PAGES

MISSING

Volume 21. Toronto, September 14, 1911 Contents of this issue on page 315

The Canadian Engineer

An Engineering Weekly.

THE EARNING POWER OF CHEMISTRY.

Mr. Arthur D. Little, in an address to the Indiana Section of the American Chemical Society, brought to that body's notice the industrial importance of the above subject, and remarked, the world, as viewed by the chemist, presents an aspect different in many ways from that in which it appears to the mind not chemically trained. As the astronomer perceives in the movements of the stars a relationship and coördination to which the average man is blind, and deduces from them generalizations by which both the intellectual and practical life of the community are profoundly influenced, so the chemist, who may be regarded as the astronomer of the infinitely minute, studies the movements and interchange of atoms and the structure of the molecular systems which result therefrom. In other words, the astronomer interprets the universe in terms of certain units, which are the heavenly bodies, while the chemist seeks his interpretation in terms of the ultimate particles of which matter is composed, whether they be molecules, atoms, ions or electrons. And, since the different forms of matter, in their flux and flow, together constitute the universe, the properties of matter and the changes which these properties undergo are of compelling interest and importance to each one of us in every activity of our lives.

Modern chemistry had its birth in the eighteenth century study of the air and its relation to the processes of respiration and combustion. Prof. Ramsay has said that "To tell the story of the development of men's ideas regarding the nature of atmospheric air is in great part to write a history of chemistry and physics."

Raleigh and other chemists have disclosed the presence in the air we breathe of five new gases of remarkable and in some respects unique properties. To one of these, neon, we now confidently attribute the long mysterious phenomena of the aurora borealis. Tubes containing highly rarefied neon may become as commonplace to our descendants as candles were to our forefathers. They glow with a rich, mellow, golden light on the passage through them of an electrical discharge.

The heavy toll of life in mine disasters would be unsupportably heavier were it not for the Davy lamp, the fire-damp indicators, the rescue outfits and the regulation of explosives, all of which have become possible only through the growth of chemical knowledge. Ventilating systems as applied to theatres, halls and dwellings are based on chemical studies of the rates and causes of increase in the carbonic acid content in the air of rooms. The proportion of sulphur permissible by law in illuminating gas finds its justification in similar studies on the air in rooms in which such sulphur-bearing gas is burned.

The chemical and biological study of public water supplies, which received its first systematic development little more than twenty years ago at the hands of Drown and Mrs. Richards in the laboratories of the Massachusetts Institute of Technology, has been the means of saving countless lives throughout the world and has led to such understanding and made possible such control of sources of pollution. Furthermore it supplies the means for correcting undesirable characteristics in a water supply as by use of filtration apparatus, coagulants, water-softening systems and the Moore method for the destruction of the algae which in many waters are the cause of unpleasant tastes and odors.

Nowhere is the practical value of chemistry in its relation to the affairs of every-day life more strikingly demonstrated than in connection with our food supply. Chemical fertilizers are in large and constantly increasing measure responsible for the enormous total of our agricultural products. The whole fertilizer business is under the strictest chemical control, and the farmer buys his fertilizer on the basis of a knowledge of its composition and effective value.

But it is not only on the side of agriculture that chemistry touches our food supply. Chemistry pervades the packing industry, reducing the cost of food by utilization of by-products of the most varied character from oleomargarine to glycerine and soap and from soap to pepsin and adrenalin. To Atwater and his co-workers we owe our knowledge of the energy-producing value of different foods in the human economy and to Wiley and those other chemists behind him on the firing line we are indebted for the far-reaching benefits of the Pure Food Law.

Carbon disulphide made in the Taylor electric furnace has preserved the wine industry of France by destroying the phylloxera as it is ridding our own fields of prairie dogs and our elevators of rats and mice. Breadmaking and brewing are coming each year more and more within the recognized domain of chemistry, which is at the same time greatly enhancing the value of our staple crop by the increasing production of glucose, corn oil and gluten. Exactly one hundred years ago Kirchhof discovered the inversion of starch to glucose by dilute acids. To-day the United States alone is richer by $30,000,000 a year by reason of that discovery.

The woolen industries are dependent upon chemistry for the processes of separating the pure fibre from the grease and dirt from which it is associated in the raw wool, and for the methods of working up this wool waste into oleic acid, soap, lubricating oils and potash and ammonia salts, as well as for the process of carbonizing by which the wool is separated from the burs and other vegetable material with which it is admixed in the fleece.

The refining of petroleum involved the solution of many difficult chemical problems. The Chicago fire is said to have been started by Mrs. O'Leary's cow which kicked over a kerosene lamp. In those days, however, it was not necessary to invoke the cow to start a conflagration with kerosene. Much of the lighting oil upon the market at that time would flash below 100° F. We owe our present safety in the use of kerosene largely to the work of Prof. Chandler.

The production of illuminating gas is wholly a chemical process. When coal gas was first employed for lighting the Houses of Parliament the members might be seen gingerly touching the pipes to discover if they were not indeed hot from carrying such flame. That gas is now so cheap is due in large part to the development by Lowe of the chemical process for making water gas by passing steam through a bed of glowing coals and to the chemical processes for gas enrichment. By the Blaugas system illuminating gas is now produced in liquid form and distributed in steel bottles to isolated consumers like so much kerosene.

The gas mantle by which the illuminating power of gas is raised from 16 to 60 candles on a consumption of 3½ feet an hour constitutes one of the most signal triumphs of chemical research. Certain sands found in Brazil and known as monazite sands had long been a happy hunting ground for chemists by reason of the number of rare metallic elements to be found therein. They seemed to be a sort of chemical garret where everything not otherwise used up during the process of creation had been stowed. Dr. Carl von Welsbach was investigating the rare elements in these sands some thirty years ago and studying their spectra. It occurred to him that a better flame for his purpose, or rather a better distribution of the metallic vapor in the ordinary Bunsen flame might be secured by distributing the metallic compound through the substance of a bit of cambric. He dipped the cambric in a solution of the salts, suspended it in the flame, burned off the cotton, and found that the fragile ash glowed with an amazing brilliance. So came into being the gas mantle which has revolutionized and saved the illuminating gas industry, though not until the initial discovery had been followed by years of the most painstaking and refined research.

A large pulp mill found itself with over 100,000 cords of peeled wood piled in its yard and this wood was beginning to rot. A few thousand gallons of sulphite liquor sprayed over the pile from a garden hose killed the fungus and saved the pile. The same mill was losing 23 per cent. of its wood as barker waste. Laboratory trials proved that an excellent quality of paper could be made from this waste, all of which in this mill is now profitably worked up. Other mills still throw 20 per cent. or more of their initial raw material away. The mill was cooking in 16 hours. Laboratory cooks were made in 7½ hours and the time of the mill cook reduced to 10. Finally, by a proper spacing of the digesters, the production of the plant was brought from 97 tons a day to 149 tons.

Cylinder oils generally cost about what you are accustomed to pay. Plants which employ a chemist pay from 19-27 cents. Manufacturers who do not need a chemist commonly pay 45 cents, 65 cents or even, if they know their own business very well, $1.50 a gallon. There is probably not a large plant in the country in which, if it is not already under chemical control, the lubrication account cannot be cut in two. In the engine room of one large cement plant the average monthly cost for lubricants had been $337.00. It is now $30.00. A concern paying 37 cents a pound for a special grease which the superintendent needed to run the mill now buys on speculation for 5½ cents, and the mill still runs.

Chemistry points out the only proper way to buy supplies which is on the basis of their industrial efficiency by means of defining the quality desired and rigid test to make sure that quality is secured. Independent estimates by those in position to know, place the efficiency value of supplies as purchased and used by United States manufacturers at 60% of what it should be.

Many manufacturers fail to realize that in buying coal they are in reality buying heat, and in many instances they pay for slate and sulphur with no knowledge of the actual number of B. T. U. they are receiving for one dollar.

Important as are the losses in the initial purchase of coal, they are small compared with those which attend its burning. Many a mill owner looks out of the window and sees, without knowing, his dividends go up the chimney. Under well regulated conditions of combustion the flue gases should contain not less than 12 per cent. of carbonic acid gas. They frequently contain no more than 3 per cent. This means that for every ton of coal burned under the latter conditions more than 52 tons of excess air are heated to the high temperature of the flue gases. Chemistry meets these conditions by analyzing the flue gases and regulating the draft as indicated by the percentage of carbonic acid found. At $2.25 a ton, which is much below the average price, the fuel bill of the United States was over $1,000,000,000 in 1910. Of that amount chemistry could easily have saved $100,000,000.

Chemistry aids the manufacturer who will listen to her teachings in countless other ways. It substitutes a rigid control of processes for the guesswork and uncertainty of the rule of thumb. It increases the productivity of labor by supplying more efficient processes.

"The United States is the most wasteful nation in the world; wasteful in living, wasteful in manufacturing, and wasteful in conserving its natural resources." So heedless and appalling is this waste that the mind trained in chemistry stands aghast. I have lately visited a southern lumber mill which burns 1,900 cords of wood a day in its incinerator. There are two hundred such burners in the country limited in destructiveness only by the amount of material sent to them. From such wood chemistry is prepared to extract three gallons of turpentine a cord, 10 gallons of ethyl alcohol, or paper pulp to the value of $20. We waste each year 500,000,000 tons of coal and each day a billion feet of natural gas. With peat deposits fringing our entire eastern coast we pay $4 a ton for coal delivered on the bog. Beehive coke ovens flame for miles in Pennsylvania and excite no comment while the burning of a $1,000 house would draw a mob. We fill the Merrimac River with wool grease making it a stench, while the towns along its course buy soap and fertilizer and lubricants from Chicago, Chili and Pennsylvania. We burn coal-tar in Massachusetts and import coal-tar colors at high prices from Germany. Over the great North-west we burn each year 5,000,000 tons of flax straw while we pay $40 a ton for imported paper stock from Norway. In the South 300,000 tons of paper fibre of the highest grade are burned with the cottonseed hulls to which it is attached or used with them to adulterate cattle feed. Cornstalks to an incalculable tonnage rot or are burned each year while chemistry stands ready to convert them into feed containing 30 per cent. of sugars on the dry basis, or into alcohol for light and power. Waste molasses is sold for three cents a gallon or dumped into the stream while alcohol sells for 40 cents a gallon. Skim milk is fed to hogs or thrown away because no one has the enterprise to extract its casein which is worth more than beefsteak for food.

