long is not likely to present conditions to successfully combine parts approximating a homogeneous member. Standard specifications allow only 6-10 of load on 100 as on 5 "radii" column.

The suggested limitations and relation of parts forming a member, are derived from our experience and practice. In a rolled channel or beam at least 30 per cent. of the section is in the flanges, but 40 per cent. has been suggested as the proper proportion of shapes in built channels or similar members. The extra 10 per cent. being in some sense to represent the proportion of shape in contact with the plates. The suggestion that multiple plates, building up webs of channels or similar sections of members, act individually is not sustained by practice, but it is hoped the suggestion may help to correct doubtful designing, considering it will present little or no difficulty and add nothing to cost.

In rolled or built channels or similar forms it is obvious that there should be a relation of "radii"; neutral axis both parallel and perpendicular to web. This proportion in practice is 1 to 5.8 extreme for rolled channels.

An extended review of specifications of American practice in bridge work indicates in the matter of unit stress, conventional relation between tension, shear, bearing and flexure of extreme fibre. The suggestion presented follows such relation. In attempting to express relations for parts forming a compressive member, it is necessary to take unit stresses in consideration, as well as formulæ for compression.

In the various standard specifications we find additions and exceptions in the application of unit stress, to be the rule and not an exception. More than fifty different unit stresses are specified in one standard specification, both confusing and exasperating in attempting to follow, and the cause of many misundertandings and blunders in proportioning parts.

For the purpose of design, dead load only is positive. The load of wind may actually exist, but is entirely an assumption as to the exact amount. The live load is usually the principal one, but is an assumption in so far as occasion for changing unit stress.

It appears to me the maximum-minimum formula, also the quite common one of assuming dead load stress at two and live load stress at one for main members is unfortunate in the fact of not caring for secondary members and details with that certainty of proportion and relation that seem desirable.

It may be doubted if the author of either of the methods suggested above can tell us where "we are at" when reversals of stress as in chords of a drawbridge, with further demand that compression and tensions stress shall be provided for separately and added to arrive at the section of a member. Surely it is unnecessary, both the uncertainty and absurdity as illustrated in this case.

Assume a stress that we are willing to use for dead load and then assume a wind pressure that we would be willing to care for with the same unit stress and wishing a structure proportioned for a live load known as Cooper's E. 50. double live load, that is, assume a Cooper E. 100; with unit stress of 20,000 pounds per square inch (or any other stress desired), we would have developed a balanced structure, undoubtedly the intention of the specifications though not fully specified.

A recent paper before an engineering society shows deficiency of standard specifications in that an increase of live load of only 25 per cent. developed in one member an increase of 166 per cent. in stress in no way provided for and in another member, a reversal of stress, where a reversal was in no way contemplated. It is obvious that the method herein proposed fully cares for all the problems of counters, under increased live load of 100 per cent.

Suggestions herewith presented, attempt to express the proportion and relation of component parts of columns as derived from practice, to the end that the relation and proportion may be used to develop columns of any size with some hope of satisfactory results.

The writer in no way claims originality in the suggestions. The various points considered are well understood by engineers familiar with metal design and have long been a matter of discussion and interchange of thought one with the other. Am inclined to say that engineers have considered the points made here merely fundamental and directed by common sense, at least I know of no written presentation of the proportions. The suggestions may be unnecessary, but surely will do no harm.

The suggestions in no way having to do with quality of material or details of connection, but are intended to fill in where standard specifications seem to be lacking.

Suggestions of Proportions of Parts for Rectangular Wrought Compresisve Members for Framed Structures.

Unit Stress————————

Compression—Unit Stress, times $\dfrac{1\frac{1}{2}}{1+\dfrac{L^2}{5000\,R^2}}$

$\dfrac{L}{R}$ = "Radii"

Compression, never to exceed ¾ unit stress.

Flexure, extreme fibre = 1½ times the unit stress.

Bearing = 1½ times the unit stress.

Shear = ¾ times the unit stress.

Tension = Unit stress.

The method of applying force shall be such as to distribute over the entire area of the member equally for each unit of the entire section of load. Force applied to the member only through the center of gravity, if necessarily otherwise applied, bending stress shall be duly considered in reducing the value of the material.

Compressive members composed of shapes or combination of shapes and plates, shall preferably have the least possible number of shapes and plates to form said member, and to be as definitely and firmly fixed by riveting together as practicable.

If an enclosed box, four or more plates and shapes, 25 per cent. of the entire area shall be of shapes; if with two or more shapes and two plates then 60 per cent. of the entire area shall be in shapes.

If a trough, one side laced, 33⅓ per cent. of the entire area shall be composed of shapes.

If of two or more built channels or similar forms, two sides laced, 40 per cent. of the entire section of the members shall be of shapes.

If of four shapes and plates, laced on all four sides, 50 per cent. of the entire section to be of shapes.

Rolled or built channels or similar forms shall have a radius of gyration at least 1/5 as great when the neutral axis is parallel to the center line of web, as when the neutral axis is perpendicular to the web.

Pitch or panel of lacing shall be such that the "radii" of a rolled or built channel or similar section with neutral axis parallel with the web never need be less than 25 and never more than the "radii" of the member of which said channel forms a part.

Plates in webs shall preferably be no more than 24 times as wide as thick on members less than 71 "radii." On members 71 "radii" and more in length, "radii" through center of any plate transverse to length of member shall be no greater than "radii" of member. Shapes used with plates to form built channels or similar sections shall have flanges equal to 1/5 the width of said channels or similar member and said shapes shall have thickness of metal equal to "radii" transverse to shape through center of flange of ¼ the "radii" of the member, 71 "radii" and more. On members less than 71 "radii," a projecting flange shall not be less than ⅙ as thick as wide.

If shapes or plates of lesser thickness than preferred thickness are used, then the area shall be reduced to equal Preferred Thickness divided by the square of the Actual Thickness.

Plates grouped together, surfaces in contact and riveted, shall not be assumed to support one another, that is, if each or any of the individual plates are thinner than the preferred relation, as indicated above, then the reduction for thickness shall apply as specified for a thinner plate.

Compressive members, box or with one or more open sides, shall be stayed on all such open sides by lattice and at the ends with batten plates.

Cover plates and lattice shall have the ability to care for ————per cent. of the entire compression, as sheer at each end of member.

Batten plates to be placed as near as practicable to the ends of compressive members with sufficient rivets; moment of inertia of the group of rivets being considered to determine their ability to transfer shear. Shear of both ends, equal to double the shear at one end, shall be considered as an equally distributed transverse load over the entire length of the member with cover plates, batten plates and lattice in vertical plane. If of more than two channels or similar sections, connections of cover plates, batten plates, and lattice shall have sufficient connection to the flange of the outer channels or similar shapes to transmit the entire shear.

Cover plates, batten plates and lattice in vertical plane shall also have the ability to sustain the member in a horizontal position acting as the web of a girder supported only at the two ends, or supported only at the center. For the purpose of this last investigation, the total weight of the member shall be increased by a ratio of 2½. Preferably lattice shall be of uniform proportions for the entire length of a member. From the stresses as indicated, lattice should be designated with limitations by compression formula for stiffness, also the connecting rivets to flanges with limitations for bearing, shear and flexure.

Lacing shall be of width not less than two diameters of the rivets used to connect the same.

Rivets may be spaced within 3 diameters and spacing shall never exceed seven diameters of the rivet either in longitudinal, transverse or diagonal directions. Neither shall the pitch of rivets ever exceed twelve times the thickness of the thinest material through which they pass. Rivets to be spaced not less than 1¼ or more than 4 diameters from the edge, except rivets in lacing, one diameter of edge. In all cases rivets to be spaced not more than 1½ diameters from an end.

Preferably rivets in single shear shall have diameter equal to the thickest material through which they pass.

Extension of Sundry Compression Formulæ.

(a)—Cooper Chord Segments . ... $20000 - 90\frac{L}{R}$

(b)—Cooper Posts, Through Bridges .... $17000 - 90\frac{L}{R}$

(c)—Cooper Posts, Deck Bridges .... $18000 - 80\frac{L}{R}$

(d)—Cooper Lateral Struts and Rigid Bracing. $13000 - 60\frac{L}{R}$

(e)—Carnegie 1903, page 143, 2 Pin Ends.. $\dfrac{20000}{1 + \dfrac{L^2}{18000\,R^2}}$

(f)—Suggested—Unit Stress, say (20000) times $\dfrac{1\frac{1}{2}}{1 + \dfrac{L^2}{5000\,R^2}}$

and compression never to exceed ¾ Unit Stress.

The move to the coast is seen in the incorporation here of the Western Explosives, Limited, in which the moving spirit is George C. Tunstall, Jr., of Montreal. With him are associated other Eastern people. A site of 805 acres has been secured on Bowen Island, not far from the entrance to Vancouver's harbor, and to George McFarlane has been let the contract to erect the various buildings that will be used in the manufacture of dynamite, black powder and acids. The initial investment on the powder plant is approximated at $150,000 and on the acid plant $250,000. Mr. Tunstall was with the Hamilton Powder Company for a number of years, and later sales agent of the Standard Explosives. The output of the plant will start with 400 cases of dynamite and 300 cases of black powder per day, and acids will be manufactured, not only for the company's own use, but also for the trade.

HYDRAULIC-FILL DAMS.*

By Walter S. Morton, Mem. Conn. Soc. C.E.

The conveyance of material by the agency of water had its origin in the hydraulic mining regions of California. Through ditches and pipes streams were delivered under high heads and great pressure and directed against the face of the bank by a controlling device known as a "hydraulic giant" or "monitor," with a velocity of from 100 to 200 feet per second, which undermined, cut and loosened everything except hard rock and at such a small cost that hydraulic mines carrying but a few cents' worth of gold to the ton were profitably worked.

This method has been successfully applied to the construction of the highest earth dams built in the world and at a surprisingly low cost, the water accomplishing all the work of the pick, plough, wagon or dump cart, and through a proper arrangement of the flumes, assorting, distributing and depositing the material at will and consolidating it to a degree impossible by the ordinary method of rolling and tamping.

The fundamental principles laid down by Mr. James D. Schuyler, member American Society of Civil Engineers, who has designed and supervised a larger part of the hydraulic-fill dams so far constructed, and applicable to any earth dam, as given in his excellent paper on "Recent Practice in Hydraulic-Fill Dam Construction," published in "Proceedngs," October, 1906, are as follows:—

1. The foundation must be of an impermeable character and have a water-tight connection with a rock or clay bottom upon which it rests.

2. It must be practically impervious to water in a whole or at least goodly portion of its entire cross section.

3. It must have slopes sufficiently flat to be stable under all conditions of saturation from the water in the reservoir or from soaking rains.

4. The crest of the dam must be sufficiently above the highest water line to insure against the possibility of overtopping by extraordinary freshets or by waves driven up its inner slopes by gales of wind.

5. It must not settle, crack, or show any signs of change or movement after final completion and when put in service.

These requirements are fulfilled in the building of earth dams by the ordinary method of moistening, rolling and tamping, and the proper selection and distribution of materials, and by the exercise of great vigilance and care in construction, but at a much greater cost and with a more limited sectional area.

In general, hydraulic-fill dams are being constructed in the following manner:—

A stream of water must be brought to a point adjacent to and above the top of the proposed dam under great pressure, either by gravity from a source still higher up, or by pumping from the stream below, the latter condition more commonly existing. In the case of very high dams there must also exist a bank of thirty or more feet in height lying above the dam site and not too great a distance from it. In dams of moderate height, not only the water, but the material can be obtained near the bottom of the dam and forced into the embankment by the use of sufficient power.

The stream conveyed to the borrow pit by means of pipes leading from the pump or from the gravity flumes terminates in short sections of hose attached to which are the monitors or controlling devices; the hose, generally of four inches diameter, and the nozzles of two and one-half inches diameter or less. The nozzles are brought within twenty to fifty feet of the face of the bank and directed against it at the bottom. The pressure at the nozzle should not be less than seventy-five pounds per square inch, and preferably more. This powerful stream undermines the bank, loosens and disintegrates the material, moving even boulders of large size. Leading from the foot of this bank

*Read before the Connecticut Society of Civil Engineers.

to the embankment is a wooden flume of rectangular cross section or a riveted steel pipe. This conveying flume, or pipe, is generally laid along the longitudinal axis of the dam and tapped at intervals over the dam site by lateral flumes. The conveying flume must have a grade sufficient to carry the water without depositing within it the material held in suspension and which has been washed into the flume from the borrow pit. Sometimes two flumes are used, one over each edge of the embankment.

The material carried by the water is in all cases discharged at the ends of the laterals, and is first deposited on the up and down stream edges of the embankment. This serves two purposes: first, depositing the coarser and heavier particles on the outer edges; and second, keeps the outer edges at a higher elevation than the interior.

A shallow pond is thus maintained in the central part of the embankment by means of the higher rim, and into this pond accumulates the finer, silt-like particles conveyed in the sluiced material, which gradually settle and deposit, and thus form a large centre core of fine, impervious material, puddled and compacted by the action of the water into a dense mass, which constitutes the water-tight portion of the dam, the heavier particles deposited on the outer slopes serving to hold it rigidly in place. Thus by a proper manipulation of the flumes the materials are assorted and graduated in size from the outer edges towards the centre, and in a far more exact manner than can be done under the ordinary process of dam construction, and forms one of the essential features of hydraulic-fill dams. The surplus water is drawn out of this pool near the surface by suitable wooden drains or pipes.

Several methods are used in maintaining the proper slopes of the sides of the embankment. In some cases small, dry embankments are constructed by teams or scrapers, or by the piling up of loose rock to confine the sluiced-in materials. In others, layers of brush are placed on the outer edges, which fill with sediment and form a water-tight rim. The method pursued by Mr. E. H. McHenry, while chief engineer of the Northern Pacific Railroad, and now vice-president of the New York, New Haven and Hartford, was that of sprinkling loose hay along the edges of the embankment, upon which was placed a small layer of earth to hold it in position. The sluiced material quickly filled the loose hay and made a water-tight edge. This method was not only simple and inexpensive, but through the subsequent sprouting of the hay into a rank vegetable growth gave additional protection to the slope after completion.

Another form of dam has been built, consisting of a combination of a loose rock-fill backed by a deposit of earth placed in position by the sluicing process. In this form of construction a diaphragm of two-inch plank was placed in the centre of the rock-fill and made water-tight so as to prevent the sifting of the finer material through the loose rock and its subsequent loss while still in a liquid state; the depositing of the material by sluicing being done in the manner heretofore described, the coarser particles being deposited on the upstream edge and the finer against and adjacent to the rock-fill.

The conveying flume, reaching from the borrow pit to the dam site, should have a grade of at least three per cent., and steeper when obtainable. The heavier the grade the greater the velocity of the water and the constant increased carrying capacity. In order to carry coarse gravel and rock it should have a grade of from six per cent. to seven per cent. Grades as high as twenty-five per cent. have been used, but in general one of six per cent. is sufficient. Effective work has been done with those as light as three per cent., but with such a light grade the flume is likely to become clogged and fill up through any accidental diminution in the water supply.

Flumes are constructed in many cases of steel riveted pipe of a diameter of sixteen to twenty-two inches. Steel pipe under the abrasion of the swiftly moving material is apt to have a short life. Wooden flumes, rectangular in shape and constructed of inch boards, twelve inches wide, and with a false bottom, which can be replaced when worn out, seem preferable. They are of less initial cost and of equal if not greater durability. This style of flume generally has an inside dimension of ten inches by eleven inches. The flume has a top until the dam site is reached, where it is left open. The laterals are placed at right angles to the main discharge flume and receive their supply from the bottom and are laid on the same grade or steeper than the main flume. The flumes are supported by temporary trestle work which is generally buried in the dam.

The capacity of the pumps required to force the water through the pipe and to give sufficient pressure at the nozzle to be effective varies with local conditions, the amount of water desired to be delivered, the aggregate volume of the material to be moved, and the rapidity with which the work must be accomplished. Pumps with as small a capacity as 1.76 cubic feet per second have been used effectively up to pumps delivering from seven to ten cubic feet per second. Mr. McHenry states that a pump of 1,000 gallons per minute capacity and with flumes laid on a six per cent. grade should move 1,000 cubic yards of material in ten hours when the lifting head is not too great. In general, it is possible to obtain second-hand pumps and boilers which should be sufficiently effective, as the duration of the work is short and high duty not necessarily essential.

The rapidity with which work can be accomplished by this process is surprising. In numerous cases material has been deposited at the rate of from 1,000 to 2,000 cubic yards and over per day, a feat impossible of accomplishment by the ordinary method of dam construction within the restricted area of an embankment, where the material must be assorted, distributed and placed in thin layers, moistened and rolled. Under these conditions a few hundred yards constitutes a big day's work.

In the construction of the Lake Francis dam, California, 195,293 cubic yards were moved, deposited and assorted in 1,581 hours of actual sluicing time, with a pumping capacity of four and one-half to seven cubic feet per second, a conveying flume of twenty-two inches in diameter laid on a three per cent. grade. It is estimated that 30,740,000 cubic feet of water were moved, depositing 4,940,000 cubic feet of solids, or 16.6 per cent. of solid matter to water. A ratio of solid matter to water when everything was running smoothly ran from thirty-two per cent. to thirty-eight per cent.; highest, 47.7 per cent. The highest weekly average was 443 cubic yards per hour, 4,430 cubic yards in ten hours; mean, 123 cubic yards per hour. The water pressure at the pump was 118 pounds per square inch. The maximum power used was 320 horse-power; mean, 236 horse-power. Total power, 410,800 horse-power hours, costing one-half cent per horse-power hour, equal to one cent per cubic yard of material moved. This was a low cost per horse-power hour, as the power was delivered electrically from a nearby water power plant. The work was more or less handicapped by the interrupted supply of power. The cost of moving material by the hydraulic process varies from two cents per cubic yard to twenty cents, depending upon conditions of uninterrupted, constant power, proper gradients in the delivery pipe giving high velocities, and ability to move larger proportions of sand, gravel, and broken spalls of stone, and the rapidity of work which reduces the labor cost and fixed charges.

Suction dredges, where the principle involved is the same, and which are in common use along the Atlantic coast, have sucked material from the bottom, forced it from 2,000 to 4,000 feet through pipes and placed it in banks eighteen to twenty feet above the water at a cost of two cents per yard. The general cost of this class of work runs from four to six cents per cubic yard. The cost of sluicing in the Lake Francis dam above mentioned was twenty cents a cubic yard. Mr. Schuyler, who had engineering supervision of this work, states that with uninterrupted delivery of power and other conditions generally found more favorable elsewhere, this work could not have been done for but a fraction of this cost, possibly as low as five cents per cubic yard. The Tyler dam in Texas, built some fifteen years ago, consisting of 24,000 cubic yards of material, cost but $1,140 in all, including the spillway, outlet gate and pipe, an average of four and three-fourths cents per cubic yard. The pump had a capacity of 520 gallons per minute, nozzle one and one-half inches in diameter, water pressure 100 pounds per square inch. The material moved was sixty-five per cent. sand and thirty-five per cent. clay.

The Western Brick Co., of Danville, Illinois, for some five years back, have been stripping the sand and gravel over their shale bed, which runs from three feet to sixteen feet in thickness by the hydraulic process. The material is moved 1,600 feet, the flume gradient being three per cent. The water is pumped 4,000 feet through a ten-inch pipe, the pressure at the nozzle varying from seventy-five to one hundred pounds per square inch. About 2,000 yards are moved daily. But four men are employed, two at the nozzles, one fireman and one engineer. The cost is two cents per cubic yard.

Many thousand yards of material were moved by the hydraulic process and embankments filled by the Canadian Pacific Road. One of these embankments was 231 feet high and contained 148,000 cubic yards. The average cost was but 7.24 cents per cubic yard. But eight men were employed, one piper at monitor, one sluice-box man, two flume men, three men on dump and one foreman. The fill was made without interrupting the train service. The average amount moved in ten hours was 1,560 cubic yards. The distance moved, nearly 1,200 feet. Water was supplied by gravity. In another fill made by the same company of 400,000 cubic yards, the average cost was 5.59 cents per cubic yard, and eight cents per cubic yard, including the cost of the plant. Flume grade, eight per cent. Some 600,000 cubic yards were moved by the Northern Pacific Railroad at an average cost of 6.39 cents per cubic yard, or 5.82 cents for labor and .57 cents for material. Some fifteen trestles on the Cascade division were thus filled by this company under the direction of Mr. E. H. McHenry, the cost running from 3.8 cents for the lowest and 30.24 cents for the highest, the latter being but 800 yards and the former 53,600 yards. The largest amount in any one fill was 158,000 yards, which cost 5.19 cents per cubic yard. The average cost of moving 377,000 cubic yards was 4.79 cents, the details of which are as follows:—

	Cents per yard
Sluicing and building side levees	3.89
Hay used in side levees	.09
Tools	.08
Lumber and nails	.22
Labor building flumes	.44
Engineering and superintendence	.11
Total	4.79

Note.—Water was supplied by gravity.