In the face of such conditions we still meet young men who would inform us that the day of opportunity is past. The truth is that opportunity is knocking not once but insistently and long at every entrance to the chemist's laboratory.

Nowhere is the earning power of chemistry better shown than in its ability to transform cheap raw materials into products of exceptional value. A cord of wood is worth perhaps $10 with a dry weight of a little over a ton. Its value, therefore, is about a half a cent a pound. In the form of chemical fibre for paper-making half the weight is lost but the remainder is worth 2¼ cents a pound. As paper it finds a market at 4 cents. Made into artificial silk by more refined chemical processes it commands $2.00 a pound, while as cellulose acetate bristles it is worth $4.00.

There are in the United States at least 100,000 doctors and nearly 125,000 lawyers. There are only 10,000 chemists to carry on a work incomparably more important than litigation and no less beneficial than medicine to the life of the community if that life is to be worth living. Some measure of the mere material benefits which chemistry can offer may be found in the fact that the annual production of the chemical industries of the United States is already nearly equal in value to our agricultural products. Let us, however, not forget that these benefits have come, as many more will follow, because chemists have never faltered in pursuing truth for years through the labyrinth of difficult researches with no better guide than the slender and often broken thread of an hypothesis. Turgot has said: "What I admire in Christopher Columbus is not that he discovered the new world but that he went to look for it on the faith of an idea."

EARTH PRESSURES.*

(Continued From Last Week.)

To show that the surcharge of a slope should not increase the horizontal pressure against a vertical surface, consider the cylinders 1 A, 2 A, 3 A, 1 B and 2 B of a d c. While 1 A evidently holds the whole tier 2 A, 3 A, 4 A — 9 A in position, it does not carry any more weight or thrust than if only 1 A, 2 A and 2 B were considered. 1 A and 1 B carry 2 A with points of contact or support at s and n. (See enlarged sketch of cylinders at upper left-hand corner.) Remove the cylinder 1 A, then to maintain 2 A in position and equilibrium, substitute a horizontal force P acting through the centre of 2 A. Then 2 A is maintained in position and equilibrium by P and the weight W, acting through their respective lever arms, with n the point of contact as the centre of moments. Total moments about n = O = Py—Wx. From which $P = \frac{Wx}{y}$. But 2 A carries one-half the weight of 3 A applied at their point of contact m. By construction, m is vertically above n. Therefore the weight from 3 A applied at m will pass through the point of support n. As n is the centre of moments for 2 A, the weight from 3A and passing through n will not disturb the equilibrium of 2 A already established. The horizontal thrust P will not be increased by the added weight at the point of contact, so long as the angle of friction between the surfaces is greater than 30°. The other half of the weight of 3 A is carried by 2 B from the point of contact o and passed on to r without disturbing the equilibrium of 2B. Thus it is seen that the cylinders above do not disturb the equilibrium or produce an added horizontal thrust in those below, but only contribute their weight to increase the vertical load. This is as it should be, for the particles on a natural slope to contribute an added horizontal thrust to those below, would imply an arching effect which does not exist. In other words, if arching of that kind took place, we would have the anomaly of the toe of the natural slope of an embankment carrying a load greater than the weight of the material in the vertical projection above.

Returning to the bin A B B_1 A_1 of Fig. 8. Suppose a prism A N A_1 is piled in the bottom of the bin. As the toes of the slopes only reach to A and A_1 there is no pressure developed in the sides A B or A_1 B_1. If a plane is passed vertically through N, however, we should expect to get the full developed horizontal pressure for the vertical height of N above the base A A_1. Compare this with the side c d of the pile of cylinders. The horizontal thrust from 2 E is no more with all of the cylinders above in position than it is when they are removed. The only cylinders producing horizontal thrust on the side c d are 2 E, 4 D, 6 C and 8 B. If now the bin is filled up to the level of N, the pressure should be the same on the side of the bin A B as on the vertical plane passing through N. In other words, the horizontal pressure against any vertical plane passed through the level fill of the height N should be the same as against the side A B. The resultant of the developed pressure within the mass should be at right angles to the force of gravity.

To take still another view. Suppose the bin is filled to the level of N and then gradually removed from one side, say first to the slope A_1 N. Then continue the removal until the slope leaves the side A B at the level of N. At what point can we say the pressure against the side A B began to be less than when the bin was full up to the level N? According to the sliding prism theory is should be when the line A D or plane of rupture is reached. But in reality has the plane of rupture anything to do with the development of horizontal pressure? Must we conclude that a bin must be wide enough for the plane of rupture A D to pass out before reaching or intersecting the side A_1 B_1 before the full pressure of the retained material can be developed against the side A B? Under that conception what is the character of the pressure developed against the side A_1 B_1? The assumptions of that theory seem at least unusual, but still do not give as great values for surcharge as given by Rankine.

In the lower right-hand corner is given a table showing the values of the earth pressure E and the angle δ which the resultant makes with the horizontal. The results are from Rankine, Rebhann, Trautwine, and the developed pressure theory. The assumptions are h = 40 ft., side A A_1 = 10 ft. γ = 100 lb. per cu. ft., $\phi = 45°$, $\alpha = 0°$, and $\epsilon = 0°$ or level in one case and ϕ or 45° in the other. It will be noted that both Rankine and Rebhann give about three times, and Trautwine nearly twice the amount of pressure E, for surcharge over what they give without. The value of E by the developed pressure theory is considered the same either with or without surcharge and is not far from a mean of the values given by the other theories when $\epsilon = 0°$ and $\epsilon = 45°$. It should be noted that there is little agreement between the different theories for the value of the single δ which the resultant makes with the horizontal.

2nd. For negative values of α (back batter toward the fill.)

With back batter toward the fill or α negative, the formula employed for obtaining the earth pressure is:

$$E = \frac{h^2\gamma}{2}\left(1 - \frac{\sin.\ \phi}{\cos.\ \alpha}\right)$$

The values of E at the limits of ϕ and α are:

$$\text{for } \phi = 0° \text{ and } \alpha = 0°, E = \frac{h^2\gamma}{2}\left(1 - \frac{\sin.\ \phi}{\cos.\ \alpha}\right) = \frac{h^2\gamma}{2}\left(1 - \frac{\sin.\ 0°}{\cos.\ 0°}\right)$$

$$= \frac{h^2\gamma}{2}\left(1 - 0\right) = \frac{h^2\gamma}{2} = \text{hydrostatic pressure.}$$

$$\text{for } \phi = 90° \text{ and } \alpha = 0°, E = \frac{h^2\gamma}{2}\left(1 - \frac{\sin.\ \phi}{\cos.\ \alpha}\right) = \frac{h^2\gamma}{2}\left(1 - \frac{\sin. 90°}{\cos.\ 0°}\right)$$

$$= \frac{h^2\gamma}{2}\left(1 - \frac{1}{1}\right) = 0.$$

For α = the complement of ϕ (or when the back batter coincides with the natural slope, $\alpha = 90° - \phi$), then E =

$$\frac{h^2\gamma}{2}\left(1 - \frac{\sin.\ \phi}{\cos. [90° - \phi]}\right) = \frac{h^2\gamma}{2}\left(1 - \frac{\sin.\ \phi}{(\cos.\ \text{complement}\ \phi = \sin.\ \phi)}\right)$$

$$= \frac{h^2\gamma}{2}(1 - 1) = 0$$

Values of C, Developed Pressure Theory, Compared With Those from Rankine and Rebhann.

This second set of comparisons is made at the risk of some restatements.

Referring again to Figs. 2, 3, 4, 5, and 6, the values of C for the developed pressure theory are shown by the solid line; those from Rankine by dashes and Rebhann by a dot and dash.

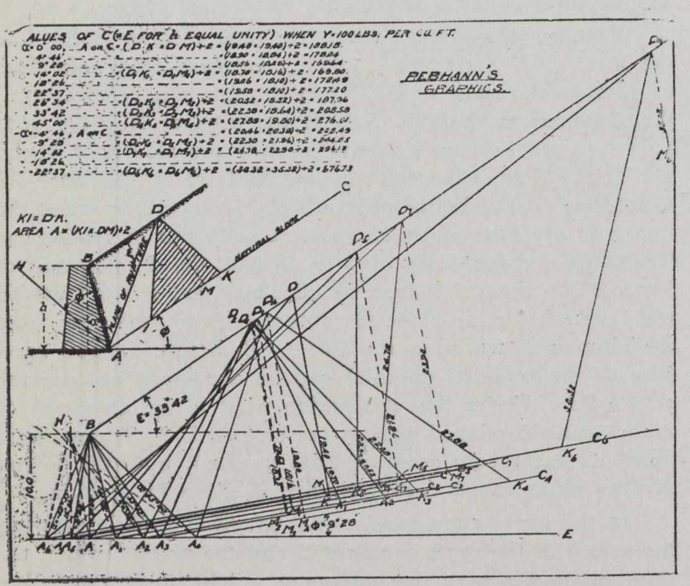


Fig. 9.—Break-down for Surcharge Greater Than the Angle of Repose.

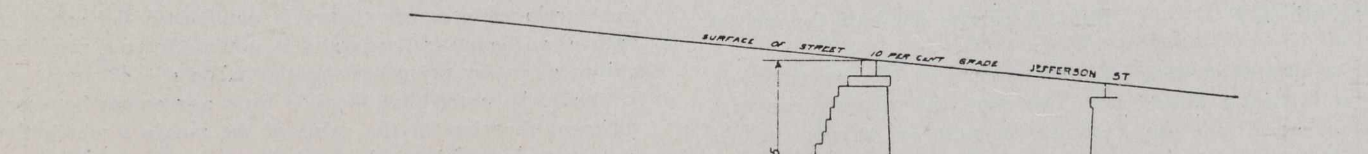
In Fig. 2 the values for "$\alpha = 0$, and $\epsilon = 0$ or ϕ," are greater than Rankine and Rebhann give for "$\alpha = 0$, $\epsilon = 0$," but are less than those given for "$\alpha = 0$, $\epsilon = \phi$." As previously stated, when $\alpha = 0$, or is negative, a surcharged fill $\alpha = 33° 42'$ and $\epsilon = \phi$, the developed pressure formulae give much lower values than the old theories, with one exception. For ϕ = about 55° Rebhann crosses the solid line and gives lower values. That, however, is an evident break-down in Rebhann. The increase shown by the solid curve is abou. as we should expect. The increase in E (C) caused by the added load of the earth wedge with its surcharge is almost offset by the decrease in the horizontal pressure P, as the angle of repose ϕ increases.

In Fig. 3 for the two groups of curves shown $\alpha = -4° 46'$ and $-22° 37'$, with $\epsilon = 0$ and ϕ, the values for the developed pressure theory are almost a mean of those given by Rankine and Rebhann.

In Fig. 4 curves are given for $\phi = 45°$, with $\epsilon = 0°$ and 45°. For $\epsilon = 0$, the developed pressure formula gives larger values than obtained from Rankine and Rebhann, but for $\epsilon = 45°$ the results are less, when α is positive. When $\alpha = 0$, the two curves join, and continue with one value throughout for α negative. Compare this with the break-down of Rankine and the very low values of Rebhann for $\epsilon = 0$. Also note the solid curve is convex upward while Rebhann is convex downward.

In Fig. 5 is given curves for $\phi = 33° 42'$, and $\epsilon = 0$, 33° 42' and 45°. The three curves for α positive join at $\alpha = 0$, and for negative α the curve is convex upward. Compare this with the very large values given for $\epsilon = \phi$ by both Rankine and Rebhann, and the break-down of Rebhann for $\epsilon = 45°$.

In Fig. 6 is given a group of curves for $\phi = 9° 28'$, and $\epsilon = 0$, 9° 28', and 33° 42'. The same general characteristics are shown on comparison as seen in Figs. 4 and 5 except that Rebhann gives two curves convex upward for α nega



Figs. 10 and 11.—Land Slide from Steep Surcharge and "Flowing" Understrata.

is not considered as giving any greater pressure than one without.

It will be noted that the values given by the developed pressure theory are almost a mean of those given by Rankine and Rebhann under the extremes of $\epsilon = 0$ and ϕ. For tive. One of these is a complete break-down and the other a very close approach. Compare this also with the complete break-down of Rebhann for $\epsilon = 33° 42'$ as previously noted. The graphic sketch from which the Rebhann results were obtained is shown in Fig. 9. Neither Rankine's formula nor the graphics give any results for the condition where ϵ is greater than ϕ. As previously mentioned, the case of a heavy surcharge over a bed of soft material and the back batter away from the fill is one of the most important to provide for. The increased value of C (E) comes both from the added height S L to h (Fig. 7) giving greater value to P, and the increased weight of the earth wedge A B S carried by the wall foundation.

A fact brought out by platting the results for the developed pressure theory is that no break-downs have been discovered so far, but the results are consistent throughout. There are no excessively high values given. For a negative the curves are all convex upward and decrease most rapidly as the zero limit of C is approached. That feature is as we should expect. The equations are satisfied at the limits.

A complete set of values for C (= E) have been worked out and tabulated for the developed pressure theory on the same bas's of angles of repose ϕ, surcharge ϵ, and back of wall batter α, as was done for Rankine and Rebhann. Also a set of constants C for the horizontal pressure P for the heights given by the different surcharge angles and back of wall batters. These will possibly be published later, as well as other added data.

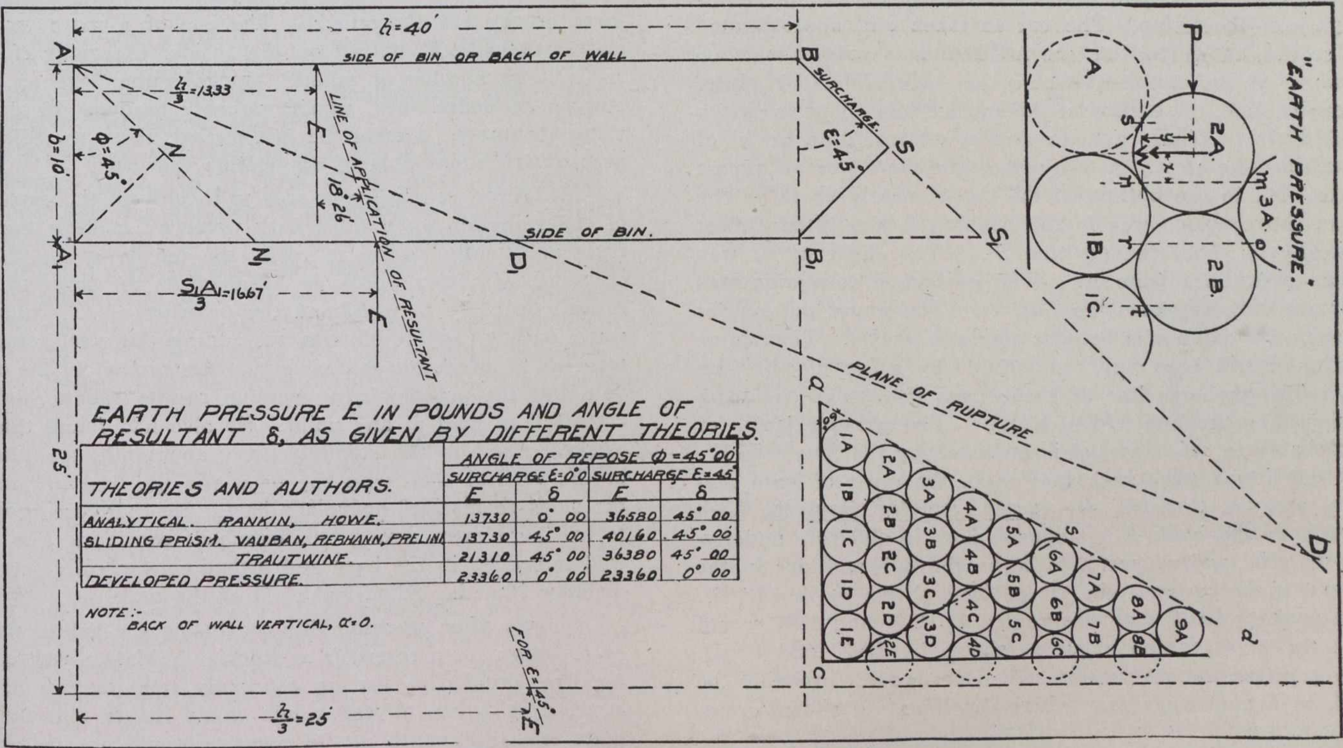
at issue, observe the caving of an ordinary bank. For several feet at the top the slope is almost invariably vertical.

It is to be hoped that tests may soon be made on a large scale to give as near as may be, by experimental data, the true values for earth pressure.

In the meantime the author respectfully presents the theory based on the assumption that "the horizontal pressure is equal to hydrostatic pressure, diminished by the sine of the angle of resistance to flow ($= \phi =$ the angle of repose) into the hydrostatic pressure," or what I have chosen to call the developed pressure theory, for the consideration of the engineering profession.

Before discussing the subject, which has so far been treated wholly on theory, it may be of interest to give an account of a landslide which took place on some work with which the author was connected some years ago.

In 1894-5 the Cleveland, Lorain and Wheeling Railroad Company (now part of the Baltimore and Ohio system) built an extension into the city of Cleveland, Ohio. The Cleveland entrance was through the valley of the Cuyahoga river. For some distance before reaching its junction with the Erie Railroad it ran along the bluffs west of the river. At Jefferson street the line was thrown into the hill far enough to get



EARTH PRESSURE E IN POUNDS AND ANGLE OF RESULTANT δ, AS GIVEN BY DIFFERENT THEORIES.

THEORIES AND AUTHORS.	ANGLE OF REPOSE ϕ = 45° 00'			
	SURCHARGE ϵ=0° 0'		SURCHARGE ϵ=45°	
	E	δ	E	δ
ANALYTICAL. RANKIN, HOWE.	13730	0° 00	36580	45° 00
SLIDING PRISM. VAUBAN, REBHANN, PRELINI	13730	45° 00	40160	45° 00
TRAUTWINE.	21310	45° 00	36380	45° 00
DEVELOPED PRESSURE.	23360	0° 00	23360	0° 00

Fig. 8.—Effect of Surcharge on Bins and Walls.

Summary.

No attempt has been made to give a complete mathematical analysis or discussion of the formula used. The author can only repeat what has been said above. The results appear to be consistent and without any break-downs. That can not be said of the old formula.

Until such time as a set of tests shall have been made on a large scale to verify or disprove any theory, we are only justified in using such theories as give the most rational and consistent results. Small model tests on a material possessing any degree of cohesion are perhaps worse than useless. That is equally true materials possessing both cohesion and friction between the particles of its composition. Owing to the fact that nearly all retained earth possesses both cohesion and friction, it is quite probable that the full resultant earth pressure is developed at a point lower than one-third the height. As an instance to illustrate the point

an under crossing. The grade of Jefferson street is ten per cent.

In making the side hill cut a short distance south of the crossing, blue clay was penetrated and slides began to develop. On reaching Jefferson street it was found it would be impossible to carry the open cut across the street as originally intended.

The excavation for the uphill abutment was then started and carried down by sheet piling the pit. The depth from street grade to foundation was about 36.5 ft., and from subgrade of track 10 ft. The timbering for the pit was 8 in. by 8 in. pine for struts and string pieces, spaced about 8 ft. Before the full depth of excavation was reached it was found necessary to put in a second set of timbers, and eventually a third set. In many cases the pressure developed was sufficient to compress the ends of the struts into the string pieces of the first sets of timbers fully four inches and many of the struts were broken. The upper part of the pit was through boulder clay and gravel. For some distance above subgrade of the track, hard blue clay was penetrated, while a little below subgrade a soft putty-like blue clay was encountered and formed the foundation bed.