In general, an estimate of fifteen cents per cubic yard would seem ample unless conditions were very unusual. The preparation of the foundation would be the same as that for any earth dam construction. However, if sufficient rock of sizes that could be moved through the flume is deposited on the up-stream face of the dam, less expensive paving for protection against wave action can be used. This estimated cost of fifteen cents per cubic yard is from a quarter to a third the cost of constructing a dam by the usual methods of wagons, spreading, moistening and rolling.

An eminent authority has said: "No type of construction that man builds to confine water can compare in permanency with earth dams."

Earth dams have a well-defined history running back some 2,500 years, and there are earth dams in efficient use to-day hundreds and hundreds of years old, and yet there seems to be no subject more prolific of controversy and upon which engineers so widely differ as to their best design and construction. New England engineers have a practical interest in this form of construction where many reservoir dams are built, often lying in hollows with high banks above the dam site, and there are instances where it may be well worth while in the interests of economy as well as that of efficiency and durability to consider the application of a hydraulic-fill rather than the expensive construction now in vogue. In one earth dam of a height less than fifty feet built by me where excellent material was found within 500 feet of the dam site and where the specifications called for layers not exceeding three inches in thickness, the contract price was over sixty cents per cubic yard, and yet the contractor made no excessive profit on this very large figure. The dam was so well compacted by rollers as to cause an expenditure of nearly $2 per cubic yard for the excavation of a small trench therein.

Mr. Schuyler, in speaking of the hydraulic-fill process, says:—

"It cheapens the cost of handling and compacting the earth in dams so greatly as to extend widely the practicable limits of dam-building by making it feasible to increase the bulk of any dam far beyond the usual dimensions without exceeding reasonable limits of cost."

Mr. Burr Bassell, author of an excellent work on "Earth Dams," and under whose engineering supervision the Tabeaud dam of California was constructed, the highest earth dam built in the United States by the usual methods. says, in speaking of hydraulic-fill dams:—

"Water performs the work of loosing the earth and rock in the borrow pit as well as subsequently transporting them to the embankment, and there to sort and deposit them, and finally to par company with them after compacting them solidly in place even more firmly than if compressed by heavy rollers."

It must be remembered that it is impracticable to compact clear sand or gravel to any degree without the admixture of some binding material by the use of rolling and tamping, whereas by water this material is reduced to a very dense mass.

The more prominent dams constructed by the hydraulic process are as follows:—

Lake Francis Dam, California.

Crane Valley, California.

Snake River, Idaho (three dams).

Dam in Hawaiian Islands.

New Mexico, built by the United States Indian Bureau.

Terrace Dam in Colorado, highest earth dam in the United States; Necaxa and Tenango in Mexico, the former the highest earth dam in the world, 180 feet high.

Tyler Dam, Texas.

Le Mesa Dam, California.

Lake Christine Dam, California, and the San Leandro Dam, California.

These dams run from forty-six to 180 feet in height, top widths twenty to twenty-five feet, up-stream slope generally three on one; down-stream slope, two and two and one-half on one. Some of them are combination dams, part loose rock-fill backed by sluiced-in earth. Rock-fill has a slope of 1.5 on one on the down-stream side and three-fourths on one on the up-stream side, with a top width of ten feet. The materials composing the dams are mostly sand, gravel, rock, with the interior core of fine sand, clay, and in some cases even quicksand and the impalpable wind-borne soil of Snake River Valley, Idaho and volcanic dust.

The Necaxa dam of Mexico has a height of 180 feet, 950 feet base, and contains some 2,000,000 cubic yards of material. It is the highest and largest earth dam ever built, and was constructed throughout by the hydraulic-fill process.

This week the Canadian National Exhibition, at Toronto, will again be in full swing. It is one of those annual institutions which have come to be regarded as part of the calendar. The change of seasons is marked in the East by the passing of the National Exhibition. When the gates are closed on new records each year, folks begin to think of the coming winter. This year the exhibits will be more varied than ever. Each Province will send something to be viewed by thousands of visitors. This makes the Exhibition literally national. In spite of the talk of lacking money, the attendance records probably will likely equal, if not surpass, previous ones. This national function deserves all the success it achieves.

THE RAILWAY TRACK OF THE PAST, AND ITS POSSIBLE DEVELOPMENT IN THE FUTURE.*

J. W. Schaub, M.W.S.E.

If you have ever noticed the approach of a heavy train on a modern railway by keeping your eye down near the track, you could not have failed to notice the extraordinary wave in the track which is formed in front of the engine. This wave appears to be about twice the height it actually is, as it is formed not only by depressing the track immediately under the engine, but the track immediately in front is actually lifted, thereby forming a true wave motion. If the train is moving at a high rate of speed as it passes, you will be impressed by the noise and the lack of rigidity of the whole structure. The cause of this wave motion is the yielding of the track. The dynamic action of the moving load must be absorbed by the rails, the ties, and the substructure underneath. This tends to push the entire track in front of the wave, and this yielding of the track accounts largely for the creeping of the rails. If the ballast is hard and frozen, as well as the sub-structure underneath, the rails must absorb the bulk of this energy, and if the conditions are such as to produce an uneven hardness, such as a sudden frost in earth full of moisture, when combined, perhaps, with a low joint, the chances are that a broken rail will result.

The railroad commission of the State of New York reports that over 3,000 rails were broken in that state during the past January, February and March. These breakages are reported by the railroads themselves, so that they can be considered as authentic. This means that over thirty-three rails per day were found broken, or one rail per day for every 240 miles of track in the State of New York alone.

The railroads are so alive to this condition that they are patrolling their tracks day and night in order to forestall the danger presented by a possible broken rail. How does this appeal to you from an engineering standpoint? Imagine a stationary engine, developing at times 2,000 horse-power, on a base or foundation which is so certain that you are compelled to have someone watch it day and night in order to forestall the danger of a wreck to the machine itself, to say nothing about the gravity of the situation when this wreck becomes a matter of life or death, every time. The Railroad Gazette has given this subject a good deal of attention, and in a recent issue publishes a collection of letters bearing on this subject, from a number of railroad officials. These letters are in answer to a request to give their views as to the cause of the great increase in rail breakages, and with one or two exceptions they all blame the poor quality of the steel. One letter, the shortest of them all, is by far the most instructive. Quoting from the above issue, "I should say, the quality of the rails furnished is gradually getting worse and the axle load of engines and their speed is gradually increasing." In a few words this correspondent sums up the whole situation. "The rails are getting worse, and the loads are getting heavier"; so that, there are two sides to this question and both sides should be given due consideration.

An examination of the rails shows the breakages usually occur near the ends of the rail. Some shows flaws due to "pipes," or a lack of weld owing to the presence of some foreign substance. These flaws correspond to "cold shuts" in the days when iron was used. Others show fractures due to brittle steel, and still others the characteristic coarse crystals due to imperfect physical treatment. Of these fractures the ones due to the brittle steel are most to be feared, as they are most insidious. The "pipes" and the imperfect physical treatment can perhaps be guarded against, but what can be done to guard against a brittle steel.

Steel is brittle, as a rule, owing to the presence of phosphorus; but, the rail manufacturer says that phosphurus has been gradually eliminated, until now it is at least 25 per cent. less than it was fifteen or twenty years ago. But what of the carbon. In the last few years the requirements for carbon have been increased by 100 per cent. It is safe to make a high carbon steel, carrying 0.60 per cent. of carbon, in the presence of 0.10 per cent. of phosphurus? In other words, has the phosphorus been eliminated sufficiently to compensate for the increase in carbon. The railroads should insist upon a reasonable limit for phosphorus and make the rail manufacturers live up to it. Just now it would be interesting to know why the railroads have to accept the manufacturer's standard.

No concerted effort has been made to analyze this problem, other than to blame the rail manufacturer, for the poor quality of the rails, but there is another side to this question that has not received proper consideration. Quoting from the excellent paper on track superstructure by Mr. O. E. Selby, bulletin No. 80, American Railway Engineering and Maintenance of Way Association, "Railroad track has grown in strength as heavier loads have made increased strength necessary, but such growth has been entirely along empirical lines, and not one single detail of track superstructure bears marks of engineering design."

To begin with, is the difficulty due entirely to the poor quality of the rail? We have heard much of the speed with which rails are rolled, and of the high temperature of the steel when on the cooling bed. This may account for some of the difficulty; but, on the other hand, is the structure upon which the rail rests free from blame?

To be sure the quality of the steel can be improved, but so can the substructure upon which it rests in the track. If it is true that the heavier rail sections have shown a higher percentage of breakages than the higher sections, under the same conditions, then the cause of the rail breakages should not be hard to find.

Increasing the weight of the rail in a track does not necessarily make a better track than a lighter rail does. Something must be left for the ties, ballast and substructure to do. If the original form of railway track, with its strap rails laid on longitudinal timbers resting on cross-ties, had been developed along these lines to its logical conclusion, the present form of railway track would have been unknown. Let us see what are some of the defects of the present cross-tie system of rail support. In the first place it is not mechanical. Given a line of rails which have to carry moving loads reaching 20,000 or 30,000 lbs. and more per wheel, the loads which they carry must be distributed over large areas. The cross-tie sytsem accomplishes this by inserting sixteen to twenty independent supports under each thirty feet of rail, and upon the track department is placed the impossible task of so adjusting these supports that each shall bear an equal part of the load. This is the real secret of the enormous amount of labor spent on surfacing a track in order to carry trains at high speeds, and it is a work that goes on forever. Moreover, assuming a joint has not been kept up to surface, what happens when a wheel passes over it? Within certain limits the ends of the rail will deflect until the tie receives a firm bearing; and, all track shows, more or less, the effect of the lack of continuity in the rail, by the dip of the rail at every joint. This happens in an instant, when the operation is repeated by the next wheel, and so on. (Fig. 1.) Assuming the deflection of the end of the rail to be Δ when the tie reaches a firm bearing;

Let "W" be the wheel load;
Let "l" be the space between the supports;
Let "E" be the modulus of elasticity of the steel;
Let "I" be the moment of inertia of the rail section;

$$\text{Then } \Delta = \frac{Wl^3}{3EI} = \frac{(Wl)\,l^2}{3EI} = \frac{Ml^2}{3EI}$$

Let "f" denote the fibre stress on the rail due to bending;
Let "yI" denote the distance from outer fibres to neutral axis.

$$M = \frac{fI}{y_1} . \; \Delta = \frac{f\,l^2}{3Ey_1} \therefore f = \Delta \frac{3Ev_1}{l^2} \quad . \; . \; . \; . \; . \; (1)$$

* Read before the Western Society of Engineers.

Equation (1) shows that for a given deflection of a rail the fibre stress varies directly with the distance of the outer fibres from the neutral axis, and nothing else. In other words, if the rail deflects until the tie brings up on a firm bearing, regardless of the wheel load, then the stiffer the rail the more work it will be called upon to do, and consequently the higher the fibre stress on the steel will be. Now, is this not approximately what takes place under ordinary conditions? The load comes on the rail, and if the rail lacks a firm bearing it will deflect until it finds a reaction. Equation (1) tells us that in order to reduce the work done by the rail it will be necessary to reduce the value of " Δ ." In other words, make the ballast and substructure as unyielding as possible so that the rail will be relieved from a duty which it is not qualified to perform, and which it should never have been called upon to perform.

To illustrate, let us assume that a fibre stress of 15,000 lbs. per square inch is acceptable for a working load, and " yI " for a 60 pound rail to be 2.15 inch, E = 30,000,000, and " l " = 40 inch; then for a 60 pound rail,

$$\Delta = \frac{15,000 \times 16,000}{3 \times 30,000,000 \times 2.15} = 0.1240 \text{ or } \tfrac{1}{8}\text{-inch.}$$

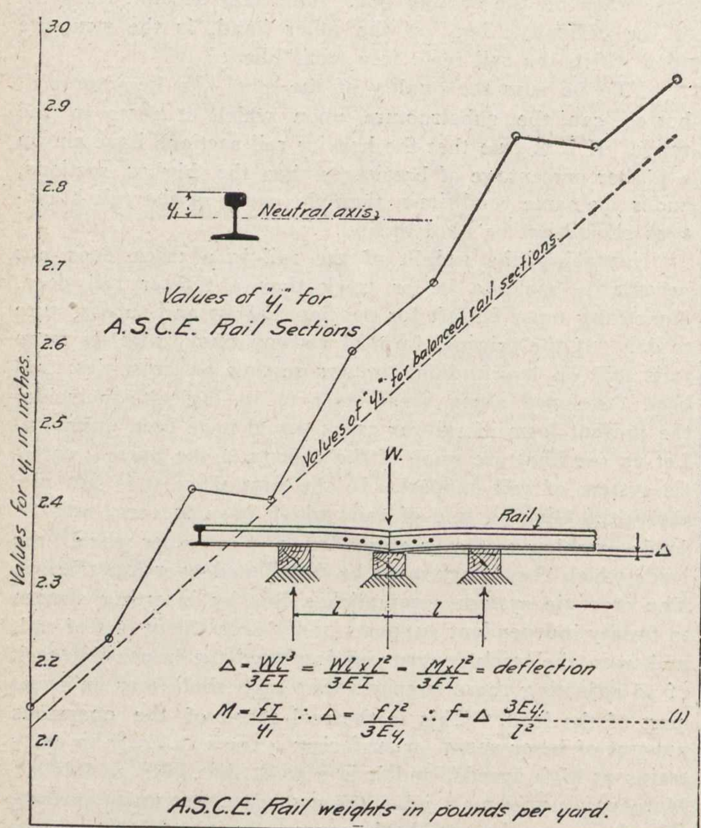


Fig. 1.

Whereas, the fibre stress for an 80 pound rail corresponding to a deflection of an eighth of an inch is 18,000 pounds per square inch. In other words, for the same deflection, the 80-pound rail should have 20 per cent. more breakages than the 60 pound rail, all other conditions being exactly the same. To be sure, this is only approximately true, but it goes to show that if the track could be made as smooth and unyielding as a planer table, an ideal condition would be realized. If this is true, then the railroads are wasting their money in buying heavier rails.

In passing, it might be well to call attention to the deficiencies in the standard rail sections, known as the A. S. C. E. rail sections. In any cross-section of a beam subjected to bending, the distance of the outer fibres from the neutral axis should be the same, both above and below, in order to have the extreme fibres above subjected to no higher stress than the extreme fibres below. In other words, the section should be balanced, that is, the centre of gravity should be in the centre of the figure. This is fundamental.

Referring to Fig. 1, it will be seen that all of the standard rail sections are unbalanced sections, with the result that, in the case of the 90 pound rail, the metal in the head receives a fibre stress 15 per cent. higher than in the flange.

In a recent proposed section for a 100 pound rail, which has been adopted by one of the trunk lines, this difficulty has been increased instead of being diminished, with the result that the metal in the head will be subjected to a fibre stress 24 per cent. higher than in the flange. This difficulty can be remedied by revising the rail sections so as to put the centre of gravity in the centre of the figure, without reducing the efficiency of the rail as a beam, and at the same time observing the requirements of the section from a metallurgical standpoint.

But, the usual argument against an unyielding roadbed is offered by the railroad manager about as follows: He says the track must be elastic, otherwise the rails would be destroyed or broken, and therefore the present form of track must be maintained. Yet this same manager will order the heaviest rails to be placed in the track to be supported on the heaviest ties that he can procure and laid on the deepest ballast, to make a firm and unyielding roadbed as near as can be made by such devices. If a rail could be laid on a solid bed uniform throughout its entire length, so that every part is supported exactly the same as every other part where will the rail break?

But how shall a roadbed be built that will meet such conditions? In the first place, the substructure upon which it is to be laid must be absolutely unyielding, and its foundation must be free from all moisture or below the action of frost. In some cases concrete walls must be built upon which the superstructure is to rest. In other cases piles must be driven, each case being treated as the conditions require. Upon this the superstructure must be laid. This must be some departure from the cross-tie laid on ballast. Nothing can be expected from any longitudinal support laid on ballast, for it can be shown that unless some transverse

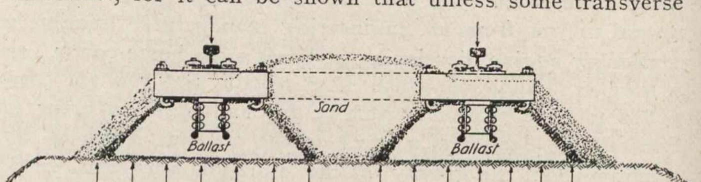


Fig. 2.

support is given to the longitudinals, it will be impossible to keep such a track in surface.

In the Railroad Gazette for March 15th, 1907, there is published an article by Mr. Gustav Lindenthal, M. Am. Soc. C.E., showing a form of steel longitudinal support for track rails. (Fig. 2.) This shows a rock ballast under two longitudinals, covered by a sand or gravel filling. Think of putting down a bed of clean rock for ballast, and then covering it with sand, as though the difficulty in keeping the ballast clean is not enough without mixing it with sand. Referring to the cross-section of the steel longitudinal system shown above, it will be seen that when the system is in place as the author shows, there will be a nice little prism of broken stone supporting the steel girder upon which the rail is to rest. Now, when, with a good deal of labor this broken stone is packed into just the right shape why not put something into it that will keep it there, instead of having it jarred out of place by the traffic? This form of track is being tried experimentally by the Pennsylvania Railroad on the Philadelphia Division, and the experience they are having with it is exactly as should be expected. It is impossible to keep such a track in surface. The reason for this is not difficult to find. Just turn the cut showing the cross-section, upside down, and if you assume the pressure on the ground as uniformly distributed, you can at once realize the tendency of the prisms under the rails to flatten out, and this is exactly what takes place in this form of track to-day. The system of longitudinal support will never prevail unless combined with some transverse support.

But how can this be accomplished, Take the present form of track, with cross-ties sawed to dimensions and surfaced on one side to uniform thickness, laid on a rock ballast sixteen inches deep. Insert steel I beams temporarily under the ends of the ties, so that each tie will have a full bearing on the beam at each end. (Fig. 3.) The steel beams are to be of the "Special" type with broad flanges to be rolled by the Bethlehem Steel Company. The beams are to be tied together by tie rods spaced two feet centres, so as to confine the ballast between the beams. On the ends of the ties previously laid, place a bond timber, notched over the ties at least one inch, and hold the same down by means of a hook-bolt passing through the tie, and anchored to the inside flange of the beams. An angle iron nosing on the inside of the bond timber serves as a guard rail. After all is in place, the extraneous ballast, that outside of the beams, is removed. No part of this operation need interfere with traffic. In bringing such a track to surface, the entire structure is to be lifted by means of track jacks placed under the flanges of the beams. After the ballast is once in place, very little work should be necessary to keep such a track in surface. The ballast is confined between the beams, so that an arch action can take place, with the thrust of the arch taken up by the tie-rods. This assumption makes it possible to find the tension on the rods and properly proportion them.

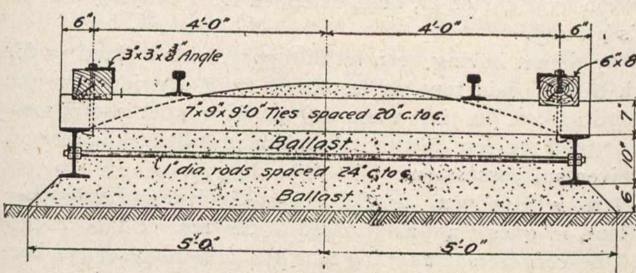


Fig. 3

But, how does this form of track offer any advantage over the present form of track? Solely in the introduction of the longitudinal beams. These beams are to perform two distinct functions. First, the special beam, with its broad flanges, having a moment of inertia equal to five times that of an 80 pound rail, and with 8 per cent. less metal, should do just five times the work done by the rail when both are working together under the same conditions, neglecting the work done between the cross-ties in either case. The work done by the rail would then be principally to distribute the load over the ties, and not to make up for the deficiencies in the substructure, as it does now. Second, in confining the ballast, and thereby preventing the track structure from working its way down through the ballast, as it does now in the present form of track; where under heavy traffic, the ballast is kept in constant motion during the passage of trains; and, as the particles of the granular mass are free to move, they follow the lines of least resistance, that is, out from under the ties. This explains why the ballast is so unstable, and accounts for the enormous amount of labor necessary to keep a track in surface and alignment. With the proposed form of track, on a solid substructure, this should largely disappear. After this form of track has been proven by experiment to be correctly designed, the timber should be removed, and the ballast replaced by concrete, flush with the tops of the beams, forming a permanent substructure upon which the superstructure is to be placed. At the same time the steel beams can be removed. This superstructure should be some form of longitudinal support bedded in concrete, so as to distribute the loads over large areas, offer perfect drainage and be absolutely imperishable and unyielding.

RAILROAD EARNINGS.

The following are the latest figures.—

	Week Ended		Inc. or Dec.
C.P.R	Aug. 21	$1,356,000	—$190,000
G.T.R.	Aug. 21	798,254	— 79,211
C.N.R.	Aug. 21	162,500	+ 6,800
T. & N. O.	Aug. 21	18,500	+ 16,200
Toronto St. Ry.....	Aug. 22	6 ,228	— 3,259

THE LAW OF EVIDENCE.