As seen in Fig. 10, the section of the wall as built was very massive. The ratios of base to heght were: neatwork, 0.52, and the footing, 0.44. To insure against the wall being pushed forward or overturned, stone struts 4 ft. by 4 ft. were built below grade, abutting against the footing of the downhill abutment. To prevent sliding of one course of masonry on the other, the courses were broken at intervals by keys of single stone, extending half their thickness in the course below and half in the course above. The wings, which were straight, were not at first provided with the struts. After a time the wings began to move forward and they had to be held in the same manner as the body of the wall.

About the time the uphill abutment was completed, and the excavation taken out from in front of it, and the excavation for some hundred feet north had nearly reached subgrade, a slip or landslide took place about as shown in Fig. 11. The top of the slope as shown at A was about 70 ft. above grade. The material penetrated by the cut is shown roughly in the figure. The cut as taken out, approximated the section shown by the line A C D B at a point about 200 ft. north of the abutment where the main slide took place. After the slide, the outline of the surface was about as shown by $A^1 F^1 D^1$. There was an almost vertical drop at A^1 of something like 16 ft. At the same time there was an almost vertical lift in the bottom of the cut of nearly 20 ft. The steam shovel which was in the position S was lifted almost vertically to about the position S^1. The shear at A^1 was about 30 ft. back from A. The geological formation was approximately as shown on Fig. 11. The upper portion for considerable depth was boulder clay and gravel. Then came a layer of stiff blue clay, underlaid by a bed of soft blue clay. The probable line of shear from the top of the bank is shown by the line $A^1 E H E^1 H^1$. The possible limits of disturbance in soft material is indicated by the line $H^1 K K^1$. The conditions were such that when the crust of hard material was cut through, the excess weight from the high portion of the bank $A A^1$ induced flow in the soft underlying material and caused it to break through and rise in the bottom of the cut and take the position shown by line $F^1 D^1$. The strata of stiff clay designated by E F and H K would take the new position about as shown by $E^1 F^1$ and $H^1 K^1$. The point of the reversal in movement would probably be back of F somewhat near where the lines are shown crossing.

As the sketch of the slide is made wholly from memory, some of the details are not so exactly reproduced. The general features were substantially as shown. The apparently remarkable feature of the occurrence was the fact that the movement was such as to lift the steam shovel for nearly twenty feet and leave it on an even keel.

The above, while at first thought appears a very unusual occurrence, is not so different from what we should expect after making a closer study of conditions. The conditions as shown in the above case are among those that are the most difficult to detect; it is also difficult to design structures that will safely resist the resultant forces.

Structures for retaining earth are among the most costly which the engineer is called upon to design and construct. In the broadest sense we are not getting as good and satisfactory results as should be obtained.

Note: The misspelling of the name Rankine, in the illustrations, occurred in the original drawings and could not be easily corrected.

REINFORCED CONCRETE RESERVOIRS.

In a paper entitled "A New Theory for the Design of Reinforced Concrete Reservoirs," Hiram B. Andrews, engineer for Simpson Brothers Corporation, presented to the Boston Society of Engineers an idea which has already been employed by him in the designing of one or more concrete reservoirs of recent construction.

The fundamental idea upon which his theory is based is not a new one. It is that if steel reinforcement is relied upon for taking the tension caused by the pressure of the contained water, and this tension becomes any very considerable percentage of the elastic limit of the steel, then the steel reinforcing bars will slightly elongate. This means that the concrete shell must increase in circumferential length, and therefore either a large number of minute vertical cracks or a few wider ones will necessarily be formed in the concrete. These cracks are almost certain to produce more or less leakage. If the steel could be kept under its working stress while the concrete was being placed and setting, or if the cracks in the concrete could be filled with cement mortar while the standpipe was filled with water, this difficulty would be met. But plastering the inside of the standpipe while it is empty can have no beneficial results so far as these cracks are concerned. The use of a more or less elastic waterproof coating on the inside, especially if there are a large number of minute cracks rather than a small number of wider ones, would probably produce the desired water tightness. Except the last named, these remedies appear almost impossible of application, however.

Mr. Andrews' theory or idea is to prevent the expansion of the reservoir when filled with water by making the concrete sufficiently strong to resist the tensile stress without cracking. In other words, he would make the concrete theoretically capable to withstand the pressure of the contained water without any reinforcement, adding the steel reinforcement as a safeguard against actual destruction of the reservoir and the accompanying serious results should the concrete fail to hold at any point. He also had found that the weakest point in the standpipe was apparently the junction of the vertical shell with the base and the first few feet of the sides themselves above the base. He therefore proposed to use here extra strong reinforcement consisting of bars well imbedded in the base and extending vertically for some distance into the cylindrical shell of the tank.

Shortly after reaching this conclusion the author prepared a design for a reservoir at Rockland, Mass.; where, said he, "we decided to use an especially rich mixture of concrete, a thickness of wall which would insure that the ultimate tensile strength of the concrete would not be reached when the reservoir was filled, to use an increased amount of vertical reinforcement especially between the base and the walls, and to install a steel dam at each horizontal joint between each day's work to prevent any direct seepage of water through the joint, provided it entered it. The hydrated lime was omitted, as we considered the proposed density of the concrete did not require it for impermeability, and also that where it had been used previously it had caused an unsightly efflorescence on the wall wherever there had been seepage. The plastering was omitted as we considered that any rigid coating upon this mixture of concrete was unnecessary; but instead, we applied three coats of soap and alum solution, commonly known as Sylvester Compound, to fill pinholes due to air bubbles, etc. The writer does not know that this was of any practical use, but it was a precaution which we took."

In working out the details the designer assumed that 1:12 concrete was good for 400 pounds tension per square inch. The steel was assumed to receive 16,000 pounds per square inch. It was also assumed that the ratio between the moduli of elasticity of steel and concrete is 10, so that if the concrete should be stressed to 300 pounds per square inch, for instance, the steel would be stressed to 3,000 pounds. In the standpipe in question, 46 feet in diameter and 104 feet high, this required a thickness of wall of 36 inches at the base, and 9.35 square inches of steel per foot of height.

In the discussion of the paper doubt was expressed by several as to whether concrete could be relied upon for 400 pounds per square inch tension; and there seemed especially to be doubt whether there might not be one or more weak places where the strength might be considerably less than this, which weak places would be the location of rupture when the reservoir was filled.

Perhaps as interesting as the paper itself was the information brought out in the discussion concerning experience with a number of standpipes which have been built for several years. The Manchester, Mass., standpipe, 50 feet in diameter and 72 feet high, leaked between the first and third joints at a maximum of 15,000 gallons in 24 hours, this being the most serious leak, according to Raymond C. Allen, who stated: "That was the most serious leak we had. The leaks at other times have been matters of perhaps a few hundred gallons a day. At the present time not more than 10 to 15 gallons a day is seeping out in a space 8 feet long and 6 inches wide at the very base." This standpipe has leaked only on the easterly and southeasterly side, where the maximum effect of the sun is felt.

Discussing the standpipes built at Westerly, R.I., and Attleboro, Mass., by his firm, L. C. Wason stated that he believed that the addition of considerable vertical reinforcement in the lower 8 or 10 feet of the standpipe wall, the ends of which are turned out and bonded well into the floor, would assist very materially and perhaps entirely obviate the formation of a horizontal crack in the lower few feet of a standpipe. "It is obvious that under water pressure the walls, owing to the deformation of the steel, must increase in circumference and the entire tank increase in diameter in proportion. At the bottom of the standpipe, however, owing to the rigid connection of the wall with the floor, this increase in diameter cannot take place. This rigidity extends a short distance upward to the point where compression on floor changes to tension in wall. At the finish of a day's work near bottom of tank at or quite close to the plane of weakness, there may be a direct movement outward of the wall above, relatively to that below, the joint when under pressure. When the pressure is relieved the elasticity of the hoops would tend to draw the wall back to its original position. That this movement is present is further indicated by the fact that when a standpipe has been kept full of water for some time, the leakage through these joints almost entirely disappears, but on emptying the standpipe and refilling it the little dams formed have apparently been broken down, as the leakage again occurs as vigorously as at first."

The Attleboro standpipe was described by F. A. Barbour. This standpipe has leaked more or less, most of the leakage having developed near a horizontal crack in the critical section a short distance above the foundation. "Some months ago a successful attempt was made to stop the several leaks, then apparent, by grouting, and the method used may be of interest. On the assumption that the repairs should be made when the wall was stretched to the maximum limit, the work was done with the tank full. At the location of each leak a hole, larger on the inside, was cut into the wall, exposing the steel. This hole was filled with small crushed stone, held in place by a piece of wire netting, and the whole plastered over with mortar, a short length of ¾-inch pipe passing through this plaster. Neat grout was mixed and poured into an 18-inch length of 6-inch wrought iron pipe with flanged top and bottom. From the bottom a lead pipe connected with the pipe in the wall, and to the top a large carbonic acid tank under 3,000 pounds pressure was connected. By a valve any pressure could be brought to bear on the grout, shooting it into the hole in the wall back of the hardened plaster facing. As much as ½-cubic foot of grout was forced into the wall at one point, and through it for a distance of several feet where it again made its appearance at the surface. Obviously, the conditions found suggested that the leakage was here due more largely to imperfect placing of the concrete around the steel, which was too close together, than to the horizontal crack resulting from the deformation of the wall."

Mr. Barbour stated that there had from time to time been a few small leaks in the Attleboro tank, but that at no time has more than one per cent. of the entire surface been even damp. As in the case of other tanks, this tends to become absolutely water tight when kept full or at a nearly constant level; but if the tank be emptied and refilled the leakage is always greater than before emptying—presumably the lime carbonate which had plugged the openings being crushed by the contraction of the steel as the pressure is removed.

What was stated to be perhaps the only standpipe yet built of concrete which has never leaked is one 30 feet in diameter and 78 feet high built on the State farm at Bridgewater, Mass., by inexperienced prison labor. At the end of 1½ years' service it was still without a leak and had been absolutely tight since being first filled. The walls were dove-tailed into the floor and a small fillet of concrete was placed between the floor and the walls and worked in with a great deal of care. The materials were of good quality, carefully graded and mixed over thoroughly by hand. Especial pains were taken to stiffen and reinforce the joints between floor and vertical walls with steel reinforcement. The concrete was mixed 1:1½:3, with 5 per cent. of lime added. The sand was bank sand, clean and coarse, and the stone was crushed from field stone picked up around the farm, screened through a 1¼-inch screen and with all dust and fine material removed. Vertical rods were used in different lengths, one set being carried up 5 feet above the base, another 10, a third set 15 and one set was carried entirely to the top.

Attention was called by A. B. MacMillan to the importance of the amount of water used in mixing the concrete He referred to a paper read before the National Association of Cement Users giving data which seemed to show "that the percentage of water added to concrete in mixing has a very marked effect upon its permeability and that even very slight variations from the proper consistency give very much greater variations in permeability; that is, if too much water is added the resulting concrete is much less waterproof than one with the ideal amount of water. This ideal amount varies for different mixtures of cement and aggregate, and the nearest approximation that can be made offhand is that enough water shall be added to make a mixture which under tamping shall show water at the surface and give what we call a dry quaking mix, that is, a mix that will not quake until it has been thoroughly tamped.

The Waltham reservoir was referred to by Bertram Brewer, especially the matter of leakage. He stated that when studying the subject of concrete reservoirs preliminary to building the Waltham one, he concluded that a concrete reservoir could be built at reasonable cost, but was not by any means sure that it would be water tight. He conferred with a firm of contractors and they finally concluded that if it was not absolutely water tight it would not necessarily endanger the structure as a whole, but that it might remain sound and at the same time show considerable seepage. He frankly informed the city government that, while a concrete reservoir ought not to cost as much as a steel one and would be desirable for other reasons, probably lasting several times as long as a steel reservoir; still, it would probably leak and the local papers might occasionally alarm the people with tales of its rapid deterioration; but they should not be alarmed by this. It was with this idea of probable leaking that the Waltham reservoir was built, costing about ten per cent. less than a steel one. At first there was considerable seepage and the lime began to appear on the surface so that stalactite formation became very noticeable. After a few months' use the moisture was very much reduced so that there was practically very little seepage; and while there is now considerable seepage when the reservoir is being filled, it would be practically impossible to collect any amount of water from the outside walls if it were kept full all the time. In this reservoir also it was noticed that the greatest seepage has been where the sun shines brightest; there being almost none on the north wall.

CONTROL OVER STREAM POLLUTION.

Additional control over stream pollution, sewerage and sewage-disposal systems in New York State has been granted to the State Commissioner of Health by recent amendments to Chapter 49 of the Laws of 1909. While several of the existing sections have been amended, these amendments are chiefly for the purpose of bringing the Act as it previously stood into accord with new section, which is substantially as follows:

"Order to discontinue pollution of waters. Whenever the State Commissioner of Health shall determine upon investigation that sewage from any city, village, town, building, steamboat or other vessel, or property, or any garbage, offal or any decomposed or putrescible matter of any kind is being discharged into any of the waters of the state, which shall include all streams and springs and all bodies of surface and ground water, whether natural or artificial, within or upon the boundaries of the state, and when, in the opinion of the State Commissioner of Health, such discharge is polluting such waters in a manner injurious to, or so as to create a menace to health, or so as to create a public nuisance, he may order the municipality, corporation or person so discharging sewage, refuse or other matter, to show cause before him why such discharge should not be discontinued. A notice shall be served on the municipality, corporation or person so discharging sewage, refuse or other matter, directing such municipality, corporation or person to show cause before the said State Commissioner of Health on a date specified in such notice why an order should not be made directing the discontinuance of such discharge. Such notice shall specify the time when and place where a public hearing will be held by the State Commissioner of Health and notice of such hearing shall be published at least twice in a newspaper of the city, village, town or county where such discharge occurs, and shall be served personally or by mail at least 15 days before said hearing and in the case of a municipality or a corporation such service shall be upon an officer thereof. The State Commissioner of Health shall take evidence in regard to said matter and he may issue an order to the municipality, corporation or person responsible for such discharge, directing that within a specified period of time thereafter such discharge be discontinued, and such proper method of treatment or disposal of such sewage, refuse or waste matter be adopted as will permanently obviate such pollution of said waters by the municipality, corporation or person responsible therefor and as shall be appproved by said commissioner. Such order shall not be valid until approved by the Governor and the Attorney-General and when so approved it shall be the duty of the Attorney-General to enforce such order. Such means or method for the treatment or disposal of sewage, refuse or other matter must be executed, completed and put in operation within the time fixed in the order. The State Commissioner of Health shall have authority to require from the officials and persons responsible for the execution of such orders satisfactory evidence at specified times of proper progress in the execution of such orders, and may stipulate and require that certain definite progress shall be made at certain definite times prior to the final date fixed in the order. For the purposes of this article sewage shall be defined as any substance, solid or liquid, that contains any of the waste products or excrementitious or other wastes or washings from the bodies of human beings or animals. But this section shall not apply to refuse or waste matter from any shop, factory, mill or industrial establishment, not containing sewage as hereinbefore defined."

Besides bringing other portions of the Act into line with the new section, further amendments make more specific and forcible the modes of procedure to be followed in the prevention of stream pollution. Effluents from sewage-disposal plants are by the amendments brought within the jurisdiction of the commissioner.

It should be noted that the additional powers conferred upon the Commissioner of Health can be exercised only with the concurrence of the Governor and Attorney-General in case of an order to discontinue the discharge of untreated sewage into the streams of the state; also that the new section does not include trades wastes unless they contain sewage.

EXPERIMENTS WITH RED BEECH RAILWAY TIES.

Since 1896 experiments with red beech for railway ties have been made in the neighborhood of Eberswalde by the Prussian Ministry of Agriculture and Forestry, in connection with the Ministry of Public Works. The carrying out of these experiments was entrusted to the main station of the experimental section of the Forestry Department, in connection with the railway authorities of the Stettin line; and later with the central railway office in Berlin.

As regards the results of these experiments, and the lessons to be learned therefrom, Professor Dr. Schwappach has published a report, a concise résumé of which is here given.

(1) Sound soft-hearted beech wood, impregnated with tar oil containing creosote, is a very desirable material for railway ties; and on main lines should last at least 25 years.

(2) Sound red-hearted beech wood may be used for ties without any apprehension, if the area of the red heart does not amount to more than 25 per cent. for the entire cross-section of the tie, and the heart of the log does not come near the outside of the tie. Ties with gray-dyed heart are to be rejected.

(3) In selecting the wood by the forestry officials care is to be taken that only sound wood is chosen for ties; rotten places, and especially at large branches, are to be avoided.

(4) Especial attention must be given to thorough drying of the wood before impregnation.

(5) In order to prevent splitting of the wood, the proper precautions must be taken at once after felling the tree. Letting the felled logs lie long in the sun in the early spring, which is often very dry, is especially to be avoided.

ECONOMIC CANAL LOCATION IN UNIFORM COUNTRIES.*

By Lyman E. Bishop, Jun. Am. Soc. C. E.

General Remarks.

As the writer has spent practically all his time, for the past three years, in the field location of canals and laterals, the method of economic location which has been developed may be of passing interest to others engaged in work of this class.

Yardage diagrams were made of standard canal sections with capacities of from 1 200 to 25 sec-ft. and a velocity of 2.5 ft. per. sec. For capacities ranging from 1 200 to 250 sec-ft., the diagrams were of sections having intervals of 50 sec-ft.; for capacities of less than 250 sec-ft., a diagram was made for each interval of 25 sec-ft. Figs. 1 and 2 are typical sections, and Table 1 gives the dimensions of standard laterals having velocities of from 1.0 to 3.0 ft. per sec. and capacities of from 1 to 90 sec-ft.

the centre-line cut, where the inside crown of the upper bank intersects the ground surface.

Whenever the full water level of the canal intersects the ground surface below the outside toe of the upper bank, the upper bank is discontinued. The note on each diagram (Figs. 1 and 2), "Do not stake out upper bank where water line intersects ground line within . . . . feet of center line," indicates where this condition prevails. This point is also indicated on the diagrams by a heavy horizontal line connecting the one-bank curve with the two-bank curve of the same transverse slope, and is supplemented by an explanatory note: "These breaks indicate center line cut at which upper bank is dropped."

Under ordinary conditions of regular location, greater center cuts require one bank only, while lighter center cuts require two banks. These requirements will always be governed by the full lines of the embankment curve. When, for any reason, the lower bank only is required, the dotted line