By A. G. Ardagh, O.L.S., Barrie, Ont.

In presenting this paper I can lay no claim for either originality in the ideas or even the phraseology and yet it may be that a compilation in briefer form than can be found in a text book may serve the purpose of an introduction to the subject for the student, and what is more important, may draw out practical "pointers" and illustrations from the more experienced members by which the theory may be rendered serviceable.

I have to admit the text book flavour of the paper and willingly make any acknowledgments to "Stephen's Digest of Evidence" and other sources of information.

Defining the law of evidence we may say that it is that part of the law of procedure which, with a view to ascertain a right or a liability in any inquiry, decides:

(1) What facts may and what may not be proved.

(2) What sort of evidence may be given of an alleged fact.

(3) By whom and in what manner evidence must be produced.

There are some facts which need not be proved as the court itself will take cognizance of them. Acts of Parliament, etc. Generally speaking, the facts which may be proved are: (a) Facts in issue, i.e., those facts upon the existence of which the right or liability to be ascertained depends; (b) facts relevant to the issue, i.e., facts from which inference may be drawn or to the existence of facts in issue.

As an illustration of relevant facts we have the question whether A, who is the owner of one side of a river, owns the entire bed of the river or only half of it at a particular spot. The fact that he owns the entire bed a little lower down is deemed a relevant fact.

Another question, whether there is a public right of way over A's land. The facts that persons were in the habit of using the road and that it was repaired at the public expense, or the facts that persons using it were turned back, and that for a length of time, beyond when the road was used, that no one had power to dedicate it to the public, are relevant.

As to facts which may not be proved there are many which, in common life, would be considered relevant, but which in law are deemed irrelevant; of these are four great classes as follows:

(a) Similar but unconnected facts.

(b) Facts coming under the term "Hearsay," e.g., the fact that a person not called as a witness has asserted the existence of any fact. In fact that a statement is contained in any record or document, proof which is not admissible on other grounds.

(c) Facts coming under the term "Opinion." The fact that any person is of opinion that a fact in issue or relevant to the issue does or does not exist.

(d) Facts as to "Character."—The fact that a person is of a particular character is deemed irrelevant to any inquiry respecting his conduct (exceptions). In criminal proceedings the fact that a person has a good character is deemed relevant, but the fact that he has a bad character is deemed irrelevant unless it is a fact in issue or unless evidence has been given that he has a good character in which case evidence that he has a bad character is admissible.

Illustrations of the foregoing four great exclusive rules of evidence.

Similar But Unconnected Facts.—A makes a sale of goods to B of his own manufacture. The fact that the goods he sold to C, D or E were of proper material is not relevant as against any contention B may make as to the quality of goods received from A unless it can be shown that they were made of the same lot of raw material.

Hearsay.—A declaration by a deceased attesting witness to a deed that he had forged it is deemed irrelevant to its validity.

A sends his agent B to make a sale. What B says at the time of the sale and as part of the contract of the sale is deemed a relevant fact as against A; but what B says upon the subject at some different time (hearsay) is not deemed relevant against A (although it might have been deemed relevant if said by A himself).

Opinion.—The question is whether A, a deceased testator, was sane or not when he made his will. His friend's opinion as to his sanity as expressed in letters addressed to him during his lifetime are deemed irrelevant. However, the opinion of an expert under ordinary conditions would be relevant.

Also if it were a question as to the person by whom any document was written or signed, the opinion of any person acquainted with the handwriting of the supposed writer would be deemed relevant.

It will be seen that modifications and exceptions will in all the foregoing rules be numerous, but all based on definite principles.

We now come to the second main point, viz., what sort of evidence may be given of a fact. Evidence is of two kinds—oral and documentary; but every fact except (speaking generally) the contents of documents must be proved by oral evidence.

Oral evidence may be defined as statements made by witnesses in court under a legal sanction in relation to matters of fact under inquiry. Oral evidence must be direct. That is to say, the witness who gives it must be the person who says he saw, heard or experienced in any other manner the fact alleged to have been seen, heard or experienced, or, if it be an opinion held, the witness must be the person who holds said opinion.

Documentary evidence is divided under two heads, Primary and Secondary. By primary evidence we understand the production of the original document accompanied by an attesting witness. In certain cases documents are admitted as primary evidence without the presence of an attesting witness, as for example, (a) when the original is in the power of the adverse party; (b) when the original is produced by the adverse party, who claims an interest in it in reference to the subject matter of the suit; (c) when the person against whom the document is sought to be proved, is a public officer bound by law to procure its due execution, who has dealt with it as a document duly executed; (d) when there be no attesting witness alive sane or subject to the process of the court; (e) when the witness called to attest may deny or may not recollect the execution of the document.

By secondary evidence we mean (a) examined copies, certified copies, office copies; (b) other copies made from the original and proved correct; (c) counter parts of documents as against the parties who did not execute them; (d) oral accounts of the contents of a document given by some person who has himself seen it.

It is necessary, of course, to limit the giving of secondary evidence to certain circumstances. I will enumerate some such circumstances: (a) When the original document is in the power of the adverse party, and who after due notice, does not produce it; (b) when the original is in the power of a stranger; not legally bound to produce it and who refuses to do so after being served with a sub pœna duces teum; (c) when the original has been destroyed or lost, and proved search has been made for it, and so forth.

We now come to the third issue; by whom and in what manner the evidence of an alleged fact must be produced. When a fact is to be proved, the person upon whom the burden of proving it rests must be the one who shall give evidence of it, unless he is estopped from proving it by his own representations, or his conduct or relation to the opposite party. A witness must be competent and (in general) his evidence must be given under oath.

In the foregoing I have endeavored to give the main points only of the enunciations defining the law of evidence. In addition, some reference to the law of presumptions and law of estoppels which run into the law of evidence should be made.

Presumptions.—When any document bearing a date has been proved it is presumed to have been made on the day on which it bears date, excepting, of course, that collusion can be shown which might defeat the object of the law, in which case independent proof of the correctness of the date will be required.

Where any document purporting or proved to be thirty years old is produced from any custody which the judge considers proper, the attestation or execution need not be proved. Alterations and interlineations appearing on the face of a deed are, in the absence of all evidence relating to them, presumed to have been made before the deed was completed, but in the case of a will after the execution thereof. A person proves that he received the rent of land—the presumption is that he is the owner in fee simple, and the burden of proof is on the person who denies it.

A fishing mill-dam was erected more than 110 years before 1861 in the River Derwent, in Cumberland (not being navigable at that place) and was used for more than sixty years before 1861 in the manner in which it was used in 1861. This raises a presumption that all the upper proprietors, whose rights were injuriously affected by the dam, had granted a right to erect it. No length of enjoyment of water, percolating through underground undefined passages, raises a presumption of a grant from the owners of the ground under which the water so percolates of a right to the water.

Estoppels.—A, a retiring partner of B, gives no notice to the customers of the firm that he is no longer B's partner. In an action by a customer, he is estopped from denying that he is B's partner.

Any tenant having been let into possession of land or for which he has paid rent, is estopped from denying that the landlord had, at the time when the tenant was let into possession or paid the rent, a title to such land, till he, the tenant, has given up possession.

Dark v. Hepburn, 27 C.P. 357—Evidence—Estoppel.—The land in question was situated at the rear of the concession (the concessions running north and south and numbering from the west), and plaintiff, claiming that it was a double front concession, had the division line run from a point on the concession line in the rear, or what he claimed to be the east front of the concession, but there was no proper evidence of the concession having, in the original survey, been laid out as a double front concession, and of the posts being planted in the rear, while the lots were granted by the letters patent as whole and not as half lots. Held, that the fact of 28 and 29 having been granted as whole lots was prima facie evidence of the concessions being single fronted and that the grant of half lots in the adjoining concession could not affect it. Held, also that the fact of defendants attempting to prove a post in rear, from which they contended the line should be run did not estop them from asserting that the concession was single fronted.

McArthur v. Brown, 17 S.C.R. 61—Estoppel.—Plaintiffs leased a certain portion of a lot of land for mining purposes described in the deed by meets and bounds, with the option that after inspection they could change the courses of the lines without increasing the area in order to follow the direction of the vein of quartz which might be there. They adopted certain lines of a survey made by one Proulx as containing the vein of quartz. The defendants leased another portion and in an action concerning the limits the court appointed three surveyors to make separate reports and the report and plan of one Degenare, who adopted Proulx's lines, was adopted by the court. Held, that the plaintiffs having located their claim in accordance with the terms of the charter were now estopped from claiming that their property should be bounded by the true course of the vein of quartz.

COBALT ORE SHIPMENTS.

The following are the Cobalt ore shipments, in pounds, for the week ended August 22nd:—O'Brien, 192,180; La Rose, 244,000; Right of Way, 124,080; Trethewey, 125,870; Drummond, 61,400; Watts, 60,100; Crown Reserve, 54,000; Temiskaming and Hudson Bay, 62,000; Silver Queen, 80,000; Nipissing, 63,700; total, 1,067,330 pounds, or 533 tons. The total shipments since January 1st are now 26,471,302 pounds, or 13,235 tons.

The total shipments for the year 1907 were 29,981,010 pounds, or 14,040 tons. In 1904 the camp produced 158 tons, valued at $316,217; in 1905, 2,144 tons, valued at $1,473,196; in 1906, 5,129 tons, valued at $3,900,000.

CORRESPONDENCE.

[This department is a meeting-place for ideas. If you have any suggestions as to new methods or successful methods, let us hear from you. You may not be accustomed to write for publication, but do not hesitate. It is ideas we want. Your suggestion will help another. —Ed.]

CAMERON SEPTIC TANK CASE.

Sir,—A statement of the Association for the Defense of Septic Process Suits appeared in a recent issue of "Engineering News." After reciting in brief the opinion of the trial court; the reversal of that opinion as to the process claims by a unanimous decision of the United States Circuit Court of Appeals; and the denial of a petition for re-hearing; the Association proceeds to place its own construction on the Process Claims as sustained, and then concedes that the Petition for Writ of Certiorari, which was stated as the primary object of the existence of that Association, had been denied by the Supreme Court of the United States and the decision of the United States Circuit Court of Appeals thereby upheld.

Having failed in the primary object of its organization, the Association invites additional contributions, and declares its determination: First, to resist all attempts on the part of the Cameron Company to have the case re-opened so far as the apparatus claims are concerned, unless the whole case is reviewed; second, to resist all attempts on the part of the Cameron Company to obtain an extension of its patent.

In a circular letter dated July 21st, addressed by the Executive Committee to all the authorities believed to be interested, the Association declared its intention of formulating a plan of future procedure upon more prominent lines than hitherto drafted, and in addition to its declared intentions mentioned in its statement outlined the following:

"Resistance to attempts, if made, on the part of the Cameron Company, to collect royalties for the past use of the so-called septic process in amounts exceeding the cost of cleaning out settling tanks with a frequency which would obviate an infringement of the said patent.

"An attempt to formulate a plan of united action by which through litigation or otherwise there can be arrived at a clearer understanding than now exists as to what tanks and what methods of operation constitute obvious infringement of the patent in question.

"In view of the uncertain attitude or position in which the whole subject of infringement is left apparently by the decision of the Circuit Court of Appeals, it seems necessary that this association should secure data in connection with its other objects above outlined for arriving at a reasonable conclusion in the premises regarding the status of numerous tanks already in existence, and which conclusion shall be fair and logical both from a legal and engineering point of view."

Adding that:

"With an increasing membership and with increasing funds to assist in securing equity in this field of municipal sanitation, there will also be accumulated data to permit a well formulated plan of procedure to be outlined and submitted at a future date, and which programme shall have for its purpose a minimum outlay by all members of the association in dealing with this question."

Furthermore, an invitation is extended to infringing municipalities and individuals to avail themselves of the advice and counsel of the Association; adding that it is its intent and purpose to render all possible advice and assistance in the equitable adjustment of claims for past use of the Cameron process, and suggesting that all negotiations and correspondence with the Cameron Company be carried on through the Executive Committee of the Association.

The Association for the Defense of Septic Process Suits consists mainly of a few engineers, who having freely recommend the adoption of the septic process, have as freely advised their clients to disregard the Cameron patent covering that process. With supreme indifference for the application of the law to such matters they long ago decided that the septic process was unpatentable; the United States Courts have decided otherwise.

Directly following a recent meeting of the Association in Columbus, Ohio, a full column article appeared in a Columbus paper with scare head-lines.

This article outlines the result of the Cameron Septic Tank Company's suit against Saratoga Springs and states that the Association had placed in the hands of Senator O. E. Harrison, special counsel in the office of the Attorney General, a list of thirty-five cities and towns in the State that have either installed septic tank plants or are proceeding under plans including the process.

It is further stated that "the company making the claim has become very extravagant now in its demands since it has won a decision in the United States Court of Appeals; and that it "is asking from Columbus $40,000.00."

As a matter of fact, no demands whatever have been made on the City of Columbus, nor is there any foundation for the statement that our demands have become extravagant since the decision of the United States Circuit Court of Appeals. For the accuracy of these statements we very confidently refer to the municipalities involved.

Since the decisions in our favor many settlements have been effected, and not one complaint has been made that our demands have been in any way unreasonable; they have been made by municipalities who prefer to accept the decisions of the courts and spend their money legitimately, rather than for the support of an organization that, having failed in its original purpose, is now making frantic efforts to rescue the professional reputations of a few of its members from the effects of their own indiscretions, and is doing everything in its power to obstruct the legitimate business of the Cameron Septic Tank Company.

The very engineers who obtained their knowledge of the Septic process from Cameron, are the ones who, while utilizing that knowledge for infringements, have kept the Cameron Company in litigation for the past five or six years, and are now seeking to force us into further unnecessary litigation by inciting their clients to resist our just and reasonable demands.

The Cameron Septic Tank Company has offered to settle with infringing municipalities on liberal terms; many have accepted that offer, while others have been induced to support the Association for Defense of Septic Process Suits, hoping thereby to avoid payment of our claims.

The large majority of engineers, while sincere in their belief that the Septic process was unpatentable, are now willing to accept the decisions of the United States Courts and are not in sympathy with the guerilla warfare being waged on the Cameron Septic Tank Company by the Association. Their belief in the unpatentability of the Septic process was probably due to their having confounded it with Putrefaction, which they have very properly insisted is a natural process and has always existed. We are quite willing to admit that Putrefaction is a natural process, and always has and always will take place in any inert mass of organic matter. It exists in the remote recesses of cesspools, and in tanks used for the sedimentation of sewage solids unless removed at frequent intervals. It is this process of Putrefaction that was so universally condemned by all the authorities on sewage disposal methods, prior to the introduction of the Septic process, as dangerous to the public health, and we might add that unless intelligently combined with oxidation or nitrification it is equally dangerous to-day.

We make the foregoing statement not only for the purpose of pointing out to your readers that there are two sides to this question, but to invite their attention to the fact that the decision of the United States Circuit Court of Appeals is merely a statement of the Court's reasons for sustaining the Process Claims of the patent and should not be taken as in any sense superseding these claims. The patent itself is so clear and distinct that there can be no reasonable ground for doubt or uncertainty either as to the scope of the claims themselves or as to the intent and meaning of the Court's decision when considered with them. Any questions arising should be decided by competent patent counsel.

Having expressed the opinion so positively, and for so many years, that the Septic process was a natural one and could not be patented, the coterie of engineers who have organized the Association for Defense of Septic Patent Suits, and have become the self-appointed champions of the municipalities they have so unfortunately misled, can hardly be expected to look favorably on a decision that has had the effect of so completely discrediting them, and their claims that the decision has left them uncertain as to what constitutes infringement and what does not, seems only natural. In ordinary business transactions we select as advisers men whose judgment can be relied on, and not those who, having placed us in an unfortunate position, are naturally more interested in justifying their own past errors than in a business-like adjustment of difficulties for which they are so largely responsible. It would seem, therefore, that their final advice that all negotiations and correspondence with the Cameron Company be carried on through the Executive Committee of the Association should be accepted at its true value.

Cameron Septic Tank Co.

H. D. Wyllie,
General Manager.

Monadnock Block,
Chicago, Ill.

"THE COMING OF THE METER."

Sir,—Your readers must frequently have been struck, while reading the reports of the Olympic games, with the repeated references to meters and other units of the Metric System, and it is most significant that most of the newspapers of the country abstained from mentioning the equivalents of the Metric measures. The reason is evidently to be found in the fact that the more efficient teaching of the Metric System in this country is being felt, and the absence of many inquiries as to the meaning of the Metric terms goes far to prove that it would not occasion much trouble to the people to become familiar with the new system of weights and measures when it is adopted.

There are none so deaf as those who will not hear, and there are none so opposed to the adoption of the Metric System as those who are least able to form a reliable opinion.

I was to some extent exercised up to a certain point during the progress of our campaign by the fact that our movement was opposed by Mr. Bennett Brough, secretary of the Iron and Steel Institute. I thought he ought to know what were the practical difficulties in the way of changing from one system to the other. But I quite changed my view when I heard that while acting as chairman of a meeting called to oppose the adoption of the Metric System, Mr. Brough said that he had been much puzzled when buying some cheap French wine at 30 francs per dozen to find out the price per bottle. The gentleman seemed to imagine that this difficulty was typical of the troubles which the use of the Metric System would impose upon Britons. His surprise and consternation were evident when a member of the audience remarked that any junior class boy could tell him that 30 francs per dozen represented 2½ francs each. As a matter of fact neither the question nor the supposed difficulty had anything to do with the Metric System.

The forward march of the Metric System has become most noticeable to those persons who are in a position to hear of the progress of the reform. For the first time in the history of the system it may now be said that every Government of Continental Europe has approved of it and has realized that its universal adoption is inevitable. The Russian Government has shown exceptional enterprise in prescribing the use of the system in the medical services of its Army and Navy, and Japan is preparing a law to further its use. The United States Army and Navy have used the Metric System for medical purposes for some years. In this country the delegates from divisions of the British Medical Association unanimously expressed their approval of the system; they will be pleased to hear that the change was made in the United States medical services without trouble. Moreover the use of Metric terms is growing rapidly in Great Britain and they are becoming widely understood; in fact, while we are unaware, we are, perhaps slowly, but surely, going through the process of adopting the Metric System.

I say this in full recollection of the adverse vote in the House of Commons last year. That adverse vote was largely influenced by the attitude of Mr. L. George—then president of the Board of Trade, who really knew so little about the subject that he said that "the Metric System had broken down hopelessly in France."

The French Minister of Commerce has since made it quite clear that such a statement was as wide of the mark as are most of the statements used by those who try to hinder the adoption of a simple and almost universal system of weights and measures which will be a great boon to the nation.

I never forget that the late Lord Kelvin described our present collection of weights and measures as time-wasting and brain-wearing.

Your Obedient Servant,
E. JOHNSON.

GATHERING CATALOGUES.

Sir,—As you are doubtless interested in anything contributing to the efficiency of technical paper advertising, we take the liberty of suggesting a matter that is often brought to our attention by clients.

Advertising in the trade and technical paper brings inquiries of various sorts, some from people who are interested in the purchase of apparatus, others from persons who wish to inform themselves about the subject in question, and still others from people who appear to apply merely through curiosity, or the desire to get something for nothing. Now, the majority of manufacturers, while they often spend considerable amounts in the preparation and printing of their catalogues and other trade literature, the bare cost of printing alone often running up to 50 or 60 cents per volume, do not, as a rule, object to filling the requests of all three classes.

However, the publication of advertising literature is only one step in the selling campaign, and once the prospect has been opened, the organization of selling forces is such that other steps should follow, as it were, automatically. The next thing, therefore, for the salesman to do after receiving an inquiry and sending the literature requested, is to call upon or write to the inquirer to find out what his needs may be. This frequently leads to much waste of time and money. The man who asks for a catalogue may not, as suggested above, be in the market, and if he is located in some out-of-the-way place, it costs a good deal to find this out by means of a personal call.

The point we wish to bring out is that people who ask for catalogues should at the least acknowledge receipt of the printed matter and of the latter which usually accompanies it, stating whether or not they expect to purchase in the near future. They rarely ever do this, thereby putting not only the manufacturer, but often themselves also, to some inconvenience and annoyance. Inasmuch as the manufacturer has gone to the expense of printing this matter and of mailing it, a simple acknowledgment would seem to be in order, especially as many manufacturers now enclose return postal cards, oftentimes stamped, for this very purpose.

Respectfully yours,
Geo. H. Gibson.

The Geo. H. Gibson Co., Advertising Engineers, Tribune Building, New York City.