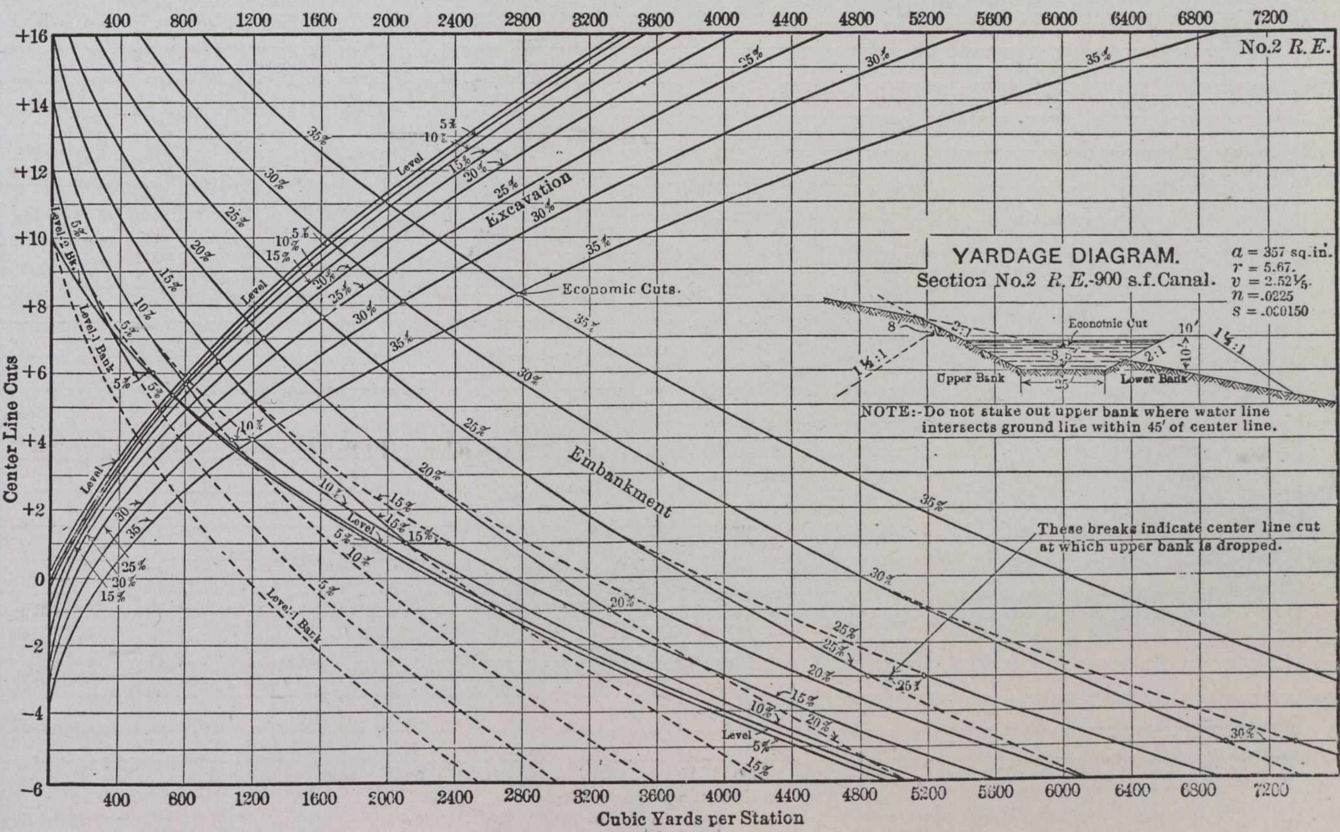


Fig 1.

In the yardage diagrams, Figs. 1 and 2, the centre cut on a given transverse ground slope is used as the argument for the excavation and embankment for a required canal section, the elements of which section are predetermined. The quantities are given in cubic yards per station of 100 ft. The embankment quantities are 10% in excess of the actual embankment, this being an arbitrary allowance for shrinkage and settlement. The center cuts vary from 6 ft. below the bottom of the canal to 16 ft. above grade, and the transverse ground slopes from the level to 35%, and is platted at 5% intervals.

Two embankment curves are plotted for each different transverse slope; one gives the total yardage in the upper and lower banks combined; the other gives the yardage in the lower bank alone. These two curves join or coincide at

*Proceedings American Society Civil Engineers, August, 1911.

below the horizontal line connecting the same transverse slope is used. When it is required to continue the upper bank beyond the point provided for under ordinary conditions, the dotted line above the horizontal connecting line is used.

When the embankment curve for a given transverse slope intersects the excavation curve of the same transverse slope, the intersection center cut is called "economic" and is so indicated on the diagrams. At these intersections the yardages in excavation and embankment are balanced, allowance having been made for shrinkage and settlement of the embankment quantities.

At the right of each diagram a template of the canal shows the dimensions and the elements which govern the quantities given in the diagram. The elements, n, s, and v (Basin or Kutter formula), may be varied to meet the requirements of the engineer, and will determine the dimensions of the section required. The dimensions alone govern the quantities in any section diagram. It is only necessary, therefore, to select a section which will meet the requirements of n, s, and v, and the quantities in excavation and embankment will be given in the diagram of the nearest corresponding section.

Estimates, prepared from these diagrams, using the center cuts and transverse ground slopes, from the final profile notes, meet every requirement of an economic location. This estimate will not vary more than 5% from the actual quantities, as determined from the cross-section notes. In making up preliminary estimates from preliminary lines, these diagrams are extremely useful.

Table 1 gives the standard sections having capacities ranging from 1.0 to 90 sec-ft. The different sections were computed on grades giving velocities of from 1.0 to 3.0 ft. per sec. The section having the required capacity and grade can be selected and varied as desired. In covering any particular tract of land, that grade will be selected which corresponds best with the general slope of the country. A

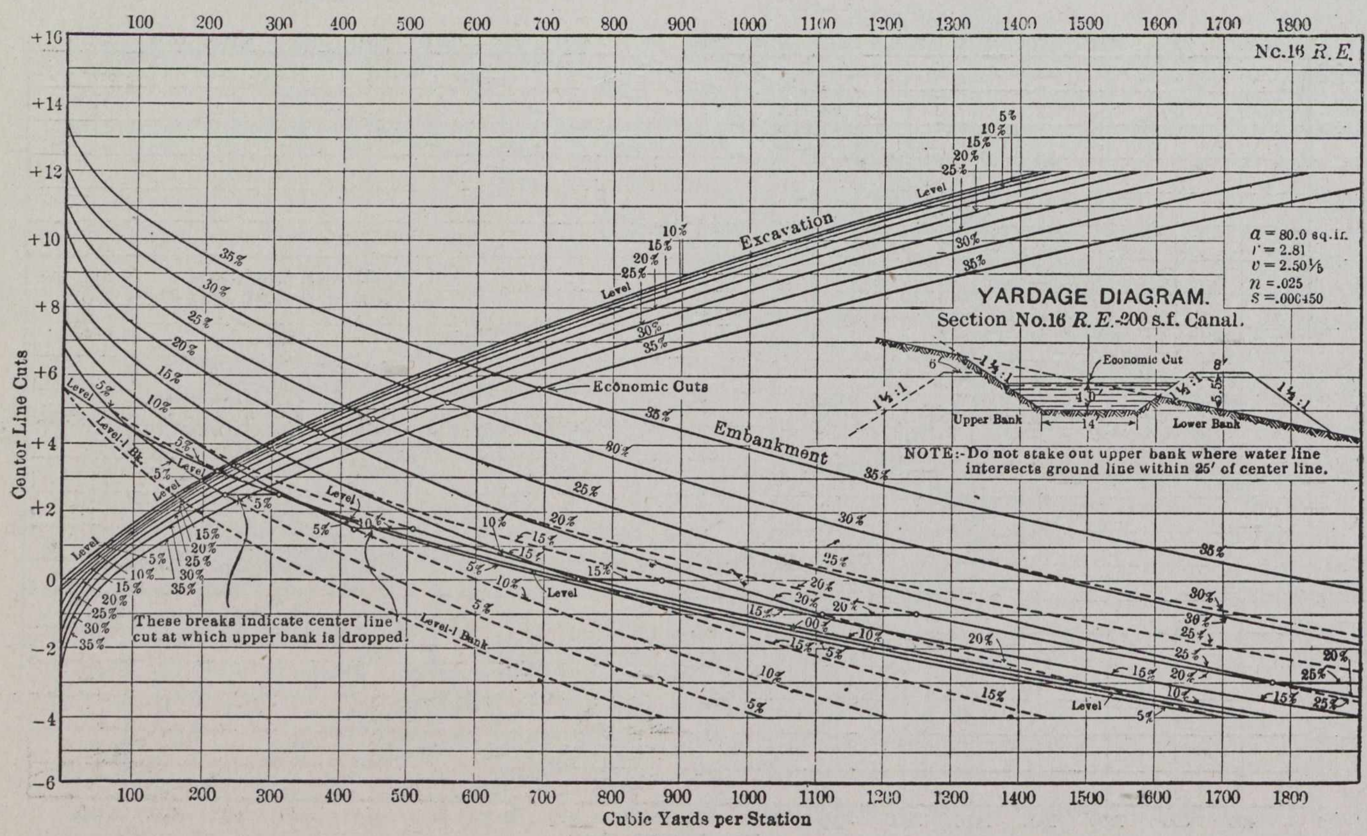


Fig. 2.

lateral of a given capacity can be located on a grade which will give any velocity required between the limits of 1.0 and 3.0 ft. per sec.

Information Furnished to Location Parties.

The information furnished to location parties consists of diagrams showing the yardage in excavation and the yardage in embankment, plus 10% for the various slopes to be encountered. From these diagrams a table of economic center cuts for the given section and transverse slopes can be prepared.

Estimates are also furnished showing the comparative cost of earth (loose and solid rock classifications); siphons under different heads; the cost per linear foot of standard flumes; the cost per linear foot of trestles of different heights; and the cost of different classes of tunnels.

The locating engineer designs and selects the section best fitted for construction through the country in which he is locating. The grade of the section having the desired water area may be changed to give the required velocity, if the material through which the location is to be made warrants a velocity other than 2.5 ft. per sec.

Organization.

The organization of a location party through uniform open countries consists of one locating engineer, one transitman, one levelman, one rodman, two chainmen, two stakemen, and a field draftsman.

Method of Location.

Level Party.—The level party, consisting of one levelman, one rodman, and one stakeman, precedes the location party. The rodman carries the stationing by pacing, following the grade contour as nearly as possible. At each station, or at closer intervals, depending on the irregularity of the country, the rodman gives two readings on the ground, 50 ft. apart, at right angles to the line of the proposed canal. These two readings give the transverse slope of the ground. The levelman then sets the rodman at a point, the elevation of which will give the desired economic center cut for that particular ground slope. The level party proceeds in this manner, setting the lath, flagged with white, not more than 100 ft. apart. These preliminary levels are carried very carefully, and, at this time, construction bench-marks are established, which are adhered to in running the final profile, in cross-sectioning, and in staking out structures.

At points where it is evident that a saving in distance and material is possible, by cutting through ridges or fills across gulches, the levelman runs a profile line on the cut-off, in addition to his contour line. From his section diagram comparative estimates of the two lines are made. In case the shorter line proves more economical, a row of red flags (red meaning off grade), is set on the economical location. Both lines are left in, and the estimate on each line is marked on its first flag.

The preliminary level line is run not more than ½ or ¾ mile ahead of the location party, on account of the difference in stations between the rodman's pacing and the measurement by the location party. This difference might be enough to affect the economic cuts due to the allowance in grade made by the levelman.

It has been found that the level party, in addition to setting the preliminary lath ahead of the transit party, is also able to take the final profile of the located line as it is run in.

haul. Having established such a tangent, the chainmen proceed along it setting the stakes not more than 50 ft. apart. The locating engineer proceeds ahead to the point of intersection of the next curve necessary. As soon as the chainmen have set the stakes to within the distance estimated as the semi-tangent for the next curve, a P. C. is put in and the transitman is called up. The chainmen then measure the

TABLE 1.—Dimensions of Standard Laterals.
Velocities and Discharges for Different Slopes.

Section.	E. C.	0.75 : 1 000		1 : 1 000		1.5 : 1 000		2 : 1 000		2.5 : 1 000		3 : 1 000		4 : 1 000		5 : 1 000		6 : 1 000		7 : 1 000		8 : 1 000		9 : 1 000		Cubic yards, 100-ft. Sta.	B	F	T	W	P	A	R
		V	D	V	D	V	D	V	D	V	D	V	D	V	D	V	D	V	D	V	D	V	D	V	D								
1	1.1																					2.0	2.3	2.2	2.5	12.8	1.5	1.0	3.0	0.5	3.3	1.125	0.34
2	1.1																			2.0	2.8	2.2	3.0	2.3	3.2	14.9	2.0	1.0	3.0	0.5	3.8	1.375	0.36
3	1.2			1.00	2.3			1.4	3.3			1.7	4.0	2.0	4.7	2.3	5.4	2.5	5.9	2.7	6.3	2.8	6.6	3.0	7.0	16.9	2.0	1.0	3.0	0.75	4.7	2.34	0.50
4	1.2			1.00	2.7			1.5	4.1			1.8	4.9	2.1	5.7	2.4	6.5	2.6	7.1	2.8	7.6	3.0	8.2			19.1	2.5	1.0	3.0	0.75	5.2	2.72	0.52
5	1.2			1.10	3.4			1.5	4.5			1.9	5.9	2.2	6.8	2.4	7.4	2.7	8.4	2.8	8.7	3.0	9.3			21.3	3.0	1.0	3.0	0.75	5.7	3.09	0.54
6	1.1			1.10	3.8			1.6	5.5			1.9	6.5	2.3	7.9	2.5	8.6	2.8	9.7	3.0	10.3					21.0	3.5	1.0	3.0	0.75	6.2	3.45	0.56
7	1.1			1.10	4.2			1.6	6.1			1.9	7.3	2.3	8.8	2.5	9.6	2.8	10.8	3.0	11.5					23.0	4.0	1.0	3.0	0.75	6.7	3.84	0.57
8	1.1			1.20	5.0			1.7	7.2			2.0	8.5	2.3	9.7	2.6	11.0	2.8	11.8							25.1	4.5	1.0	3.0	0.75	7.2	4.22	0.59
9	1.0			1.20	5.5			1.7	7.8			2.0	9.2	2.4	11.0	2.6	11.9	2.9	13.3							24.1	5.0	1.0	3.0	0.75	7.7	4.59	0.60
10	1.3	1.00	4.5	1.30	5.8	1.60	7.3	1.8	8.1	2.1	9.5	2.3	10.4	2.7	12.2	3.0	13.5									23.8	3.0	1.0	3.0	1.0	6.6	4.50	0.68
11	1.3	1.15	5.7	1.30	6.5	1.60	8.1	1.9	9.5	2.1	10.5	2.3	11.5	2.7	13.5	3.0	15.0									26.8	3.5	1.0	3.0	1.0	7.1	5.00	0.70
12	1.3	1.15	6.3	1.30	7.1	1.60	9.0	1.9	10.4	2.1	11.5	2.3	12.9	2.7	15.1											28.6	4.0	1.0	3.0	1.0	7.6	5.50	0.72
13	1.2	1.20	7.2	1.40	8.4	1.70	10.2	1.9	11.4	2.2	13.2	2.4	14.4	2.8	16.8											28.0	4.5	1.0	3.0	1.0	8.1	6.00	0.74
14	1.2	1.20	7.8	1.40	9.1	1.70	11.0	2.0	13.0	2.2	14.3	2.4	15.6	2.8	18.2											30.2	5.0	1.0	3.0	1.0	8.6	6.50	0.76
15	1.2	1.20	8.4	1.40	9.8	1.75	12.2	2.0	14.0	2.25	15.7	2.5	17.5	2.9	20.3											32.4	5.5	1.0	3.0	1.0	9.1	7.00	0.77
16	1.1	1.25	9.3	1.40	10.5	1.80	13.5	2.0	15.0	2.30	17.2	2.5	18.8	2.9	21.8											31.2	6.0	1.0	3.0	1.0	9.6	7.50	0.78
17	1.3	1.30	9.5	1.50	11.0	1.90	13.9	2.2	16.1	2.45	18.0	2.7	19.8													28.6	4.0	1.0	3.0	1.25	8.5	7.34	0.86
18	1.3	1.35	10.7	1.60	12.7	1.95	15.5	2.25	17.9	2.50	19.9	2.75	21.9													31.1	4.5	1.0	3.0	1.25	9.0	7.97	0.88
19	1.3	1.40	12.0	1.60	13.7	2.00	17.1	2.30	19.8	2.55	21.9	2.80	24.0													33.5	5.0	1.0	3.0	1.25	9.5	8.59	0.90
20	1.3	1.40	12.9	1.60	14.7	2.00	18.4	2.40	22.1	2.55	22.5	2.90	26.8													35.9	5.5	1.0	3.0	1.25	10.0	9.22	0.92
21	1.3	1.40	13.7	1.60	15.7	2.00	19.6	2.40	23.6	2.60	25.5	2.90	28.5													38.3	6.0	1.0	3.0	1.25	10.5	9.84	0.94
22	1.2	1.45	15.2	1.70	17.8	2.05	21.4	2.50	25.6	2.65	27.8	3.00	31.4													36.9	6.5	1.0	3.0	1.25	11.0	10.47	0.95
23	1.2	1.45	16.1	1.70	18.8	2.05	22.7	2.50	27.2	2.65	29.4	3.00	33.3													39.1	7.0	1.0	3.0	1.25	11.5	11.09	0.96
24	1.2	1.45	17.0	1.70	19.9	2.10	24.6	2.50	29.3	2.65	31.0	3.00	35.2													41.3	7.5	1.0	3.0	1.25	12.0	11.72	0.98
25	1.2	1.50	18.5	1.80	22.2	2.10	25.9	2.50	30.9	2.70	33.3	3.00	37.0													43.6	8.0	1.0	3.0	1.25	12.5	12.34	0.99
26	1.5	1.50	14.0	1.80	16.9	2.15	20.1	2.50	23.4	2.75	25.7	3.00	28.1													34.7	4.0	1.0	3.0	1.50	9.4	9.37	1.00
27	1.5	1.50	15.2	1.80	18.2	2.20	22.2	2.50	25.8	2.80	28.3															37.5	4.5	1.0	3.0	1.50	9.9	10.12	1.02
28	1.5	1.55	16.8	1.80	19.6	2.25	24.4	2.55	27.7	2.80	30.4															40.3	5.0	1.0	3.0	1.50	10.4	10.87	1.05
29	1.8	1.55	18.0	1.85	21.5	2.25	26.1	2.60	30.2	2.90	33.7															54.7	5.5	1.5	4.0	1.50	10.9	11.62	1.07
30	1.7	1.60	19.8	1.85	22.9	2.25	27.8	2.60	32.2	2.95	36.5															53.8	6.0	1.5	4.0	1.50	11.4	12.37	1.08
31	1.7	1.60	21.0	1.90	24.9	2.30	30.2	2.65	34.8	3.00	39.4															56.9	6.5	1.5	4.0	1.50	11.9	13.12	1.10
32	1.7	1.65	22.9	1.90	26.4	2.30	31.9	2.65	36.8	3.00	41.6															60.1	7.0	1.5	4.0	1.50	12.4	13.87	1.12
33	1.7	1.65	24.1	1.90	27.8	2.35	34.4	2.70	39.5																	63.3	7.5	1.5	4.0	1.50	12.9	14.62	1.13
34	1.7	1.65	25.4	1.95	30.0	2.40	36.9	2.70	41.5																	66.4	8.0	1.5	4.0	1.50	13.4	15.87	1.15
35	1.6	1.70	27.4	1.95	31.4	2.40	38.7	2.75	44.4																	64.6	8.5	1.5	4.0	1.50	13.9	16.12	1.16

TABLE 1.—(*Continued.*)