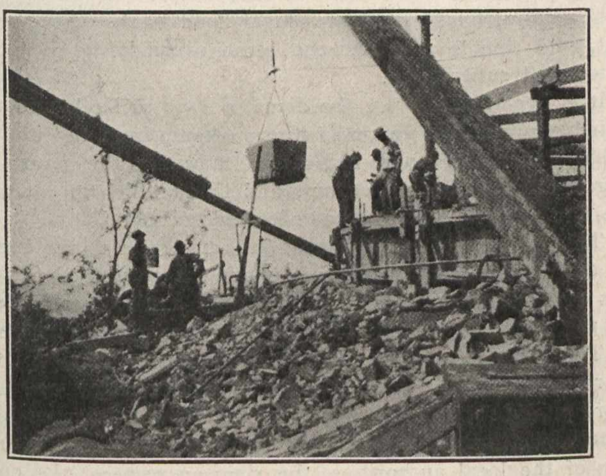
MILL ROCK WATER TOWER, NEW HAVEN, CONNECTICUT.*

By Edward E. Minor, Mem. Conn. Soc. C. E.

The New Haven Water Company constructed during the last year a reinforced concrete water tower on Mill Rock. The purpose of the water tower was to provide, in case of necessity, a means whereby water could be supplied to the high pressure service in the city, independently of its usual source of supply.

The high pressure service covers what is known as Prospect Hill, and is supplied by gravity from an impounding reservoir, Lake Wintergreen. This lake is situated on the easterly side of West Rock Range at an elevation of about 240 feet above mean high water in New Haven harbor, which is city datum.

Mill Rock is a precipitous trap rock ledge, lying just north of the Whitneyville pumping station and near Prospect Hill. The water tower is located on the highest point of the ledge. Its elevation underside of roof girders is 246 feet above city datum. The tower is connected with the high pressure service and with the Whitneyville pumping station. The former connection is usually open, the latter closed. The function of the tower then consists in storing the water during the night, when the draft is light, and feeding it out during the day as the consumption increases, in effect much like a fly wheel on an engine. There remains, as already spoken of, its ability to altogether replace the Lake Wintergreen supply, if desired.



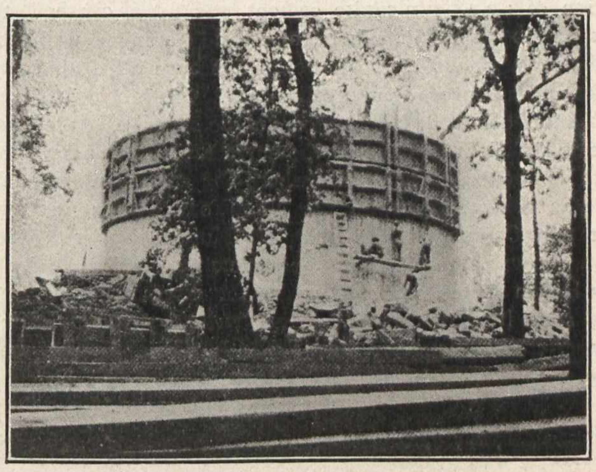
Filling First Section of Wall Towers.

There were certain requirements, arising from its location and surroundings, which made it necessary so to construct the tower that it might be used as an observatory. It is covered by a flat, concrete roof, around which is a parapet wall, and leading up to the roof, an iron stairway. The stairway is located in a small octagonal tower adjacent to the water tower and opening out upon the roof.

The water tower is 50 feet in diameter and 25 feet in clear height to the underside of the roof girders. The walls are vertical, 18 inches in thickness, and reinforced with round, steel bars ranging in size from 1¼ to ½ inch in diameter. The bars came in lengths of about 30 feet, and are lapped about 3 feet and fastened with four Crosby wire rope clips at each joint. They are spaced uniformly 5 inches on centers, being fastened to 2 x 2-inch vertical spacing angles 5 feet apart.

The roof is supported by four reinforced columns, 18 inches square, across which run beams 12 inches in width, and varying from 12 inches to 16 inches in depth; the bottom of the beams being level and the pitch of the roof, four inches, being formed by the top of the beams. They are reinforced by four ⅞-inch square, twisted steel bars and ½-inch square stirrups. They divide the roof into panels about 16 feet square. The roof slab is 8 inches in thickness and reinforced by ½-inch square, twisted steel bars, 6 inches on centers each way. The beams and roof slab are reinforced as acting continuously across points of support and were put in at one time.

The side walls were built in lifts of 6 feet in height. Two complete sets of forms were used, and when the upper set was filled, the lower one was taken out and set up on top. Each form unit was 6 feet in height and about 12 feet in length. When these were set up, they were held very accurately in place by battens spiked to uprights set inside the tower about five feet away from the wall. These uprights formed a rigid tower inside the water tower and were used not only as a temporary support for the wall forms, but for a working platform as the walls were carried up, and later as part of the staging for the roof forms.



Tower, Showing Wall Forms in Place.

The inner and outer forms were held by ¾-inch bolts, the center section of the bolts with two sleeve nuts being left permanently in the walls. One set of wall forms was built over into the forms for the corbel course running around the top of the tower, and the other into the forms for the parapet.

The tower is located on top of a rocky ledge about two hundred feet above the road. A narrow gauge incline cableway was built, having a grade of about 50 per cent. in the steepest place, and running from the concrete plant at the base of the rock to the water tower. All concrete was mixed at the bottom. The track ran below the mixing plant, which was set well up in the air with large hoppers for all materials. A one-yard Smith concrete mixer was used. The buckets, mounted on small cars built up for the grade, were run under the mixer, loaded, and hauled to the top by a two-drum Lidgerwood hoisting engine. At the top, two stiff-leg derricks, set so as to command practically all sides of the tower, lifted the concrete to place. For the walls a three-sided box was built, set on wooden rollers, and the buckets dumped into this. In this way a cubic yard of soft concrete

Mill Rock Water Tower.

* Read before the Connecticut Society of Civil Engineers

was placed in the walls easily and quickly and the box kept travelling along the walls at a good speed.

A wall section would be taken off and reset above in two days. It would take one day to fill it. The old surfaces throughout the work, where new concrete set on old, were picked and then thoroughly cleaned with a steam jet. Great pains were taken to have old surfaces well cleaned and to have all concrete thoroughly spaded.

The concrete above the foundation was mixed in the proportion of 1-2-4. Vulcanite cement was used, crushed trap rock passing a 1½-inch hole, and sand having a uniformity coefficient of about 3.5. The tower has been filled for several weeks and has proved practically tight. On the southerly side for a short distance there appears some seepage at the joints. This is sufficient to dampen the surface of the concrete for a width of about 3 inches. Elsewhere the surface appears dry.

The contractors were the New York Continental Jewel Filtration Company, Mr. John G. Munson superintendent. The work was planned and the construction carried out for the New Haven Water Company under the direction of Albert B. Hill, consulting engineer. The writer was engineer in charge. The inspector was Fred. L. Coe, of Mr. Hill's office.

ENGLISH RIVERS: THEIR USES AND CONTROL.*

By Frank Rayner, Assoc.M.Inst.C.E.

The treatment of rivers, both in regard to engineering and administration, forms a subject which may, without apology, be brought before an association of engineers engaged in the public service, because the public interest is concerned in many very material ways.

A river is fundamentally the provision made by nature for the drainage of lands, and any interference with that function must call for the careful consideration of the advisers of governing bodies. It is, however, beyond question that rivers can be subjected to control by engineering operations so as to make them become channels along which traffic can pass without in any way prejudicing them in their capacity of land drains.

That rivers should be so treated is undoubtedly to the public advantage, and the following reasons may be cited:—

(a) A river which is properly mantained as a navigation is kept clear of vegetable growth and shoals, which, when present, seriously impede the flow of water, and consequently cause it to become a less effective drain.

(b) An efficient navigation secures to the public a perfect means of competition in reducing rates for the conveyance of merchandise. There is no monopoly in the use of a river, and in this respect it is a real highway. In the case of the district served by the River Trent, which at present is far from being an efficient navigation, the railway rates in grain, for example, are admittedly about 30 per cent. lower from the Humber ports than in the case of rates on corresponding distances from other places.

(c) As traffic can be loaded or unloaded practically along the whole length of a navigation and not at isolated sidings only, this forms a convenient means of transport for those descriptions of traffic in which local authorities are largely interested—viz., roadstone and nightsoil and refuse for manurial purposes.

(d) An efficient navigation usually causes manufacturing works to be brought into the district which it serves, and this must cause a material increase in the rateable value.

In some foreign countries, particularly in Germany, a navigation is considered so valuable an asset to a district that the local authority will contribute a large portion of the cost of construction of works, the State bearing the remainder.

Speaking generally, the administration of English rivers is in a state of chaos.

There are cases where local authorities have expended money in the development of rivers as a means of transport; the city of York, for example, who control many miles of the River Ouse, have constructed works which have much improved the river to the benefit of the city, and have been the means of important industries being established there. There are also cases where the control of rivers—the Thames and the Severn, for example—is vested in conservancy boards, which comprise representatives of the local authorities and the commercial interests along the course of the river.

In other cases rivers are managed by boards who are mainly concerned in the drainage of the district; and there are other cases where the rivers are at the mercy of the landowners, who may, or may not keep the river in a fit state to fulfil its varied functions.

In the case of many rivers the obligations in regard to navigation are vested in statutory companies, and where these are in a satisfactory financial position their obligations are usually well attended to; but in cases where the revenues are inadequate the rivers must be more or less neglected, and the service rendered by the river become restricted. It frequently happens, however, that companies are prevented from developing a river to its fullest extent, both from the point of view of navigation and arterial drainage, by ancient riparian rights, as, for example, water mills.

It is, moreover, usually the case that companies controlling navigable rivers are not responsible for the upkeep of the natural banks or the artificial flood banks where such exist, and this is apt to cause some overlapping of jurisdiction and supervision.

It is deplorable to see the damage done to lands and the wasted opportunities in many rivers where, from the uncontrolled mill powers and neglect to maintain the rivers as arterial drains, flooding occurs, and lands which might provide fine pastures become water-logged swamps.

This absence of method leads in many cases to the carrying out of purely local schemes under the powers of private Acts of Parliament, the works being of a piecemeal nature and regardless of the effect on the neighboring districts.

There is no doubt much to be said, in the case of a river where the drainage of large areas of land is concerned and where public rights of navigation are involved, in favor of a conservancy board, which should be comprised of representatives of the local authorities, the riparian owners, the commercial and trading interests, the owners of craft, and any special interest directly concerned. This board should have jurisdiction in regard to navigation and drainage, with power to levy drainage rates as the present drainage boards have.

There should be a central board, who should have power to define the limits of the conservancy boards, but, generally speaking, the conservancy boards should have jurisdiction extending throughout the drainage area of the main river, and there could be local committees to deal with questions of drainage in the non-navigable rivers.

The central board should further ensure that there was some uniformity between the works carried out on the different rivers. At the present time, for example, the dimensions of the locks and bridges which control the sizes of the craft, vary tremendously on the different navigable rivers; and it may be mentioned that in the case of the waterways communicating directly with the Trent there are hardly two alike, and consequently boats constructed for one navigation are unsuitable for any other.

Provision should also be made, as is done in the Division of Hydrography of the Geological Survey of the United States of America, for the gauging of the various rivers and streams, which is of the utmost service for purposes of water supply, navigation and drainage.

Passing on to the nature of the works for regulating rivers, it may be broadly stated that tidal water should be made use of as far inland as possible, and that, when the tidal limit is reached, locks and weirs should be constructed and dredging carried out.

It is impossible to specify too closely in a paper of this nature what the proportions of the works should be, but, in the author's opinion, no attempt should be made to construct

* Paper read at Institute of Municipal Engineers.

the locks of identical dimensions in all cases, but to establish a minimum standard lock, and where the water supply and other conditions permit, make the locks of so many multiples of that unit.

With regard to the weirs, the normal water level should be so regulated as to ensure the land being sufficiently, but not excessively, drained. In the case of rivers with an easy, natural gradient, the weirs may be of solid construction, or limited provision for reducing their vertical area in times of freshets and floods may be made. In the case of works carefully proportioned and designed, and with adequate dredging, it will usually be found that flooding will be materially reduced. In such a river the capacity to pass flood waters is usually determined, not by the discharging capacity of the weirs, but by the capacity of the river between its banks at points intermediate to the weirs.

Many contests before Parliamentary Committees have been fought on the question of fixed versus movable weirs, and no doubt each case must be considered on its merits. The main argument, however, in favour of movable weirs is that the normal water level could be kept higher, and some dredging in that way would be avoided; but, in the author's opinion, the holding up of the water level in close proximity to the land surface is of itself liable to promote flooding, because in time of heavy rainfall the land is sooner saturated, and the river required to pass a large percentage of the rainfall within a short time, whereas if the water line is at a lower level the land will absorb much of the rainfall, and its passage down the river is thereby spread over a longer period.

It is, of course, possible, from an agricultural point of view, to have an excessive as well as an insufficient margin for drainage, as most of the great river valleys have for a large portion of their areas alluvial deposits of considerable thickness, and excessive drainage will undoubtedly be prejudicial to their agricultural value.

In any scheme for the improvement of the navigation of a river dredging is almost of necessity bound to be resorted to to a greater or less extent, depending on the natural conditions of the river, the depth of navigation required, and the design of the weirs and other works. This dredging, if properly carried out, will be of advantage to the river in various ways, in addition to the improvement of navigation. In the tidal portions it will cause a greater tidal flow, which will result in a cleansing and scouring of the river, and throughout the whole of the dredged course the capacity to discharge flood waters will be substantially increased. There is also a marked tendency for the scour to be drawn from the banks into the channel, and this leads to the river banks suffering less damage by erosion.

During the last few years the author has been called upon to design works for the improvement of the navigation of the Trent, and it was, of course, necessary that due regard should be paid to the important question of land drainage.

These works will consist of the construction of weirs, which will be solid up to a certain level, and above this level will consist of planks so fixed that they can be lowered on the approach of freshets or floods. In this way the water will never fall below a level suitable, it is believed, both for navigation and for agricultural purposes, and extensive dredging will be necessary between the weirs, which will ncrease the capacity of the river for discharging flood waters.

Side cuts with locks will, of course, be constructed for the passage of vessels.

The experience of rivers which have been dealt with on similar lines proves that with well-designed works the interests of a district in the development of navigation, the drainage of lands, and the abatement of flooding can be advanced to the undoubted benefit both of its urban and its rural population.

ENGINEERING SOCIETIES.

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

CANADIAN STREET RAILWAY ASSOCIATION.—President, E. A. Evans, Quebec; Secretary, Acton Burrows, 157 Bay Street, Toronto.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, J. F. Demers, M.D., Levis, Que.; Secretary, F. Page Wilson, Toronto.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, J. Galbraith; Secretary, Prof. C. H. McLeod. Meetings will be held at Society Rooms each Thursday until May 1st, 1908.

QUEBEC BRANCH OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.—Chairman, E. A. Hoare; Secretary, P. E. Parent, P.O. Box 115, Quebec. Meetings held twice a month at Room 40, City Hall.

TORONTO BRANCH OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.—96 King Street West, Toronto. Chairman, C. H. Mitchell; Secretary, T. C. Irving, Jr., Traders Bank Building.

MANITOBA BRANCH OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.—Chairman, H. N. Ruttan; Secretary, E. Brydone Jack. Meets first and third Friday of each month, October to April, in University of Manitoba.

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

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

CANADIAN MINING INSTITUTE.—413 Dorchester Street West, Montreal. President, W. G. Miller, Toronto; Secretary, H. Mortimer-Lamb, Montreal.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. H. Winfield; Secretary, S. Fenn, Bedford Row, Halifax, N.S.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS (TORONTO BRANCH).—W. G. Chace, Secretary, Confederation Life Building, Toronto.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—29 West 39th Street, New York. President, H. L. Holman; Secretary, Calvin W. Rice.

SOCIETY NOTES.

Independent Telephone Association.

The Canadian Independent Telephone Association will hold their Third Annual Convention in the City Hall, Toronto, on Wednesday, September 9th, 1908, not only will there be an interesting programme but there will also be a display of telephone equipment and supplies. Among the papers read will be the following:—

(1) Bell Connections—Dr. W. Doan.

(2) Independent Telephones at Railway Stations—C. Skinner.

(3) Organization of Rural Companies—(a) Mutual vs. Joint Stock Companies—A. R. Walsh. (b) Rural Line Equipment and the Best Way to Serve the Farmers—F. A. Dales.

(4) Telephone Rates—(a) Rates to be Charged, and the Best Form of Collecting—A. Hoover. (b) To what extent should Free Service be given?—A. D. Bruce.

(5) Division of Territory between Telephone Companies—Levi Moyer.

(6) Toll Line Connections: How best Effected—Alex. Neilson and Henry Sneath.

(7) Western Situation and its Future—F. Dagger.

(8) Our Interests in Towns and Cities—M. Gee.

(9) The Independent Movement in Towns and Rural Communities—T. R. Mayberry, M.L.A.

(10) Exclusive Franchises and Government Regulation—Dr. A. Ochs.

Besides the papers on set subjects given in the programme a number of prominent gentlemen interested in the Independent Telephone movement are expected to be present. The list includes Hon. Richard Turner, Hon. Jules Allard, Hon. Adele Turgeon, and Sir E. B. Garneau, of Quebec; Mr. J. H. Shoemaker, President of the Iowa Independent Telephone Association, and J. B. Ware, Secretary of the International Independent Telephone Association. Mr. F. Page Wilson, 405 Confederation Life Building, is secretary.

Union of Nova Scotia Municipalities.

The Union of Nova Scotia Municipalities concluded its third session at Sydney, B.B. Mayor Hood, of Yarmouth, was elected president, Warden McMahon, of King's County, vice-president, and F. W. W. Doane, C.E., of Halifax, secretary. The next place of meeting will be Yarmouth.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Copies of these orders may be secured from the Canadian Engineer for a small fee.

5194—August 18—Approving local mileage freight tariff, C.R.C. No. 1, of the Brantford and Hamilton Electric Railway Co. to be designated as the "Standard Freight Mileage Tariff."

5195—August 18—Approving local passenger tariff of the B. and H. Electric Railway Co. with following exceptions: That the toll between stations 5 and 11 read "5" instead of 10 cents, and that the toll between stations 5 and 13 read "10" instead of 15 cents.

5196—August 18—Extending until the 15th September time within which the Q.M. and So. Railway may cross the track, at rail level, of the G.T.R. near St. Gregoire Station, Que.

5197—August 19—Extending until September 1st time within which the C.P.R. may install bell at railway crossing, Dorchester Street, Quebec, P.Q.

5198—August 19—Authorizing the Bell Telephone Co. to cross with its aerial wires the track of the P.M.R. at public crossing one mile north of Port Stanley Station, Ont.

5199—August 19—Authorizing the Bell Telephone Co. to cross with its aerial wires the track of the C.N.O. Railway Co. at public crossing, Parry Sound (Gibson Street), Ont.

5200—August 19—Authorizing the C.P.R. to cross certain streets in the city of Calgary with spur to the premises of Fairchild Co. and Wm. Gray & Sons, Calgary, Alta.

5201—August 19—Authorizing the C.P.R. to construct spurs to and into the premises of Fairchild Co. and Wm. Gray & Sons, Calgary, Alta.

5202—June 24—Authorizing the C.P.R. to construct branch lines of railway or spurs at Terrebone, P.Q.

5203—August 22—Extending for twelve months from August 88nd, 1908, Order authorizing the G.T.R. to complete the passenger station and passenger station yards at Toronto, Ont., authorized by Order of the Board dated February 23rd, 1905.

5204—August 20—Granting leave to the Essex Terminal Railway to cross with its track the track of the C.P.R. on the Gravel Road, Township of Sandwich West, County of Essex, Ont.

5205—August 20—Granting leave to the C.P.R. to construct bridge No. 87.37 over Hamilton Creek, on the Alberni extension of the Esquimalt and Nanaimo Railway, Province of British Columbia.

5206—August 20—Authorizing the Yellow Grass Rural Telephone Co. to erect, place and maintain its wires across the tracks of the C.P.R. at five different points in the Province of Saskatchewan.

5207—August 20—Authorizing the C.P.R. to construct bridge No. 87.12 over Harry Creek, on the Alberni extension of the Esquimalt and Nanaimo Railway, Province of British Columbia.

5208—August 20—Authorizing the C.P.R. to construct, maintain and operate a branch line at Calgary, Alta., from end of spur already constructed for R. C. Thomas to and into the premises of the Canadian Port Huron Co.

5209—August 20—Granting leave to the Ontario Pipe Line Co. to lay gas pipe under the track of the G.T.R. where the same crosses Victoria Avenue, Hamilton, Ont.

5210—August 20—Authorizing the C.P.R. to construct spur to and into the premises of the Detonite Explosive Co., Limited, County of Vaudreuil, P.Q.

5211—August 18—Granting leave to the Milestone Southwestern Telephone Co., Limited, to erect, place, and maintain its telephone wires across the track of the C.P.R. on Carrington Street, Milestone, Sask.

5212—August 25—Granting leave to Guillaume Poulin to erect, place, and maintain electric light wires across the track of the C.P.R. Co. at Farnham, P.Q.

5213—August 25—Granting leave to the Barton and Binbrook Telephone Co. to erect, place, and maintain its aerial wires across the track of the G.T.R. at a point 1,100 feet south of Rymal Station, Ont.

5214—August 23—Authorizing the C.N.O.R. to construct its highways in the Township of Clarence at mileage 29, 30, 31, 32 and 33, and across Mill Street, Rockland, Ont.

5215—August 23—Authorizing the C.P.R. to divert public road from a point in Lot 15, Parish of Brighton, County of Carleton, N.B., to a point in Lot 11 of the Parish of Northampton, County of Carleton, N.B.; also in part of Lot 10, and from a point in Lot 9 to Lot 8m, Northampton, County of Carleton, N.B.

5216—August 25—Granting leave to the Wilbur Iron Ore Co., Limited, to erect, place, and maintain its wires across the track of the K. and P. Railway at Lavant, Ont.

5217—June 23—Authorizing the C.P.R. to construct new road from the proposed new station, location at mile-post 22, to the road that runs to the village of Bolton from the 6th line.

5218—August 25—Granting leave to the Bell Telephone Co. to erect, place and maintain its aerial wires across the C.P.R. at the highway at Nipissing Junction, Ont.

5219—August 25—Granting leave to the town of Kenora to erect, place, and maintain its transmission wires across the track of the C.P.R. at Hamilton Street, Kenora, Ont.

5220—August 21—Granting leave to the Northern Pipe Line Co. to lay a six-inch pressure pipe under the track of the C.P.R. at Lot 2, Concession 3, Township of Raleigh, Ont.

5221—August 15—Dismissing application of the C.P.R. Co. to fix the compensation to be paid by the G.T.R. Co. for the use and enjoyment of the right-of-way and tracks of the C.P.R. between Nipissing Junction and North Bay, Ont., and the terminals, stations, and station grounds of the C.P.R. at North Bay, Ont., and allowing appeal to Supreme Court of Canada.

5222—August 26—Granting leave to the city of Winnipeg to erect, place, and maintain electric transmission wires across the track of the C.P.R. to reach Pumping Station No. 6, Winnipeg, Man.

5223—August 26—Approving by-laws of the G.T.R. authorizing the freight and passenger traffic officers to prepare and issue tariffs of tolls to be charged for the carriage of freight and passenger traffic respectively.

5224—August 25—Amending Order of the Board No. 4796, dated the 20th May, 1908, directing that the toll to be charged by the M.C.R.R. from or to its point of interchange with the Pere Marquette R.R. for the switching of cars delivered to the P.M.R.R. be $3 pr carload by striking out the word "three" in the last paragraph and substituting therefore the charges authorized and provided in paragraph 4 of the General Interswitching Order No. 4988.

5225—August 26—Granting leave to the T.H. and B.R. to reduce the headway of the subway or undercrossing of the T.H. and B.R. Co.'s branch line of railway of the Great Western Division of the G.T.R. in Township of Baron, County of Wentworth, Ont., from 17 feet 6 inches to 16 feet 10 inches.

August 29th, 1908.

CHEDDITE—AN EXPLOSIVE.

A test with an explosive called "Cheddite," which it is proposed to introduce upon the Canadian market, was carried out in the presence of a number of civil engineers at the Montreal quarries on the 14th instant. The demonstrator was Mr. Lionne, civil engineer of the "Societe Universalle des Explosifs," of France. "Cheddite" is a compound of chlorate of potassium, or of sodium, in the form of an extremely fine powder incorporated into an oily mixture. This oil mixture, while furnishing the chlorate with what it needs to make it an explosive, acts as a restrainer in the compound, and insures the qualities of stability which are claimed for the Cheddite.

In a short lecture previous to the experiments, Mr. Lionne claimed for the explosive that it did not freeze, that it would burn without exploding, and that, while burning, the flames could be easily extinguished with water, that it was insensible to strong shocks, and that it was equal in strength to 70 per cent. dynamite.

One of the first tests to which the demonstrator exposed the Cheddite was that of fire. He calmly threw a stick of it into a receptacle in which there was a hot fire, and then, with a match, ignited a quantity of the powder which had been spread upon the grass. The Cheddite in both cases burned with a fierce heat, but no explosion followed, and, a cup of water being thrown upon the burning powder, the flames almost instantly died away. Mr. Lionne inhaled the fumes of the burning Cheddite, inviting the spectators to do the same, in order to test their harmlessness, even when released in underground workings. He then suspended two sticks of Cheddite to the limb of a tree, and, standing a few feet distant, fired point blank into it with a rifle, repeating the performance upon a box of the powder. The bullet blew the sticks to atoms and went clear through the box without causing any explosion whatever. A difference of opinion taking place between the spectators as to whether a flame developed upon the bullet coming in contact with the Cheddite, Mr. Lionne was asked to repeat the performance. This request being complied with, the spectators became satisfied that a flame actually developed at the moment of impact, this being apparently due to local explosion. A detonator cap was then attached to one stick of Cheddite and another stick was placed about two inches distant. The fuse was ignited, and after the explosion had taken place it was evident that the shock of the first stick had exploded also the second. The sticks were then placed three inches apart, and apparently the second stick in this instance had only been shattered by the concussion. In order that the test might be more satisfactory, the spectators asked that it be repeated. This time the sticks were suspended to the limb of a tree by the same string, one stick being, however, three or four inches higher than the other. To the lower stick was attached the detonator cap, while, for purposes of identification, a number of the spectators marked the paper in which the upper stick was wrapped. After the explosion, the paper containing rather more than half the contents, was found a few feet away and identified. In order to assure themselves that this package actually contained Cheddite, the spectators asked Mr. Lionne to attach the detonator cap to the material remaining in the paper covering and fire it. Mr. Lionne complied, and the usual explosion followed. In order to illustrate the direction of the downward force of the Cheddite explosion, a steel disc of over one inch diameter and perhaps one-eighth in thickness, together with a piece of lead of the same diameter and about four inches in length, were placed beneath the stick of Cheddite and the latter was exploded. The result was that the disc was visibly flattened, while one end of the lead plug was mushroomed so that it looked like a rivet with an immense head.

The final test was a practical one, being applied to the rock of the quarry. Fifteen holes had previously been bored and filled with Cheddite. These being fired with a battery, the wall of rock was lifted into the air, and rocks weighing many tons were thrown a score of feet away. In order to test the frost-resisting quality of the Cheddite. holes in several large rocks were charged with sticks of Cheddite taken from a pail which had been for some time surrounded by ice and salt, and where the thermometer registered not far from zero F. The explosion blew the rock into small pieces.

In the above tests, as much care as was possible under the circumstances was taken by the spectators in order to prevent the manipulation of the Cheddite in such a manner as to deceive them, yet nothing was discovered which would cast doubt upon the genuineness of the performance. Mr. Lionne also produced a book of freight rates in force in Great Britain showing that the railways there transport Cheddite at rates ranging between those for dynamite and black powder. He also stated that the rates in France were lower than dynamite, showing the comparative safety of Cheddite.

Among those who witnessed the test were Messrs. Henry Holgate, C.E., E. Marceau, C.E., S. A. Baulne, C.E., D. Lapierre, C.E., J. L. Michaud, district engineer, Public Works Department; T. E. Mercier. C.E., Public Works Department; G. Dupont, Montreal Water Works; Professors C. C. Leleau and Jos. Haynes, Ecole Polytechnique; J. McPherson, assistant chief N.T.R.; G. Legrand, bridge engineer, G.T.P.; Harry Holgate, Capt. A. T. Chagnon, and the representative of the "Canadian Engineer." Several other tests have been made in Montreal, and one was recently made at Winnipeg, at which a number of the principal engineers and contractors of the country were present.

METERS AND WATER CONSUMPTION OF THE HARTFORD WATERWORKS.*

By Ermon M. Peck, Mem. Conn. Soc. C.E.

When the big, new Tumble Down Brook Reservoir was completed in 1895, it was predicted confidently by many wiseacres that Hartford would not need another reservoir for many years to come. The population of the city at that time was about 66,500.

In December, 1899, only a little more than four years later, however, with a population of about 80,000, or only about 13,500 greater, the city suddenly found itself confronted by one of the worst water famines in its history. To produce this condition of affairs, two factors were dominant, viz., unfavorable occurrence of rainfall and consumption greatly in excess of its needs. In this exigency the hustle gong was sounded for the construction department, and in record-breaking time, pumps, boilers, intake, and a new force main were installed, only to "die a bornin"; for, with all the irony of fate, on the very day upon which the new plant was to be tested, Jupiter Pluvius deluged the earth, and Hartford's latest water famine passed into history. In the meantime, however, for several weeks the decrepit old pumping plant which had been used to supply the city from the Connecticut River nearly half a century before, had been started into action, and limped along until one morning, crystallized from many years of overstraining, the piston rod of its engine broke, and the fortune of the Hartford Water Department looked darker than ever. The Hartford Street Railway Co. was our good ange. in this dilemma, and its general manager very kindly furnished and installed a motor to operate the pumps, so that in a few hours we were able to force filthy Connecticut River water into our mains with as much gusto as formerly, and continued to do so until the occurrence of the storm noted above.

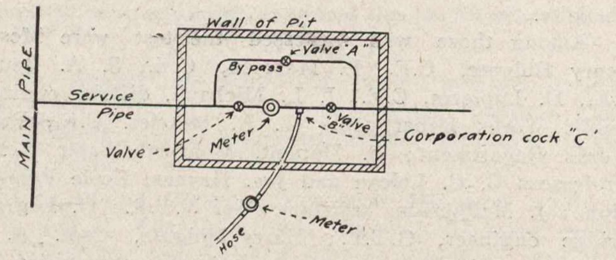
When the drouth was broken and our nervous systems were relieved of the temporary strain, it was evident that something must be done.

The department had two inspectors who regularly covered the city twice per year on the assessment plan; and,

*Read before the Connecticut Society of Civil Engineers.

while these men knew that many leaks existed and that gross abuse prevailed along the line of permitting faucets to run to prevent freezing of pipes in very cold weather, their duties were too arduous to allow them to make detailed inspections for the purpose of detecting these sources of waste. Accordingly ten additional inspectors, one for each ward, were employed, who shortly gave good accounts of themselves by the number of premises where water waste occurred which they reported. These reports, coupled with the recent shortage, spurred the Board of Water Commissioners on to adopt the policy of general metering of service pipes. It was planned to complete metering the city in about three years, and this was very nearly accomplished.

The following table is an exhibit of the number of meters in use and the per capita consumption by years. The 84.6 gallons per capita opposite the year 1900 may be



taken as the best information we have of the per capita consumption previous to general metering, and was computed from scattering Venturi meter readings.

In 1902, the automatic register was attached to the Venturi and since that time the records are reliable.

Year.	No. of services in use.	No. of meters in use.	Per capita consumption.
1900	8,951	550	84.6
1901	9,256	2,783	76.3
1902	9,514	6,993	78.8
1903	9,683	9,156	75.0
1904	9,809	9,604	66.7
1905	10,006	9,860	62.6
1906	10,328	10,137	61.6
1907	10,623	10,433	59.1

These figures are based upon the total population supplied, which at present is estimated to be divided as follows: Estimate of population in Geer's 1907 Hartford Directory, 106,000. Population supplied in West Hartford, Wethersfield and Bloomfield, 3,000. Floating population, equivalent to 4,000 regular consumers. The estimate of the floating population was arrived at by stationing observers at the outskirts of the city on the various trolley lines to count the passengers bound cityward.

Similarly, observers were placed at the Union Railroad Station. Each "floater" was estimated equal to one-third the regular consumer.

At the present time the department has 10,922 services and 10,814 meters, 99 per cent. of the taps being metered. This is a high percentage compared with that of other cities.

It should be said in this connection that the above reduction in the consumption of water has not been accomplished by meters alone, but partially by a rigid waste and leak inspection, which has gone hand-in-hand with it. Inside the premises the inspection has been prosecuted by the meter readers. In the streets the water mains, services, hydrants, etc., have been inspected regularly by parties of men who did nothing else. The early experiences of this leak survey party were marked by the discovery of many leaks—some large and of long standing. The leak survey was established in 1902, but did not operate extensively until 1904. The large drop in consumption for that year I consider largely due to its work.

The rise in consumption in 1902 I consider due to the fact that the "big bill bogey," always easily conjured by the excited mind of the water taker, had failed to materialize and the reaction towards increased consumption, usually noted in such cases, had set in. This, of course, was cut down in the succeeding years by fighting waste and leaks.

In this connection I may say that a very interesting computation was made during the past year designed to show the proportion of the water passing the Venturi meter at the distributing reservoir which could be accounted for. After making proper allowances for unmetered water and under-registration of meters, it was found that only 16 per cent. of the water as registered by the Venturi remained unaccounted for. Since that time several of our fire service pipes have been metered, with the result that this percentage could be somewhat reduced.

Recently the Board of Water Commissioners has become impressed with the importance of systematic tests in order to keep the meters within permissible limits of registration. We require all meters to test not lower than 98 per cent. and not more than 100 per cent. on full flow.

All five-eighth inch, three-quarter inch, and one inch meters are required to register on a one-thirty-second inch stream under the pressure at our testing bench, which would be equivalent to a flow of .0230 cubic feet per minute. It is the intention to test all meters at least once in four years, and perhaps oftener.

Meters larger than one inch are required to test more in accordance with the service for which they are used than by a fixed rule, although as a general proposition one and one-half inch and two inch meters are required to register on a one-sixteenth inch stream equal to a flow of about .113 cubic feet per minute, the other requirements being the same as for smaller meters. The larger part of the meters above two inches in size are being fitted out to be tested in place. This is done by putting in a valve in front of the meter with a hose connection between the two. To test the meters the valve on the service is closed, the hose being connected up with an accurate meter in series with the one to be tested, as in the following sketch:—

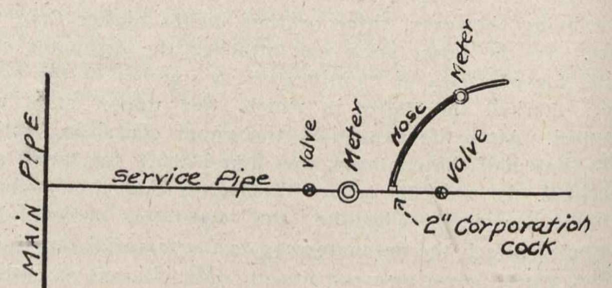
In laying new services the following plan has been adopted: A is a valve on a by-pass around meter. This valve is closed and locked at all times excepting when meter is being tested.

B is a valve in front of meter and C is a corporation cock for connecting up hose with accurate meter. To test meter, hose is connected up, as in the sketch above.

Valve A is then opened and valve B is closed.

The whole arrangement of valves and by-pass is placed in a concrete pit. By this method large meters can be tested without shutting off the supply from the consumer, which is often a great consideration. The following sketch shows the arrangement of piping for this testing work:—

Although this method of testing large meters has been in use for some time in other cities it has not been employed in Hartford any more than experimentally to ascertain its practicability. A party of men has been at work for some



time during the present winter fitting up the larger services for these tests. It is our intention to test all the meters so arranged at least once each year and in some cases twice.

The meter card which has been lately designed for the Hartford Water Board, and which will shortly be put in use, is a large one, being approximately nine by fourteen inches. It is ruled and printed on both sides, one side being devoted to information regarding installation and the other to maintenance. An eighteen inch Elliott-Fisher billing machine is used for writing up the cards.

The writer may add that the card system has been adopted recently for the meter readers' books, and these, too, are written up on this machine.

ELECTRIC LIGHTING.

Mr. J. Holmes, West Ham Corporation Electric Light Department.

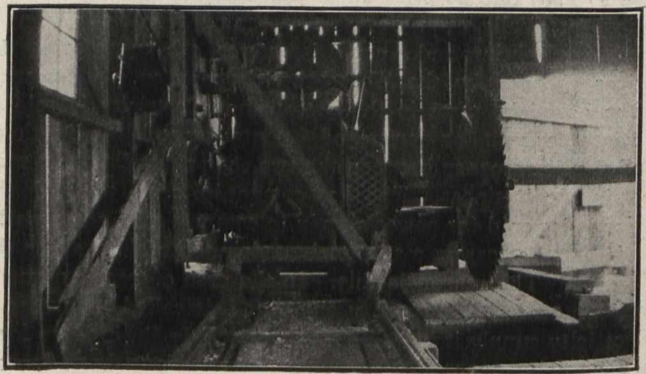
Power supply in West Ham has become a great factor, bringing in a revenue amounting to about five-sixths of the total, with the consequence that we devote more attention to power supply. At the same time we are not losing sight of lighting. Speaking of the carbon filament lamp, it has been mentioned that the discovery of electricity as an illuminant was coincident with the first application of the gas flame on a commercial scale—both in about the year 1800—and it may be asked how it is that gas is now practically universally adopted while electricity is almost in its infancy so far as commercial matters are concerned. To explain that, it may be of interest to know that gas was an agent for lighting which had its tools almost ready to hand when it was first introduced, while electricity had a great number of drawbacks. The possibilities of the carbon filament lamp were known forty years before it was put into use simply because they were unable to get the proper vacuum, and it was only when the Sprengle pump was invented that the necessary high vacuum could be obtained. The carbon filament lamp is the one in which most electric lighting extensions have been made and, at the time when first introduced, was undoubtedly the cheapest and most efficient form of lighting. It was equally as cheap as its great rival, gas, and for some time it looked as though electricity was going to oust gas from the field, but at that time, when the use of electricity was fast gaining ground, the Welsbach mantle was introduced and gas once again took the lead. I am not going to detain you so much now with particulars regarding the introduction of electric light, but will say a few words from the commercial point of view. I will try to put what I have to say into ordinary everyday words, but technical terms are apt to slip out which may not be quite clear to those who are not so conversant with them. The dynamo has been alluded to. That was the first introduction of an electrical apparatus which would give a constant current of electricity at a reasonable cost. Within the last week I happened to be talking to a man who was working on the first installation in London, and he said the prices charged were never put down on paper, the installation was put in and at the end of a certain time a fixed charge was made to cover all expenses. The actual price, however, came to about 2s. 6d. per unit. For some time plants were put down for different electric lighting schemes and no accounts at all taken of the price per unit, the people who had the electric light had to pay whatever those who supplied them thought would be the cost. But soon after electricity was supplied on a commercial basis a law was made by the Government that no charge should be made over 16 cents per unit, and for some time that maximum was paid, simply because the cost of generating and distributing the electricity was so high that no price under that would be profitable. The prices gradually came down to 12 cents, then as low as 6 cents for lighting and 2 cents for power, the latter being the prices charged by the West Ham Corporation. A question often asked is, what is the reason that electricity is sold at 2 cents per unit for power and 6 cents per unit for lighting? and the discrepancy between the two seems puzzling to a man not in the business. The gas companies seem to think the price is lowered for power simply to compete with other works and that the loss is made up by raising the charge for the lighting. The reason is this. In the case of gas, the gas is made, stored and sent out at any time it is called for, but with electricity supply it is a different matter. In the modern form of electricity generation the plant must be put down in stations to supply the maximum amount for a specified time. In the case of power that plant is going eight hours a day, in the case of lighting only three hours a day, that is a ratio of about 3 to 1, consequently the capital charges per unit for lighting are one-third of those for power, and as the capital charges amount to about 80 per cent. of the total in the case of lighting, that explains the difference in the prices charged to the consumer. At the time to which I referred, when electricity was competing with gas successfully as an illuminant, people began to realize the advantages of electricity, the ease with which it could be turned on and off, its cleanliness and its advantages from a hygienic point of view, and electric light, in spite of the cheapness of incandescent gas continued to make headway. The electrical apparatus was much more reliable than it used to be, and the prices for current were also considerably lower; but it was not until during the last two years that any great advances in electric light economies were made. The gas companies had made a great step forward in having introduced for them, rather against their wish, the Welsbach mantle. That mantle meant a great reduction in cost of lighting, but it was by its introduction that the gas companies began to find that they had a weapon in their hands with which they might oust electricity as electricity had threatened to oust gas previously. But another point arose. Due to the economy of gas effected by the mantle, the companies found their revenue declining. They looked about for other fields, and as a result the gas cooker was introduced, causing large increases in the consumption of gas, the wholesale production bringing about a lowering of the price. For five or six years the gas mantle was in great demand, but electricity also kept in the forefront so far as cleanliness, healthfulness, etc., were concerned, and at the end of those years there was a new revolution in electric lighting through the introduction of the metallic filament lamp. The first metallic filament lamp introduced was the "Osmi" lamp, a lamp not quite so efficient as the "Osram" and with a very delicate filament, which prevented it coming into general use. Shortly after its introduction came the "Tantalum" lamp, of which I have some specimens here. This lamp is made in exactly the same way as the carbon filament lamp, excepting that the filament is made of pure tantalum metal. The introduction of this lamp brought the cost down to about one-half or one-third of the former cost, but it had various drawbacks. The price of the lamp was fairly high—that was not such a great drawback—but the lamp did not last very long. Of course it is now improved and is far better than it was. Another drawback was that it could not be used on alternate supplies. To those who are not acquainted with electrical matters I might say there are two systems of supply, one the direct current system, the other the alternate system used for the purpose of keeping down the distributing and generating charges. (It is, as the general rule, the only system under which commercial electricity can be supplied for power at a low price.) In the greater number of supply areas, therefore, the use of the "Tantalum" lamp was debarred on account of its very short life. There was a concerted action against electricity in the middle of 1906, and it seemed that electricity would have to go to the wall as far as lighting was concerned, but just at that time the "Osmi" lamp came in again in a practical form, and I think it was one of the greatest commercial electrical achievements of the last ten years that the "Osram" lamp, after being used for a short time almost as an experiment, within six months was being supplied on a sound commercial basis to the extent of thousands a day, so great was the demand in this country. Of course it was first introduced in Germany—most of these things are—but it was not taken up so much in Germany as in England. In Germany the carbon filament is still very much in use. The saving effected by the "Osram" lamp is approximately in the ratio of 4:1, that is to say, if the carbon filament lamps in a room are taken out and "Osram" lamps put in their place, the quarterly bill would be only quarter of what it was. Electricity, therefore, is now on a footing which makes it a serious competitor to gas for lighting in the matter of cost alone. The effect of this lamp bringing the cost down to one-quarter has given to electricity a lead-off similar to the impetus given on the introduction of the carbon filament, when it had to face only the ordinary gas-burner. That, up to the moment, gives the history of incandescent lighting in small units. I will now show the different kinds of lamps. This is the "Tantalum," this is the "Osram," and that is an ordinary 16 c.p.

* Paper read before Institute of Marine Engineers.

carbon filament lamp. This is a 50 c.p. "Osram" lamp. You will see the filament in the latter is much longer. It is one of the disadvantages of the metallic filament that its resistance is low. The metallic filament allows a lot more current to pass over the same length, with the consequence that it is difficult, with the metallic filament, to keep the current low enough, thus necessitating an increase in the length of the filament. It is a big disadvantage, as it makes the lamp comparatively brittle, but every fresh delivery from Germany is better than the preceding one. At present, however, it cannot be used in a slanting position. If it is used, the filament being soft, bends, touches the glass and breaks, bringing the cost of renewals up to a somewhat big figure. Referring to the competition between the "Osram" lamps and gas, there has been some considerable agitation in the gas and electrical world on this matter, and the supporters of gas have sent me a mass of figures showing that gas must be at least three times as cheap. The figures obtained from the people of West Ham who have adopted electricity show that there is a saving of at least 40 per cent. on their gas bills. The reason for the difference between these figures is due to a fact which I will explain. Take, for instance, one of your own lights in this room. That light in the back of the hall is supposed to be giving 64 c.p. and is supposed to be burning 3½ ft. of gas per hour. I am almost sure it is burning nearer 5 ft. of gas and that the candle-power is under 30 at the present moment. But even assuming the candle-power and consumption of gas is what they say, the people who have adopted electricity find that there is a saving of 40 per cent. in their bills, and that is a big amount to explain away. I have spoken of the incandescent part of electric lighting, but there is another form of electric lighting which has been altogether from the start up-to-date and more forward than the incandescent, that is, the arc lighting. The "Nernst" mantle comes between the two, and was going to do for electricity what the "Welsbach" mantle did for gas, but, unfortunately, they could not get sufficient life out of the filament or mantle to make it a commercial success. The filament was made of practically the same material as the Welsbach mantle. There was the trouble, first of all, that it was a non-conductor, with the consequence that they had to put a subsidiary filament in to heat the main filament up so that it could pass electricity through it. Then again it was of no use with the alternate supplies. The old idea I refer to is seen in the Jabblockoff candle, consisting of a couple of carbons in a converging position, held together by non-conducting material in the centre, the arc being formed at the bottom by a mechanical arrangement. As the carbon burnt away, the non-conducting material in the centre burned also, and the arc gradually burnt upwards. In the latest type the same idea of the converging carbons is used, but of this later. The next great step was the introduction of the open type arc lamp. It has been briefly explained by Mr. Battle, and I have not much more to add excepting that it consists of a couple of carbons in a vertical position. These are brought together automatically, the current switched on, and brought away again and the arc formed between the two. There is a crater at the top, and the carbon there is raised to an intense heat, the highest temperature obtainable. It is only a small thing, only 1/16-inch square in some lamps, and the whole of the light is admitted from that crater. That is the first type of are-lamp that was really satisfactory, there are some of them in the Romford Road now. They run on direct current. The alternate current was not a success because, owing to the rapid alternations, there was first the crater at the top to be formed, and then at the bottom, and the light was only going half way between the two, giving only half the efficiency. Of course the drawback to arc-lights is the cost of carbon renewal, a great amount is spent on labor and a large number of carbons are used, and to obviate this the Jandus Arc Light Co. introduced a lamp in which the arc was enclosed in a vacuum. There is a later one similar to the one they introduced. The arc is inside the globe, with the consequence that the air in the globe is burnt up and the carbon dioxide and carbon monoxide formed in the globe prevent the further burning away of the carbon. The difference in the amount of light obtained is very marked, because the light is not only obtained from the crater, but also from the arc. That is an ordinary enclosed arc-lamp. The amount of light given in different directions by that is much more than that given by the ordinary open type arc-lamp. This was considered a very great improvement in arc lighting, but shortly afterwards the "Bremer" lamp was introduced, which went back to the old form of converging carbons, with the use also of a secret mixture of impregnated salt. These vaporized salts gave an intense yellow light, the amount of candle-power given out being nearly six to one as compared with the ordinary open type lamp. This Bremer lamp was later materially altered in its construction, improvements being made in the salts in the cores of the carbons and in the shape of the arc. The arc was regulated by a magnetic field which, although invisible, had the property of holding the arc in any desired position. The difference in candle-power is very marked, and in the matter of cost as compared with gas, the cost of this type of electric light is cheaper than any other form of illuminant. The drawback is that it is not easy to make it as a small current lamp, otherwise the gas companies would not have much chance. The carbons are comparatively expensive and need renewing about once every eight to ten hours, but this very week I have received a communication from a gentleman to the effect that a new arc has now come out that will do for the flame arc what the enclosed arc did for the open type. They call it the Regenerative Arc Lamp. The principle is that instead of burning the vapour from the core of the arc, the vapour, first of all, is brought into the arc from the core, but then taken round different parts of the lamp and brought back again, the salts being burnt over and over again, and, whereas the carbon in the ordinary flame lamp lasts ten hours, in the new lamp will last about seventy hours. I will not say much more about the different kinds of lamps, but what I have said may have sufficiently interested you in electrical matters to lead you to visit the generating station, which I have no doubt would prove a most interesting visit, as it is one of the most up-to-date stations in the country. If I were to make a prophecy as to the future of electricity as against gas, I would say that for very many years there will be room for both, but I am fully persuaded of this, that electricity, if electrical engineers are more businesslike and enterprising than the majority are now, will soon oust gas from the foremost position as an illuminant.

A CONTRACTOR'S ELECTRIC MOTOR.

The adaptability of electric motors to all sorts of service is well illustrated in the view of a direct current motor with a circular saw on the extended shaft. The motor only differs from a type " S " motor of standard Westinghouse design in that the shaft is somewhat larger and longer on the pulley and that a commutator end bracket is supplied on this end to



provide a bearing nearer the saw. The motor speed may be varied from 1,125 to 1,800 R.P.M. to provide for various classes of work, with saws of different diameters. This motor is rated at 10 horse-power.

It will be noted that a pulley has been installed on the extended shaft at the commutator and to act as a flywheel, and also to provide a place for a brake. This latter is thrown on by means of a lever near the operator whenever it is desired to stop the saw quickly. The contractor has also installed a bladed fan on the pulley to blow air over the motor and throw the chips and sawdust away from the track and the motor. These cannot be seen in the illustration.

The illustration, a large circular rip-saw, is shown taking a cut in a heavy oak timber to be used in dam wickets on the Ohio River. The material must finish 10 x 12. A cross-cut saw is also used by the contractor who owns the outfit.

The motor is mounted on a frame with wheels which run on a short piece of track, that the saw may be fed through the work. Attention is called to the method adopted by the contractor to keep the track clear of sawdust. In front of all four wheels a flap of leather is arranged to rub on the track which effectually clears away all material and allows the groove-cutter to make a cut of even depth at all times.

Mounted on the frame which carries the motor is the switchboard panel with a field rheostat for adjusting the speed, a starting rheostat and a circuit braker. As the motor must move back and forth the current is supplied through two short stretches of trolley wire on which the trolley wheels run, similar to the method used in a travelling crane.

TRACK CONSTRUCTION IN STREETS FOR INTERURBAN SERVICE.*

By Thomas B. McMath.

The use of 40 and 50-ton cars upon tracks laid in city streets demands a decided change in track specifications. Track formerly laid for street railways shows several reasons for failure when subjected to this heavy loading. The most striking of the difficulties are: First, the selection of proper rail section; second, the foundation on which the track is laid.

We can learn very little toward a proper selection of a rail section from steam railroad experience, as the deflection of the rail and the distortion of its cross-section under load are not noticeable. A track laid in city streets, however, promptly shows in its destruction of street paving the effect both of deflection and distortion of rail section.

Assuming at first that the ballast is perfectly supporting the track, the deflection of the rail can be governed by a proper tie spacing. Ties can be so spaced that the distance between ties is a little more than the width of a shovel. This is the practical limit to permit of good tamping and maintenance. With hewed ties, as ordinarily furnished under a contract for 6 x 8-inch ties, the average space between ties spaced 2-foot centers is about 12 inches. Instead, however, of an arbitrary spacing of 2-foot centers, the writer would advocate a specification to make the space between ties uniform, and if this be made the factor for tie spacing instead of an absolute number of ties per rail, a roadbed of more uniform supporting qualities will result.

The following elements occur relative to the selection of a proper rail section: First, maximum life of rail under traffic; second, economical distribution of metal in section; third, safety to car, passengers and public; fourth, economical expenditure of energy in moving load; fifth, least obstacle to wagon traffic.

The public generally feel that the railway company will look out for the first mentioned requirements and the city engineer for the last. Unfortunately the city authorities are sometimes apt to assume that the use of an absolute section is necessary on account of this last requirement. However, the public is just as interested in the other requirements.

An economical rail section means reasonable operating expenses, which promptly show results in the comfort and safety of passengers. It is not necessary to dwell on the condition of rolling stock and general disgust of the public when a property can not be kept up due to maintenance being in excess of income. Compare the number of persons carried daily on our city cars with the number using the streets in vehicles and you will easily see that perhaps 90 per cent. of the people only use the street as a car passenger, and 10 per cent. use it in a vehicle. The public are therefore as greatly interested in the safety of the car as the railway company.

The T rail is the best shape that heavy interurban cars can be safely and economically operated upon, and if properly selected will answer all of the above requirements. For streets paved with brick, any section deep enough to provide a sand cushion under the brick can be used successfully. The 80-pound standard section having a depth of 5 inches can be successfully used. The high T rails can also be used. Many of the old high T sections, however, are not adapted for heavy loads, due to weakness in the web, having been designed for lighter loading. If used, the bending of the web throws crushing strain on the paving, which gives way. The 7-in. T used in this city was specially designed with web stiff enough to support the load, the 9-inch girder section having failed utterly in this requirement.

The rail requirements are: Sufficient width of head to protect paving from the wheels, sufficient height to permit paving, base wide enough to sustain and distribute load, web thick enough to resist the bending moment of the wheel load when applied at the extreme edge of the head.

Ballast is usually depended on for the foundation of the ties, if the soil is sand or gravel, but enough ballast to tamp is necessary. Clay or loam requires heavy ballast. A good foundation can be made by putting in a layer of ballast, stone or gravel, thoroughly rolling, and then laying the track and tamping with ballast, filling finally with concrete to the height required by the paving. Concrete makes the best foundation and ballast. However, concrete to be useful must be under the ties, and as the layer of concrete will be over 1 foot thick, a cheap natural cement can be used with safety and keep the expense within reach. The subgrade should be excavated to a depth of 6 inches below the bottom of the ties.

The track is to be laid on this subgrade and raised up to grade, surfaced and lined on blocking. Concrete is made in the proportions of 1-2½-7 with natural cement and tamped specially under the ties and base of the rail and leveled at a proper grade for the brick surface.

This construction makes a rigid roadbed, and if proper time for setting be given will give a first-class roadbed and is preferable to any type of concrete beam construction.

The reconstruction of streets having tracks on which traffic must be maintained during construction can be accomplished by the use of dry concrete as a foundation. Excavate and lower the track until a depth of 6 or 8 inches below grade is attained. Then mix cement, sand and gravel in the proper proportions, 1-2-6, using no water. Throw the mixture in the track and raise track and tamp ties to grade the same as if ballast was used. Tamp until ties are solid under passing cars. When the track has been properly surfaced on the dry concrete, line up the track and finish concreting with wet concrete. Some five years' experience with this type of work has shown that work so done will hold to surface and line as well as if laid on wet concrete without traffic. Excavations made show that the dry concrete has set, perhaps not 100 per cent. of the strength of properly wetted concrete, yet if liberality has been shown in the amount of cement used, such dry concrete will be ample. The feature accomplished is that the track is in operating condition all the time and at the end of six months an expert could hardly tell upon excavating but what the concrete had all been given the same mix.

Portland cement gives better results than natural cement, but the cheapness of the latter allows a liberality in its use, which is necessary when dry mixing is done.

The writer has excavated gravel from a bank with a half-yard orange peel excavator, thrown the cement on top of the bucket of gravel, dumped the bucket in his No. 2 Drake mixer, which discharged the mix directly into the ballast cars, the extra cost of 100 yards of mixed material being $67.00 above the cost of ordinary ballast. In this case the dry concrete cost about $1.00 per cubic yard ready to spread and tamp. However, gravel pit conditions did not permit this kind of work for more than three weeks, after which it was impossible to reach the mixer directly with the excavator and a second handling was necessary.

*Read before the Indiana Engineering Society.

ENGINEER'S LIBRARY

ELECTRIC FIRING: HANG-FIRES AND MISS-FIRES.

Abstract of a Paper by William Maurice in The Quarry.

In view of the fact that recently there has been so many accidents reported as due to the "hang-fire" of explosives that it might not be out of place to point out that electric detonators can, and do at times, hang fire.

It is not unusual for one in a group of simultaneously fired shots to miss, and consequently there is always an element of danger in group-firing. Probably a nearer approximation to perfect safety would lie in the use of electrically ignited time fuses, though it must also be admitted that the use of a suitable detonator would go a long way towards insuring the simultaneous ignition of any number of shots. Hang-fire, or retarded ignition, may occur in the electric detonator, or it may occur in the explosive. A damp detonator might readily hang fire.

It is well known that a shot will sometimes explode some time after the coming to rest of the exploder-handle, whereas in general less than half a turn will suffice. The retardation might be caused by increased resistance in the circuit through broken wires, bad joints, or grease or dirt on spring contacts and terminals permitting the passage of only just sufficient electrical energy to warm the fuse bridge. The latter has then to be kept heated during several seconds before the temperature rises to the point of ignition of the priming. The same effect would be produced if the exploder were under-powered, owing for instance, to loss of magnetism. Or delayed ignition might be caused by defects in the fuse, such as badly mixed, damp, or insufficient priming, or by a wet charge.

Captain Desborough states that he had electrical hang-fires when firing experimental shots with three different ammonium-nitrate explosives, that of greatest duration involving an interval of about 50 seconds between the explosion of the detonator and the explosion of the charge. With all these explosives he subsequently had several miss-fires, and in each case, when the charge was extracted, he found that the detonator had fired, but had failed to explode the charge. The difficulty was overcome when a stronger detonator was employed. In this connection Captain Desborough mentioned that a cartridge of carbonite was found to be burning in a shot-hole in a colliery in South Wales. This was by no means the first instance of the kind, and the cause seemed to lie in the use of a faulty or insufficiently powerful detonator.

The British "Annual Report of Inspectors of Explosives for 1906" also records three cases in which a "hang-fire" has occurred with electric firing. In one of these cases two attempts were made to fire a shot electrically (high tension). The cable was then disconnected from the detonator-leads and tested. It was found to be all right. The shot then exploded. There is practically no doubt, according to the report, that this was a case of hang-fire. The time elapsing between the disconnection of the cable and the explosion of the charge was about five minutes.

Dynamite, gun-cotton, nitrate of ammonia, and other blasting materials containing nitrates decompose gradually in the air and give out nitric oxide, but if they are ignited in a closed space they instantly decompose without forming a trace of nitric oxide. The first slow process changes immediately into the second if the free evolution of gas be hindered and the pressure raised. The reaction produced by a detonator is the same as that by ignition in a closed space at high pressure. Both are so rapid that the whole of the charge is at once converted into gas. But if the ignition be defective the charge may ignite and burn, instead of exploding; it is then said to "cook," and gives off nitric oxide. The explosive power of a charge also varies with its composition, and depends, in grisounite, upon the small quantity of nitro-napthalene that it contains. If the charge begins to burn, the increasing pressure caused by the gases given off may produce an explosing, and ignite the cartridges one after the other.

BOOK REVIEWS.

Books reviewed in these columns may be secured from Vannevar & Company, 438 Yonge Street, Toronto, Ont.

Hydraulic Calculator. — By R. O. Wynne-Roberts, M.I.C.E. Published by the St. Bride's Press, Limited, 24 Bride's Lane, Fleet Street, London, E.C. Price, $1.50.

This is a pocket hydraulic calculator, prepared to expedite the work of the hydraulic engineer. The simplicity of the operation to ascertain the necessary information respecting dimensions, gradients, velocities and discharges of any circular pipe is one which will doubtless appeal to the practical engineer occupied in the design of a variety of hydraulic or sewerage works which necessitate intricate and tedious mathematical calculations. This Pocket Hydraulic Calculator is applicable for circular pipes ranging from 3 to 40 inches, with gradients of from 1 in 1 to 1 in 10,000. It has, of course, been impracticable to insert any figures except the leading ones, but the others can be easily interpolated with a sufficient degree of accuracy. It will solve any of the following problems: Given—(1) Velocity and gallons. (2) Velocity and diameter. (3) Velocity and inclination. (4) Gallons and diameter. (5) Gallons and inclination. (6) Diameter and inclination. To find—Diameter and inclination, gallons and inclination, gallons and diameter, inclination and velocity, diameter and velocity, gallons and velocity.

Electrical Railroading or Electricity as Applied to Railroad Transportation.—By Sidney Alymer-Small. Handbook size bound in leather; 924 pages, 539 illustrated. Frederick J. Drake & Company, Chicago, publisher. Price,——

This book is primarily written for railroad men, but will also prove interesting to those who desire knowledge of the application of electricity and transportation by rail. It has, however, been written more as a help to the railroad man to permit him by a little study to become familiar with the underlying principles of electric traction and the operation of such systems. It is not written in the usual way, but is gotten up as a series of lessons or cathechisms, the style of which is questions and answers, placed alternatively. The author has endeavored to explain in a simple and practical manner the principles of electricity and magnetism and the adaption of electrical power and railroading. The first five lessons take up Static electricity condensers and Static electrical machines. Lessons 6 to 9 deal with lightning phonomena, explanation of, and method of protection. Lessons 10 to 15 explain the elementary principles of magnetism, magnetic induction, electro magnets and the law of magnetic circuits. Primary cells and storage batteries also receive attention. The theory of electric circuits, dynamos and motors is taken up in order and discussed with attached catechisms. Several lessons cover the description of modern substations, power houses and switchboards. The remaining 450 pages cover a detailed description of the principal systems used in electric traction. This part is very well illustrated with cuts of machines and apparatus, transmission, comparative data between steam and electric traction, advantages and disadvantages of AC and DC motors and equipment; rolling stock and a detailed description of the Westinghouse AC system. The Sprague and Westinghouse control are discussed. The book ends up with catechisms on suburban motor and air-brakes. The book will prove useful and of value to the railroad man, and those who desire to gain knowledge of the principles, electric traction and operation of electric roads.

F. A. G.

Reinforced Concrete: A Manual of Practice.—By Ernest McCullough, M.W.S.E., author of "Engineering Work in Towns and Cities," "The Business of Contracting," "Municipal Public Works," "The Vrooman Act," "Engineering Contractors Pocket Book," etc. Chicago: The Cement Era Publishing Company. Cloth, 5 in. x 7¾ in.; pp. 128; 31 illustrations and 17 tables. Price, $1.

This little book is one that would be a valuable addition to the library of the engineer or contractor engaged on concrete work of any kind and being free from complex mathematics can be read and understood by anyone. While being essentially a book on construction it would be useful to both designer and constructor; the former would gain valuable information of the practical side of the work, while the latter would be made familiar with the principles of design.

The first four chapters of the book are given over to the theory of reinforced concrete and the author deserves credit for the clear manner in which he has presented the subject. Chapters I. and II. take up the design of the beam and give some very simple formulae for the computation of area of steel, diagonal tension, horizontal shear, etc., for single and double reinforcement and for "T" beams and slabs. In addition a summary of the statics of the simple beam is given. Chapter III. is devoted to the design of columns and Chapter IV. to miscellaneous structures such as walls, tanks, footings, retaining walls, etc.

The remainder of the book is devoted to the practical side of concrete engineering. Chapter V., entitled "Design and Cost," is a discussion on costs and a general consideration of the various details which effect the cost of a work. The author points out that definite figures on costs are often misleading and refrains from giving and figures except in the most general sense. Chapter VI. on forms is probably the most useful in the book. It is exceedingly well illustrated and gives more real information on this subject than is given in many of the books that are regarded as authorities on reinforced concrete construction. The remaining Chapters, VII. and VIII., deal with practical points for the contractor, such as bending and placing steel, mixing and placing concrete, treatment of surfaces, joints in concrete, and the general conduct of the work. A number of very useful tables for estimating quantities are given, such as tables of cement, sand and stone for different mixtures; wire and bolts required for forms; safe loads on posts, braces, and forms; weights of nails, bolts, spikes, etc.

In conclusion we would say that this book contains for its size more valuable matter than any we have seen. Every page is worth reading and there is very little superfluous matter. It is well got up and is of a convenient size to be carried in the pocket. It would be equally useful to the engineer, contractor, or superintendent. R. E. C.

Tables for Setting Out Curves.—By H. Williamson, C.E. Published by E. and F. N. Spon, 57 Haymarket, London, Eng. Size, 4 x 5, pages 50. Price, 50 cents.

This work has been written for the use of engineers in laying out curves in countries where the metrical system is in vogue and to save laborious calculations. Data have been also given for setting out curves by offsets by tangents.

The tables are complete and convenient, and should be very useful.

Hydro-Electric Developments.—By Preston Player. Published by McGraw Publishing Co., 239 West 39th Street, New York. Size, 5 x 7, pages 70. Price, $1.

The utilization of water powers in connection with electric power development has, during the last few years, become somewhat of a fetish. Many water powers have been developed without giving sufficient consideration to the points involved. It is with the object of pointing out what information should be obtained that this book has been prepared.

In the small space at his disposal the author has handled the subject splendidly. The question is discussed in nine chapters: Preliminary Determinations; Methods of Procedure; Engineering Examinations; Extent of the Market for Energy; Central Station Economies; Sale of Electric Energy; Primary and Secondary Powers, and Capital Costs.

The book is carefully written in a style readily understood by the general reader, and yet the author writes forcefully of things the engineer too frequently forgets.

PUBLICATIONS RECEIVED.

Canal Statistics.—The report of the Department of Railways and Canals of Canada for 1907, giving statistics for the season of navigation. Size, 6 x 9, pages 178. Hon. Geo. P. Graham, Minister of Railways and Canals, Ottawa, Canada.

Education in Ontario.—The report for 1907 of Dr. R. A. Pyne, Minister of Education, containing Technical Education, etc. Size, 6 x 9, pages 960.

Indiana Engineering Society.—The transactions of the Society for 1907. Contains official annual report and papers read at Indianapolis Convention. Chas. Brossmann, secretary Union Trust Building, Indianapolis, Ind. Size 6 x 9, pages 200. Price, 50 cents.

Precise Levelling.—A report for 1904 to 1907, giving the list of bench marks established in connection with the line of precise level ran from Lake Ontario to the French River. E. D. Fafleur, Chief Engineer Department of Public Works, Ottawa. Size 6 x 9, pages 150. Price, 15 cents.

Connecticut Society of Civil Engineers.—Papers and Transactions for 1907, and also contains the report of the twenty-fourth annual meeting. J. Frederick Jackson, New Haven, Conn., secretary. Size 6 x 9, pages 160. Illustrated.

CATALOGUES AND CIRCULARS.

Friction Clutches.—The Allis-Chalmers-Bullock .Co., of Montreal, are prepared to distribute Bulletin No. 1,207, which describes fully their friction clutch pulleys and cut-off couplings. The bulletin gives principal dimensions, shipping weight and prices, besides several sections showing the construction.

Triple Valves.—The Westinghouse Air-Brake Co., of Pittsburg, Pa., have issued a 30-page book of instructions describing the construction, operation and parts of the Westinghouse air-brake.

Electric Elevators.—Harpell & Stokes, 155 King Street West, Toronto, Ont., are distributing Brodesser Elevator Co.'s catalogue. They are the Canadian agents for this firm, and the catalogue well illustrates the parts of this elevator.

Storage Batteries.—The D.-P. Battery Co., of Lumford Mills, Bakewell, Derbyshire, Eng., have prepared handsome catalogues describing their storage batteries. These catalogues are for their export trade especially, and are carefully prepared, giving diagrams, dimensions, weight, prices, etc., of their various batteries.

Steel Cars and Buckets.—Mussens Limited, of Toronto, Winnipeg and Vancouver, are distributing Bulletin No. 20, descriptive of the Atlas steel car. Cars of various sizes and styles are described, both side and end dump. A table giving principal dimensions is also given. In the same catalogue ore and water buckets are listed.

"Expulsor" Steam Pump.—Holden & Brooke, Manchester, Eng., in List No. 82 describe the special features of their pump, which is especially suitable for rough and emergency work. A price list is attached.

Expanded Metal.—The Northwestern Expanded Metal Co., of Old Colony Building, Chicago, Ill., send a booklet called "Hints for Specifications." The booklet contains tables and formulæ useful in calculating reinforcement for concrete work.

Locomotives.—The Jeffrey Manufacturing Co., Columbus, Ohio, in Bulletin No. 15 present a description of the Jeffrey crab locomotive for use in mine operation.

Propellor Fans.—Sheldons Limited, Galt, Ont., have in Bulletin No. 50 described the construction and uses of their disc and propellor fans. Besides being well illustrated the booklet contains tables of sizes, principal dimensions, range, etc. They will be pleased to send it to interested parties.

CONSTRUCTION NEWS SECTION

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

TENDERS.

New Brunswick.

FREDERICTON.—Tender for Clarke Bridge will be received at the Department of Public Works, Fredericton, until Monday, 7th Day of September, 1908, at noon, for rebuilding the Clarke Bridge, near Iron Bound Cove, parish of Chipman, Queen's County, N.B., according to plan and specification to be seen at the Public Works Department, Fredericton, N.B. John Morrissy, Chief Commissioner, Department of Public Works.

Quebec.

MONTREAL.—Sealed proposals, addressed to the city clerk, city hall, Montreal, will be received at the office of the said city clerk until noon, Friday, the 18th September, 1908, for the construction of a reinforced concrete compensating well and a reinforced concrete double conduit to the pumps at the Low Level Pumping Station, Point St. Charles. George Janin, Superintendent and Chief Engineer Montreal Waterworks.

Ontario.

PORTH ARTHUR.—Tenders will be received by the city clerk until 6 o'clock p.m. of Monday, September 7th, 1908, for the work of strengthening Ray Lake Dam on Current River. J. McTeigue, City Clerk.

GANANOQUE.—Sealed tenders, addressed to W. Y. Boyd, Esq., chairman of waterworks, in care of the town clerk, Gananoque, Ont., will be received till 12 o'clock, noon, on Wednesday, September 9th, 1908, for the following: The laying of about 1,200 feet of 9-inch sewer pipe, average cut 10 feet, and the laying of about 1,200 feet of 4-inch cast iron pipe in same trench; also the necessary manholes, gate valves, fire hydrants, etc. All material to be furnished by the contractor. S. B. Code, Town Engineer.

NIAGARA FALLS.—Tenders for Niagara, Ont., Rifle Range, and addressed to the Secretary of the Militia Council, Department of Militia and Defence, Ottawa, will be received until noon, the 8th September proximo, for the construction of a Rifle Range at Niagara-on-the-Lake. E. F. Jarvis, Secretary, Department of Militia and Defence, Department of Militia and Defence.

ST. CATHARINES.—Tenders, addressed to the chairman of the committee on works, will be received by the city clerk until 12 o'clock, noon, on Tuesday, 8th September, 1908, for the construction of asphalt block pavements on Geneva Street and Church Street. D. Benzie, C.E., City Engineer.

Manitoba.

WINNIPEG.—Tenders for lock gates, St. Andrew's Rapids, Man., will be received at this office until 4 p.m. on Monday, September 14, 1908, for the construction of lock gates at St. Andrew's Rapids, Red River, Province of Manitoba. Plans and specifications can be seen at this Department; at the offices of Mr. A. R. Dufresne, resident engineer of the Department at Winnipeg; Mr. J. G. Sing, resident engineer, Confederation Life Building, Toronto. R. C. Desrochers, Assistant Secretary. Department of Public Works.

CONTRACTS AWARDED.

Nova Scotia.

WESTVILLE.—Messrs. McNeil were notified that they were the successful tenderers for about one thousand tons of bridge work, viz.: One 80-foot span over the Segas River; one span over Green River; one over Grand River; one over Baker River, and one over Four-Mile Brook. The latter is a thirteen-deck girder, spans carried on six towers, which are sixty feet high.

Quebec.

MONTREAL.—Mr. J. Bourque, of Hull, Que., has been awarded the contracts for the new Commercial High School. Contract price, $390,000.

Ontario.

FENWICK.—Contract for cement sidewalk was awarded to Marcus Ware, Fonthill, Ont., at 11¾ cents per square foot.

KINGSTON.—Six tenders for 1,200 tons of soft coal were received. That of James Swift & Co., offering 1,200 tons of Reynoldsville at $3.13 a ton, was accepted. The other tenders ran as high as $3.55, according to the quality of the coal tendered upon. The coal recommended by the superintendent would cost ten cents a ton more, and the committee did not feel like expending the extra amount of money for it. Last year $3.15 a ton for coal was paid by the Waterworks Committee.

NEW LISKEARD.—Sinclair & Smith, of New Liskeard, will erect a bridge across the Blanche River. Their tender is $5,000.

NORTH TORONTO.—Mr. C. H. Conery, of Guelph, has been awarded the contract for sidewalks at 13½ cents per square foot.

PARRY SOUND.—The Government awarded to Wm. Beatty, of this town, the contract for building the new registry office here and the addition to the jail.

TORONTO.—The Board of Control accepted the offer of Weddell & Co. to deposit the sand from the new western channel in Ashbridge's Bay for two cents per cubic yard.

TORONTO.—The contract for the magazine for the Militia Department, Toronto, was awarded to Anders Jordal, the price being $3,500.

Manitoba.

WINNIPEG.—The tenders for the new manhole castings were awarded by the Board of Control recently to the Vulcan Iron Works, and Peterson Brothers' Iron Works, who are both Winnipeg firms. Their tenders were equal and they will share the contract.

Saskatchewan.

MOOSE JAW.—The tender of Navin Bros., of Moose Jaw, for the construction of the collegiate institute was accepted, the figure being $93,713. There were six bids submitted for the construction of the building as follows: Navin Bros., $93,713; W. H. Ellis & Sons, Moose Jaw, $97,335; Smith Bros. & Wilson, Regina, $102,000; S. A. Covert, Moose Jaw, $107,850; Davidson Bros., Winnipeg, $108,000; Thos. Kelly, Winnipeg, $108,693; Carter Hall Co., Winnipeg, $108,875. Smith Bros. & Wilson submitted an alternative tender, allowing $6,000 reduction from $102,000 if Bedford stone were substituted for Tyndal stone preferred.

REGINA.—The contract for the construction of the line from Lumsden to Saskatoon has been awarded to J. S. Bartleman, of Regina, at the contract price of $79.75 per pole mile. The other tenders received were: Saskatchewan Telephone Co., Moose Jaw, $82.50 per mile; V. G. O'Brien & Co., Portage la Prairie, $120; Rural Construction Co., Regina, $98.75. The contract for the construction of the line from Regina to Antler has been awarded to the Saskatchewan Telephone Co., Moose Jaw, at the contract figure of $79.50 per pole mile. The other tenders were: Simpson Bros., Virden, Man., $82.50; V. G. O'Brien & Co., Portage la Prairie, $110.00; J. S. Bartleman, Regina, $79.75; Rural Construction Co., Regina, $98.75. These prices are for building only. The Government supplies all material.

Foreign.

NEW YORK.—The Atlas Portland Cement Co. has been awarded the contract to furnish 4,500,000 barrels of cement to the Isthmian Canal Commission at a cost of about $5,500,000, the largest single contract ever given out in the Portland cement business in its entire history. The cement is to be used on the Panama Canal, for which this company has already furnished upward of 100,000 barrels in the course of its construction to date. The Atlas Company was the lowest bidder throughout, American and foreign mills alike being underbid, and the award of the contract came as no surprise.

RAILWAYS—STEAM AND ELECTRIC.

Ontario.

PORTH ARTHUR.—Contractor McQuigge, of the Nepigon Construction Company, is in the city to-day from the works at the head of Lake Nepigon. Mr. McQuigge stated that the work on the contract would be rushed ahead much faster as soon as the tramway at Lake Nepigon is completed. The grading has been finished and some miles of steel laid. The work had been delayed considerably, however, by delay in the arrival of one of their locomotives. The engine was en route from the East but was travelling in slow stages. The work of building docks on Lake Nepigon for the purpose of handling the supplies is now completed.

WINDSOR.—The fifth of the ten double tubes necessary to finish the under-the-river portion of the Michigan Central ten million-dollar tunnel between Detroit and Windsor was successfully placed in position in the bed of the river to-day. The river proper portion of the tunnel is now half down. It is expected that at least two more tubes will be put down before running ice or cold weather compels suspension of work on this section of the tunnel. The sub-marine section is 2,600 feet in length. The open cut and approaches to the river section on both sides of the river measures about 13,000 feet, making the total length approximately two and a half miles. Unless unforeseen obstacles arise, Buller Bros. & Hoff, the contractors, expect to complete their work by June, 1909.

Manitoba.

WINNIPEG.—The Chicago & Milwaukee Railroad is negotiating for running rights into Winnipeg, via the Duluth & Rainy River Road and the C.N.R. The company has, however, secured options on suitable terminal property, and when the deal is complete will clip fifty miles off the present distance to Chicago.

WINNIPEG.—After repeated trial with concrete pile for the Fort Garry station, it has been decided that they are unsuited for the conditions prevailing here. The ground work will be built on timber piles, and the change of construction methods will be at once instituted.

WINNIPEG.—The J. D. McArthur Company will commence work on the eighteen-stall round house, which is to be erected at the Grand Trunk shops site on the Springfield road. A large gang of men will be put to work on the excavations, and it is expected to have the spacious building completed before next winter. The roundhouse is to be erected near the centre of the property, and the shops, which are to be built later, will be in the same vicinity.

Alberta.

EDMONTON.—A by-law authorizing the purchase of the charter of the Strathcona Radial Tramway Company for $10,000 and the raising by debentures of $135,000 to put the entire street car system in operation was all but unanimously endorsed by the ratepayers yesterday. The vote was very small, standing 710 for and 7 against, but the lack of interest was the strongest evidence of approval of the citizens, who made practically no opposition.

British Columbia.

VANCOUVER.—Messrs. Cleveland & Dutcher, civil engineers, have been appointed by the council of the municipality of Point Grey to make an examination of the district for the purpose of recommending what tramway extensions shall be made in the future.

TELEPHONY.

Ontario.

BRANTFORD.—The Bell Telephone Company is making rapid headway laying its conduits on the city street.

PALMERSTON.—The line material for the Hawthorn Hill Rural Telephone line has arrived and a number of the poles are in the ground and the work of wiring and making connections will be commenced right away.

WALLACE.—The East Wallace Telephone Line has been completed from Listowel to Wallaceville. The line is controlled by the Bell Telephone Company.

Saskatchewan.

LUMSDEN.—To fill in the gap between Regina and Lumsden on the north arrangements have been made with the Bell Company by the Government, by which that company will string a No. 10 copper wire between these two points.

REGINA.—The Provincial Department of Railways, Telegraphs and Telephones has lost no time since its organization in preparing to give effect to the policy of the Government in regard to the construction of a complete telephone system for the province. The Government's telephone legislation only became law two months ago, yet already contracts have been let for the construction of 400 miles of long distance trunk lines, all the necessary poles, wire and other materials for these, also for additional lines have been ordered, and scores of rural companies are in process of organization throughout the province.

LIGHT, HEAT, AND POWER.

Ontario.

TORONTO.—In spite of the opinion that Toronto's position in respect to the power contract with the Hydro-Electric Commission was unassailable, two injunctions were asked for at Osgoode Hall, and now the big legal fight over power, of which there have been rumblings in parts of the Province, has at last reached this city. In a sentence, it is claimed in the writs that the city council had no authority to enter into any contract with the Commission, and it is sought to restrain any action on the by-law.

WELLAND.—Gainsboro' is objecing to the Hydro-Electric power line going through the township on the highways, principally because they will have to take eight feet off the roadway and eight feet of private ground. This will make it necessary to cut down the trees. It is claimed that being a commercial enterprise the line should buy the right-of-way.

Manitoba.

BOISSEVAIN.—The town of Boissevain contemplates installing an up-to-date light plant, and have appointed W. E. Skinner, electrical engineer, Winnipeg, to look after the work.

WINNIPEG.—The largest contract for Nernst electric lamps ever awarded in Western Canada has been let to W. E Skinner & Co. for the lighting of the new Grain Exchange Building, Winnipeg.

RECENT FIRE

Ontario.

SAULT STE. MARIE.—Fire at Lake Superior Corporation yards resulted in a loss of about $100,000. It started in the lumber yards near the sawmill and destroyed about 3,500,000 feet, estimated to cost $30 per thousand. The lumber was owned by Miller & McCool, the Algoma Commercial Co., and the Saginaw Lumber Co.

MISCELLANEOUS.

New Brunswick.

WOODSTOCK.—Mr. C. LeBaron Miles, C.E., has started out in charge of a party of eight men to make a survey of the river between Woodstock and Hawkshaw. There has never been a survey made of the river between the above points, and the present work is being done for the purpose of getting at the cost of dredging. It will probably take two months to complete the work.

Ontario.

BRANTFORD.—The city council has been deadlocked for some time on the street paving issue. This has now been broken, and the by-law providing for advertising an extension of the work now in progress has been passed. The majority of the aldermen objected to the policy of giving all the work, involving an expenditure of $150,000, to the Warren Bitulithic Co., thus killing competition from other companies. This company is laying the pavement on Dalhousie and George Streets. Hence the by-law will be advertised as providing only for "permanent" pavement and not bitulithic. It is claimed by some that this is illegal, as the paving material must be specified. An effort may be made to upset the by-law on that ground. To-night the council deputation leaves for Chicago and Indiana to inspect pavements there as guests of the Westrumite Co.

NORTH BAY.—Mr. Geo. W Volckman, representing a company of canal and dock builders, was in this city last week and left for a ten days' inspection of the French River, beginning at the Big Chaudiere. In October, he is to inspect the proposed cut on the Georgian Bay Canal between Lake Nipissing and Trout Lake, starting in at the McMurray property.

SEWERAGE AND WATERWORKS.

Ontario.

WESTON.—At the next municipal election Weston will submit to a vote a proposition to install waterworks. In the meantime they will secure an expert to report on the matter.

PERSONAL.

MR. JAMES HUNTER has been made Deputy Minister of Public Works, Ottawa, Can.

Mr. H. H. BREWER has been appointed to the position of general superintendent of the C.P.R. at Winnipeg, Man.

MR. R. E. W. HAGARTY, B.A. Sc., of Toronto, has just returned from a three months' trip to the Alaska gold fields.

MR. W. C. C. MEHAN has been appointed superintendent of the G.T.P. Railway, effective September 1, 1908, with headquarters at Melville, Sask.

Mr. W. G. BROWNLEE, General Superintendent of Transportation for the Grand Trunk Railway, has been Pacific Railway. Mr. Brownlee's new headquarters will be at Winnipeg.

MR. ALBERT MARSHALL announces that he has recently severed his connection with the engineering department of the Holophane Co. and has associated himself in the capacity of chief consulting and designing illuminating engineer with the Bureau of Illuminating Engineering, 437 Fifth Avenue, New York City.

MR. E. H. BECKLER, one of the best known civil and construction engineers in the United States, dropped dead at the West Tunnel camp of the St. Paul Pass, near Taft, aged fifty-two years. Under the direction of Mr. Beckler the Pacific extension of the Great Northern Railroad was constructed. Mr. Beckler was born at Livermore Centre, Me., and was a graduate of the University of Maine.

NOVEL ADVERTISING.

The following circular letter has been sent by the Toronto Fire Brick Co. to the city and town engineers of the Province, and demonstrates that they have no reason to fear the merits of their product being investigated:—

The City Engineer:—

We take pleasure in calling your attention to samples of our drain tile, sent to-day by express addressed to you. We have also written to His Worship the Mayor, the Town Clerk, and the chairman of your Works Committee.

Our reason for apparently repeating the same matter to different officials is that experience has shown, according to reports of investigations, that many communications of importance addressed to one civic official (of course, not of your corporation) have not reached their proper destination at the right time. There may have been a plausible explanation, and there may not.

We are acting on the supposition that lightning does not frequently strike four points in the same town on the same day, and by calling the attention of four of your officials to the entirely exceptional strength of our drain tile we feel reasonably confident that its merits will at least be looked into by someone.

The permanency of expensive roadways is undoubtedly the greatest element involved, and authorities have declared that a very frequent cause of defective roadways and pavements is weak drain tile used in their construction. In view of this undoubted fact is it not the worst kind of economy to have a poor article used when you can have the best at a mere fraction more?

If you agree with us, do justice to yourselves and the taxpayers you represent by investigating the merits of Mimico drain tile. That will be enough to satisfy us, and we think to satisfy all but those who manufacture or make a profit out of inferior material.

Our prices are reasonable—but inferior tile is sold lower.

In order to prevent a municipality being "held up" by a contractor (if the best drain tile is specified) we will ship to any corporation our tile in assorted sizes of 2½, 3, 4, 5, 6, 7, 8-inch, one carload or more, at the same price contractors would have to pay.

We can make immediate shipment—and as to the condition of the tile on arriving at its destination? Note the way our samples were shipped—four tile, one inside the other, with a quarter-inch rope holding them together. Is it a fair test?

Accompanying the sample of drain tile we are sending samples of our Mimico red pressed brick and light and dark "panel flashed." They have been used in municipal buildings with excellent effect, and have given entire satisfaction Tests of them made by the University of Toronto, School of Practical Science and Engineering have shown them to have a maximum compression strength of 4,320 pounds to the square inch—35 per cent. higher than the highest test of samples from the three other principal pressed brick yards in and nearest Toronto.

Enquiries are solicited, and will receive prompt reply.

Yours respectfully,
The Toronto Fire Brick Co.
134 Confederation Life Building.

MARKET CONDITIONS.

Montreal, September 2nd, 1908.

The American pig iron markets continue very flat. Consumers hesitate about buying; yet it is said that a somewhat heavier volume of business is moving now than for a long time past. It is reported that Southern furnaces have been well sold up, particularly as their output has been considerably reduced on account of the coal strike, which is necessitating limited operations. The output, however, continues fair and prices are generally regarded as a shade firmer. Northern and Eastern furnaces are finding business very quiet and there is, if anything, a weaker tendency, particularly in steel-making grades. On special lots, for prompt delivery, customary prices are being shaded to the extent of $1.50 to $2 per ton. This, however, cannot be taken as indicating any change in the situation. In finished material, there seems to be a somewhat better feeling, more especially for plates, sheets and steel bars. There is a very considerable tonnage in rails and structural material in prospect, but the continued financial depression prevents the actual placing of orders. On the whole, the situation seems to be slightly improved, whereas it was hoped that by this time a very great improvement would have taken place.

The English market continues to labor under adverse conditions. Consumers are still following the hand-to-mouth policy, both in Great Britain and on the Continent. Notwithstanding this, however, prices hold quite firm, especially those for Cleveland warrants. Stocks in store show a slight increase, but not sufficient to in any way effect the situation, the quantity reported being still under 55,000 tons.

The local market shows but little change. There are a few inquiries and a little business is moving. There is always a fair tonnage of import iron being bought for mixing purposes, but, in a general way, the most of the orders for pig are going to Canadian furnaces.

So far as prices are concerned, practically no change is observed in pig, Canadian furnaces still being the lowest. In the matter of finished and partly finished iron and steel products, no change is reported, but building material, including building paper of all kinds, roofing and tar and pitch may be had at a discount of probably 25 per cent., on an average, as compared with prices of last spring.

Antimony.—The market is firmer, at 9½ to 10c.

Bar Iron and Steel.—Prices are steady all round, and trade is decidedly dull. Bar iron, $1.90 per 100 pounds; best refined horseshoe, $2.15; forged iron, $2.05; mild steel, $1.90; sleigh shoe steel, $1.90 for 1 x ⅜-base; tire steel, $1.95 for 1 x ⅜-base; toe calk steel, $2.40; machine steel, iron finish, $2.

Boiler Tubes.—The market is steady, quotations being as follows:—2-inch tubes, 8½c.; 2½-inch, 10c.; 3-inch, 11½c.; 3½-inch, 14¾c.; 4-inch, 19c.

A new invention that is capable of converting ordinary German felt into a very tough material that is almost indestructible is likely to revolutionize the boat-building industry. The new material will take the place of cedar for canoes; and rowboats and launches covered with it are greatly enhanced in floatability and non-leakableness. It is absolutely impervious to water and consequently will not swell or shrink, and, therefore, will not part at the seams, of which there will be fewer in number.

Building Paper.—Tar paper, 7, 10, or 16 ounce, $1.50 per 100 pounds; felt paper, $2.25 per 100 pounds; tar sheathing, No. 1, 50c. per roll of 400 square feet; No. 2, 35c.; dry sheathing, No. 1, 40c. per roll of 400 square feet, No. 2, 26c. (See also Roofing.)

Cement—Canadian and American.—Canadian cement, $1.65 to $1.75 per barrel, in cotton bags, and $1.90 and $2.05 in wood, weights in both cases 350 pounds. There are four bags of 87½ pounds each, net, tc a barrel, and 10 cents must be added to the above prices for each bag. Bags in good condition are purchased at 10 cents each. Where paper bags are wanted instead of cotton, the charge is 2½ cents for each, or 10 cents per barrel weight. American cement, standard brands, f.o.b. mills, 85c. per 350 pounds; bags extra, 10c. each, and returnable in good condition at 7½c. each.

Cement—English and European.—English cement is steady at $1.70 to $1.90 per barrel in jute sacks of 82½ pounds each (including price of sacks) and $2 to $2.20 in wood, per 350 pounds, gross. Belgian cement is quoted at $1.75 to $1.85 per barrel in bags, and $2.05 to $2.2c per barrel, in wood.

Copper.—The market is steady at 14¼ to 14½c. per pound. Demand continues limited.

Explosives and Accessories.—Dynamite, 50-lb cases, 40 per cent. proof, 18c. in single case lots, Montreal. Blasting powder, 25-lb kegs, $2.25 per keg. Special quotations on large lots of dynamite and powder. Detonator caps, case lots, containing 10,000, 75c. per 100; broken lots, $1. Electric blasting apparatus:—Batteries, 1 to 10 holes, $15; 1 to 20 holes, $25; 1 to 30 holes, $35; 1 to 40 holes, $50. Wire, leading, 1c. per foot; connecting, 50c. per lb. Fuses, platinum, single strength, per 100 fuses:—4-ft. wires, $3.50; 6-ft. wires, $4; 8-ft. wires, $4.50; 10-ft. wires, $5. Double strength fuses, $1 extra, per 100 fuses. Fuses, time, double-tape, $6 per 1,000 feet.

Iron.—Prices continue steady, pig iron now arriving being as follows for carload lots, on cars, on dock, Montreal; for larger lots, lower prices would be taken: No. 1 Summerlee, $19.50 to $20 per ton; No. 2 selected Summerlee, $19 to $19.50; No. 3, soft, $18.50 to $19; Cleveland, $18.50; and No. 3 Clarence, $18; Carron, special, $19.50 to $20; Carron, soft, $18.50 to $19.

Lead.—Trail lead is weak, but prices hold steady, at $3.60 to $3.70 per 100 pounds, ex-store.

Nails.—Demand for nails is moderate, but prices are steady at $2.30 per keg for cut, and $2.25 for wire, base prices.

Pipe—Cast Iron.—Small sizes of pipe are in good demand and prices are steady: $33 for 8-inch pipe and larger; $34 for 6-inch pipe; $34 for 5-inch, and $34 for 4-inch at the foundry. Pipe, specials, $3.10 per 100 pounds. Gas pipe is quoted at about $1 more than the above.

Pipe—Wrought.—The market is quiet and steady at last week's range:—¼-inch, $5.50, with forty-eight per cent. off for black, and 48 per cent. off for galvanized; ⅜-inch, $5.50, with 59 per cent. off for black and 44 per cent. off for galvanized. The discount on the following is 69 per cent. off for black and 59 per cent. off for galvanized; ½-inch, $8.50; 1-inch, $16.50; 1¼-inch, $22.50; 1½-inch, $27; 2-inch, $36; and 3-inch, $75.50; 3½-inch, $95; 4-inch, $108.

Roofing.—Ready roofing, two-ply, 60c. per roll; three-ply, 80c. per roll of 100 square feet. (See also Building Paper.)

Spikes.—Railway spikes are in dull demand and prices are lower at $2.40 per 100 pounds, base of 5½ x 9-16. Ship spikes are also dull and steady at $3 per 100 pounds, base of ⅝ x 10-inch and ⅝ x 12-inch.

TENDERS CALLED FOR

NOTICE TO CONTRACTORS.

Sealed Tenders addressed to the undersigned, and endorsed "Tender for Lock Gates, St. Andrew's Rapids, Man.," will be received at his office until 4 p.m., on Monday, September 14, 1908, for the construction of Lock Gates at St. Andrew's Rapids, Red River, Province of Manitoba.

Plans and specifications can be seen at this Department; at the offices of Mr. A. R. Dufresne, Resident Engineer of the Department at Winnipeg; Mr. J. G. Sing, Resident Engineer, Confederation Life Building, Toronto; Mr. C. Desjardins, Clerk of Works, Post Office, Montreal, and Mr. Ph. Beland, Clerk of Works, Post Office, Quebec. Forms of tender can also be obtained at the above mentioned places.

Persons tendering are notified that tenders will not be considered unless made on the printed form supplied, and signed with their actual signatures.

The contractor will be required to conform to regulations to be made by the Governor-General-in-Council, respecting the accommodation, medical treatment and sanitary protection of the working men employed on the work.

Each tender must be accompanied by an accepted cheque on a chartered bank, made payable to the order of the Honourable the Minister of Public Works, equal to ten per cent. (10 per cent.) of the amount of the tender, which will be forfeited if the person tendering decline to enter into a contract when called upon to do so, or fail to complete the work contracted for. If the tender be not accepted the cheque will be returned.

The Department does not bind itself to accept the lowest or any tender.

By order,
R. C. DESROCHERS, Asst. Sec.

Department of Public Works,
Ottawa, August 13, 1908.

Newspapers will not be paid for this advertisement if they insert it without authority from the Department.

Toronto, September 3rd, 1908.

The following are wholesale prices for Toronto, where not otherwise explained, although for broken quantities higher prices are quoted:—

Antimony.—Dull and unchanged. We quote: 8¾c.

Bar Iron.—$1.95 base, from stock to the wholesale dealer.

Boiler Plates.—¼-inch and heavier, $2.40. Fair supply, prices weaker. Boiler heads 25c. per 100 pounds advance on plate.

Boiler Tubes.—Demand limited. Lap-welded, steel, 1¼-inch, 10c.; 1½-inch, 9c. per foot; 2-inch, $8.50; 2¼-inch, $10; 2½-inch, $10.60; 3-inch, $12.10; 3½-inch, $15.30; 4-inch, $19.45 per 100 feet.

Building Paper.—Plain, 30c. per roll; tarred, 40c. per roll. Decidedly more active.

Bricks.—Common structural, $9 to $10 per thousand, wholesale, and the demand is still active. Red and buff pressed are worth, delivered, $18; at works, $17.

Cement.—Market still weak, and we have heard of a sale of 1,000 barrels at less than $1.50. Some mills are still closed, while some are busy on contracts. We quote: 1,000 barrel lots at $1.95 per barrel, including the bags, which is equal to $1.55 to $1.60 without bags.

Coal Tar.—In improved request; $3.50 per barrel the ruling price.

Copper, Ingot.—More inquiry; prices unchanged, at 14 to 14½c. here.

Detonator Caps,—75c. to $1 per 100; case lots, 75c. per 100; broken quantities, $1.

Dynamite, per pound, 21 to 25c., as to quantity.

Roofing Felt.—There is much more demand and a better feeling. Price $1.80 per 100 pounds.

Fire Bricks.—English and Scotch, $32.50 to $35; American, $28.50 to $35 per 1,000. Demand continues fair.

Fuses—Electric Blasting.—Double strength, per 100, 4 feet, $4.50; 6 feet, $5; 8 feet, $5.50; 10 feet, $6. Single strength, 4 feet, $3.50; 6 feet, $4; 8 feet, $4.50; 10 feet, $5. Bennett's double tape fuse, $6 per 1,000 feet.

Galvanized Sheets—Apollo Brand.—Sheets 6 or 8 feet long, 30 or 36 inches wide; 10-gauge, $3.05; 12-14-gauge, $3.15; 16, 18, 20, $3.35; 22-24, $3.50; 26, $3.75; 28, $4.20; 29 or 10¾, $4.50 per 100 pounds. Fleur de Lis—28-gauge, $4.30; 26-gauge, $4.05; 22-24-gauge, $3.50. Queen's Head—28-gauge, $4.50; 26 gauge, $4.25; 22-24-gauge, $3.70. A good business being done.

Iron Pipe.—Black, ¼-inch, $2.03; ⅜-inch, $2.25; ¾-inch, $2.63; ¾-inch $3.56; 1-inch, $5.11; 1¼-inch, $6.97; 1½-inch, $8.37; 2-inch, $11.16; 2½-inch, $17.82; 3-inch, $23.40; 3½-inch, $29.45; 4-inch, $33.48; 4½-inch, $38, 5-inch, $43.50; 6-inch, $56. Galvanized, ¼-inch, $2.86; ⅜-inch, $3.08; ½-inch, $3.48; ¾-inch, $4.71; 1-inch, $6.76; 1¼-inch, $9.22; 1½-inch, $11.07; 2-inch, $14.76. The supply on hand is fair.

Lead.—Not much doing; price,, $3.90.

Lime.—In adequate supply and moderate movement. Price for large lots at kilns outside city 21c. per 100 lbs. f.o.b. cars; Toronto retail price 35c. per 100 lbs. f.o.b. car

Lumber.—Dressing pine we quote $32 to $35 per thousand for usual lengths (12, 14, and 16 ft.), and stock sizes of boards, and $38 to $40 for special lengths, common stock boards, as to grade, $24 to $28; culls, $20. No large stocks of pine at present in Toronto. Southern pine has advanced $3 per thousand in primary markets; Norway pine continues easier with considerable stock moving. Hemlock is also active, with

TENDERS FOR TRANSFORMER STATION EQUIPMENT

TENDERS will be received until 6 p.m. Monday, 28th September, 1908: (a) For the supply and erection of 63,500 Volt Single-Phase or 110,000 Volt Three-Phase Transformers for operation on the Commission's 110,000 Volt Transmission System; (b) for the manufacture, supply and erection, complete, of the Switching and Indicating Apparatus for the 110,000 Volt Transformer Stations. Apparatus is required for the following high tension transformer stations: Niagara Falls Step-up Transformer Station, Toronto, London, Dundas, Guelph, Preston, Berlin, Stratford, St. Mary's, Woodstock, Brantford, and St. Thomas Step-down Transformer Stations; all according to plans and specifications to be obtained at the Commission's Office, Continental Life Building, Toronto. Accepted cheques on chartered banks for amounts specified in "Instructions to Bidders" must accompany each Tender for the work. These cheques will be forfeited providing the Tenderer declines to enter into a contract after due notice by the Commission.

The lowest or any Tender not necessarily accepted.

Tenders must be sealed and addressed:

HON. ADAM BECK,
Chairman Hydro-Electric
Power Commission of Ontario,
Toronto, Ont.

Newspapers inserting this advertisement without authority from the Commission, will not be paid for it.

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an easy feeling. British Columbia shingles have advanced to $3.20, and another advance is looked for, the supply is not large, and they came forward slowly. Spruce flooring is worth $25. Lath are somewhat firmer.

Nails.—Wire, $2.55 base; cut, $2.70; spikes, $3.

Pitch.—An active trade at 70c. per 100 pounds. Stock reduced and the feeling much firmer.

Pig Iron.—More demand can be reported; prices likely to advance. Clarence quotes at $19.50 for No. 3; Cleveland, $19.50 to $20; in Canadian pig, Hamilton quotes $19.50 to $20.00.

Steel Beams and Channels.—Quiet. We quote:—$2.50 to $2.75, according to size and quantity; if cut, $2.75 to $3; angles, 1¼ by 3-16 and larger, $2.50; tees, $2.80 to $3 per 100 pounds. Extra for smaller sizes of angles and tees.

Steel Rails.—80-lb., $35 to $38 per ton. The following are prices per gross ton; Montreal, 12-lb. $45, 16-lb. $44, 25 and 30-lb. $43.

Sheet Steel.—There are some signs of weakness in the lower numbers, but we quote: 10-gauge, $2.50; 12-gauge, $2.55; American Bessemer, 14-gauge, $2.35; 17, 18, and 20-gauge, $2.45; 22 and 24-gauge, $2.50; 26-gauge, $2.65; 28-gauge, $2.85.

Tool Steel.—Jowett's special pink label, 10½c. Cyclops, 18c.

Tank Plate.—3-16-inch, $2.50.

Tin.—Moderate movement; price still 32 to 32½c.

Zinc.—Business of good volume and prices tending upwards. Price here $4.90 to $5.

* * * *

Winnipeg, September 1st, 1908.

The quotations on local market are as follows:

Anvils.—Per pound, 10 to 12½c.; Buckworth anvils, 80 lbs., and up, 10¼c.; anvil and vise combined, each, $5.50.

Bar Iron.—$2.50 to $2.60.

Beams and Channels.—$3 to $3.25 per 100 up to 15-inch.

Building Paper.—4½ to 7c. per pound. No. 1 tarred, 84c. per roll; plain, 60c.; No. 2 tarred, 62½c.; plain, 56c

Bricks.—$11, $12, $13 per 1,000, three grades.

Cement.—$2.65 to $2.75 per barrel.

Chain.—Coil, proof, ¼-inch, $7; 5-16-inch, $5.50; ⅜-inch, $4.90; 7-16-inch, $4.75; ½-inch, $4.40; ⅝-inch, $4.20; ¾-inch, $4.05; logging chain, 5-16-inch, $6.50; ⅜-inch, $6; ¼-inch, $8.50; jack iron, single, per dozen yards 15c. to 75c.; double, 25c. to $1; trace-chains, per dozen, $5.25 to $6.

Iron.—Swedish iron, 100 lbs., $4.75 base; sheet, black, 14 to 22 gauge, $3.75; 24-gauge, $3.90; 26-gauge, $4; 28-gauge, $4.10. Galvanized—American, 18 to 20-gauge, $4.40; 22 to 24-gauge, $4.65; 26-gauge, $4.65; 28-gauge, $4.90; 30-gauge, $5.15 per 100 lbs. Queen's Head, 22 to 24-gauge, $4.65; 26-gauge English or 30-gauge American, $4.90; 30-gauge American, $5.15; Fleur de Lis, 22 to 24-gauge, $4.50; 28-gauge American, $4.75; 30-gauge American, $5.

Pipe.—Iron, black, per 100 feet, ¼-inch, $2.50; ⅜-inch, $2.80; ½-inch, $3.40; ¾-inch, $4.60; 1-inch, $6.60; 1¼-inch, $9; 1½-inch, $10.75; 2-inch, $14.40; galvanized, ½-inch, $4.25; ¾-inch, $5.75; 1-inch, $8.35; 1¼-inch, $11.35; 1½-inch, $13.60; 2-inch, $18.10. Lead, 6½c. per lb.

Pitch.—Pine, $6.50 per barrel; in less than barrel lots, 4c. per lb.; roofing pitch, $1. per cwt.

Dynamite.—$11 to $13 per case.

Roofing Paper.—60 to 67½c. per roll.

Nails.—$4 to $4.25 per 100. Wire base, $2.85; cut base, $2.90.

Tool Steel.—8½ to 15c. per pound.

Lumber.—No. 1 pine, spruce, tamarac, British Columbia fir and cedar—2 x 4, 2 x 6, 2 x 8, 8 to 16 feet, $27.25, 2 x 20 up to 32 feet, $38.

Timber.—Rough, 8 x 2 to 14 x 16 up to 32 feet, $34; 6 x 20, 8 x 20 up to 32 feet, $38; dressed, $37.50 to $48.25.

Boards.—Common pine, 8-inch to 12-inch wide, $38 to $45; siding, No. 2 white pine, 6-inch, $55; cull red or white pine or spruce, 6-inch, $24; No. 1 clear cedar, 6-inch, 8 to 16 ft., $60; Nos. 1 and 2 British Columbia spruce, 6-inch, $55; No. 3, $45.

Flooring.—No. 2 red pine, 4-inch, $43; No. 3 red, 4-inch, $38; No. 4 red and white pine or spruce, 4-inch $28; ceiling, No. 2 white pine, 4, 5, and 6-inch, $55; No. 3 red pine, $38.

Lath.—No. 1 red and white pine mixed, $5.50; No. 2, $4.75.

Shingles.—No 1 British Columbia cedar, $4.25; No. 2, $3.75; band sawn, $6.