Section.	E. C.	0.75 : 1 000		1 : 1 000		1.5 : 1 000		2 : 1 000		2.5 : 1 000		3 : 1 000		4 : 1 000		5 : 1 000		6 : 1 000		7 : 1 000		8 : 1 000		9 : 1 000		Cubic yards, 100 ft. Sta.	B	F	T	W	P	A	R
		V	D	V	D	V	D	V	D	V	D	V	D	V	D	V	D	V	D	V	D	V	D	V	D								
36	1.6	1.70	28.7	1.95	32.9	2.40	40.5	2.75	46.4																	67.6	9.0	1.5	4.0	1.50	14.4	16.87	1.17
37	1.6	1.70	30.0	2.00	35.2	2.45	43.2	2.80	49.3																	70.5	9.5	1.5	4.0	1.50	14.9	17.62	1.18
38	1.6	1.70	31.2	2.00	37.7	2.45	45.0	2.80	51.4																	73.5	10.0	1.5	4.0	1.50	15.4	18.37	1.19
39	2.0	1.70	22.7	2.00	26.7	2.45	32.7	2.85	38.1																	59.3	5.0	1.5	4.0	1.75	11.3	13.35	1.18
40	1.9	1.75	26.6	2.00	30.4	2.50	38.0	2.90	44.1																	62.3	6.0	1.5	4.0	1.75	12.3	15.20	1.23
41	1.9	1.80	30.2	2.05	34.4	2.50	42.0	2.95	49.6																	69.3	7.0	1.5	4.0	1.75	13.3	16.80	1.26
42	1.8	1.85	34.6	2.10	39.3	2.60	48.7	3.00	56.1																	71.3	8.0	1.5	4.0	1.75	14.3	18.70	1.31
43	1.8	1.90	38.6	2.15	43.7	2.65	54.0																			78.0	9.0	1.5	4.0	1.75	15.3	20.35	1.33
44	1.7	1.90	42.0	2.20	48.6	2.70	59.7																			79.0	10.0	1.5	4.0	1.75	16.3	22.10	1.35
45	1.7	1.90	45.3	2.20	52.4	2.70	64.3																			85.3	11.0	1.5	4.0	1.75	17.3	23.80	1.37
46	1.6	1.95	50.0	2.25	57.6	2.75	70.5																			85.3	12.0	1.5	4.0	1.75	18.3	25.60	1.40
47	2.2	1.85	29.6	2.15	34.4	2.60	41.6																			67.6	5.0	1.5	4.0	2.00	12.2	16.00	1.31
48	2.1	1.90	34.2	2.20	39.6	2.70	48.6																			71.2	6.0	1.5	4.0	2.00	13.2	18.00	1.36
49	2.0	1.95	39.0	2.25	45.0	2.75	55.0																			74.1	7.0	1.5	4.0	2.00	14.2	20.00	1.41
50	2.0	2.00	44.0	2.30	50.6	2.85	62.7																			81.5	8.0	1.5	4.0	2.00	15.2	22.00	1.45
51	1.9	2.05	49.2	2.35	56.4	2.90	69.6																			83.4	9.0	1.5	4.0	2.00	16.2	24.00	1.48
52	1.9	2.05	53.3	2.40	62.5	2.90	75.4																			90.4	10.0	1.5	4.0	2.00	17.2	26.00	1.51
53	1.8	2.10	58.8	2.40	67.3	2.95	82.6																			91.3	11.0	1.5	4.0	2.00	18.2	28.00	1.54
54	1.8	2.10	63.0	2.45	73.5	3.00	90.0																			98.0	12.0	1.5	4.0	2.00	19.2	30.00	1.56

In Kutter's Formula $n = 0.025$.
T = Width of Top of Bank, in feet.
D = Discharge, in cubic feet per second.
P = Wetted Perimeter, in feet.
E. C. = Economic Cut, Level Section.
W = Depth of Water, in feet.
B = Width of Bottom, in feet.
A = Area of Cross-Section, in square feet.
F = Distance, Top of Water to Top of Bank, in feet.
V = Velocity of Water, in feet per second.
All slopes 1½ : 1.
R = Hydraulic Radius.

Transit Party.—The transit party, in charge of the locating engineer, proceeds as follows: Being ahead of the transit party, the locating engineer picks out a tangent which will fit the flags established by the levelman. It is his endeavor not to follow exactly the contour as shown by the levelman, but to lay a line which balances the yardage in excavation and embankment within the limits of economic semi-tangent to the point of intersection, as established by the locating engineer. From this P. I. they chain the same distance along the other tangent of this curve, being lined in on the tangent by the locating engineer. This will give the approximate P. T. of the curve required. The transitman reads the angle from P. C. to P. T. and calculates the degree and length of curve to swing into the next tangent.

The chainmen then proceed setting stakes on this curve and establish a hub with a tack at the P. T.

The field draftsman plots the alignment notes and section line ties, and makes the right-of-way map. He also prepares and finishes all profiles and estimates of quantities, including the quantity and direction of hauled material, keeping his work up as fast as the notes are turned in from the field. No estimate is placed on the profile until it is approved by the locating engineer. Any piece of location which does not balance up well in excavation and embankment, within the limits of economic haul, after the estimate on it has been prepared, is relocated.

In country where shale or rock comes close to the surface, a testing party is put on. In cases where the rock is so close to the surface that the economic cut would necessitate the excavation of some rock, the location is made so that there will be a minimum of rock excavation, it being cheaper to borrow the material for embankments than to make the rock excavation.

At points where it is necessary to have structures, such as drops, culverts, siphons, and highway or railway bridges, the locating engineer should choose the most economical location under the circumstances. He also draws detailed sketches in his notebook of the kind of structure best fitted for that location. In addition, topography is taken, showing accurately the lay of the surrounding country within the possible limits of changes in location.

Profile.—The level party takes the final profile, showing all the breaks in the ground, also the slope of the ground at right angles to the located line. The final profile and alignment notes are turned over to the field draftsman, and the notes and estimates of quantities are worked up.

Curvature.—The maximum curvatures allowed for canals of different sizes in earth are as follows: For canals with a carrying capacity of less than 400 sec-ft. the minimum radius permissible is six times the bottom width; for canals carrying from 900 to 400 sec-ft. the minimum radius is ten times the bottom width; and for capacities from 900 to 1,500 sec-ft. the minimum radius is twelve times the bottom width.

Curves of moderately long radius are not detrimental in the operation of any canal, and they should be used as far as possible to lighten the expense of construction. In locating around sharp rocky points, where the radius of curvature used is less than the allowable, the water slopes of the canal must be paved or rip-rapped for an adequate distance, in order to preclude the possibility of erosion.

In open country, where there is no timber to contend with, location by the above method costs from $45 to $65 per mile. This covers engineering salaries and expenses.

When the location on any particular canal has been finished and the estimates and profiles have been worked up, the data are sufficient to let the contracts. Until the line is cross-sectioned and the final quantities are worked up, the contractors are paid for work completed from the location quantities. The difference between the two estimates is balanced when the final measurements are made.

ENCASTRE BEAMS.

Mr. Arthur Morley is the author of the following, which appeared recently in "Engineering":

The following method of dealing with beams which are firmly clamped at their ends appears in its applications to be simpler than any other. It consists of treating the "encastré" beam as a particular case of the cantilever, of which the otherwise "free" end is subjected to (1) a supporting force, and (2) a couple, such as will together make the beam comply with the required end conditions.

Let $AB = l$ be the span of a horizontal beam, R be the reaction at B, and M be the fixing couple at B. If the beam were simply clamped at A, and otherwise entirely free, let i be the slope and δ be the deflection which the loads would produce at the free end B. Let E be Young's modulus, and I be the moment of inertia of cross-section for the beam. Then, if A and B are to be at the same level, and the beam is to have zero slope at these two points, considering the joint effects of R, M, and the loads in producing first slope, and second deflection at B,

$$\frac{Rl^2}{2EI} - \frac{Ml}{EI} - i = 0 \quad . \quad . \quad (1)$$

$$\frac{Rl^3}{3EI} - \frac{Ml^2}{2EI} - \delta = 0 \quad . \quad . \quad (2)$$

and from these two simple equations

$$R = \frac{6EI}{l^3}(2\delta - li) \quad . \quad . \quad (3)$$

$$M = \frac{2EI}{l^2}(3\delta - 2li) \quad . \quad . \quad (4)$$

The shearing force, bending moment, slope, and deflection anywhere may now be found, as for a cantilever, by superposing the effects of R, M and the loads, or the supporting force and fixing couple at A may be found by the ordinary rules of statics, and any method used to complete the problem.

If the ends are fixed at any slopes other than zero, it is only necessary to add to the left-hand side of equation (1) the increase of slope from A to B. And if the two ends are not at the same level, it is only necessary to add the increase of deflection from A to B to the left side of equation (2).

The results (3) and (4) may also be stated for a general form of loading thus:—

$$R = \frac{6A(2x-l)}{l} \quad . \quad . \quad . \quad (5)$$

$$M = \frac{2A(3x-2l)}{l} \quad . \quad . \quad . \quad (6)$$

where A is the area of the bending-moment diagram for the loads with the end B quite free, and x is the distance of the centroid of this area from A (horizontally).

Similar methods are applicable to other kinds of beams; for example, the beam freely supported at its ends may be regarded as a cantilever fixed horizontally at one end A, propped at the other end B with such a supporting force as will reduce the bending moment at A to zero, and then rotated about A through such an angle as will bring down to the level of A—viz., the angle

$$\frac{Rl^3}{3EI} - \delta \div l.$$

This angle added to the slope of the propped cantilever gives that of the freely supported beam; the deflection at a distance x from A is found by adding x times this angle to the deflection of the propped cantilever.

Example.—A beam of clear span l built in at both ends and carrying a load W at a distance n l from one end (A).

For the cantilever,

$$i = \frac{W(nl)^2}{2EI}, \qquad \delta = \frac{Wl^3n^2(3-n)}{6EI},$$

and, substituting these in (3) and (4),

$$R = Wn^2(3-2n), \qquad M = Wln^2(1-n).$$

The Canadian Engineer

ESTABLISHED 1893.

Issued Weekly in the Interests of the

CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

Managing Director.—James J. Salmond.
Managing Editor.—T. H. Hogg, B.A.Sc.
Advertising Manager.—A. E. Jennings.

Present Terms of Subscription, payable in advance:

Canada and Great Britain:		United States and other Countries:	
One Year	**$3.00**	**One Year**	**$3.50**
Three Months	**1.00**	**Six Months**	**2.00**
Six Months	**1.75**	**Three Months**	**1.25**

Copies Antedating This Issue by More Than One Month, 25 Cents Each.
Copies Antedating This Issue by More Than Six Months, 50 Cents Each.

ADVERTISING RATES ON APPLICATION.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone, Main 7404 and 7405, branch exchange connecting all departments.

Montreal Office: B33, Board of Trade Building. T. C. Allum, Editorial Representative, Phone M. 1001.

Winnipeg Office: Room 404, Builders' Exchange Building. Phone M. 7550. G. W. Goodall, Business and Editorial Representative.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square, T. R. Clougher, Business and Editorial Representative. Telephone 527 Central.

Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor.

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

NOTICE TO ADVERTISERS.

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

Printed at the Office of The Monetary Times Printing Company, Limited, Toronto, Canada.

Vol. 21. TORONTO, CANADA, SEPT. 14, 1911. No. 11.

CONTENTS OF THIS ISSUE.

CHANGES IN THIS ISSUE.

The reader will notice a change this week in the make-up of The Canadian Engineer. We are running a pink insert of six pages on which this and each successive week will appear Index to Advertisements, Buyers' Guide, and Catalogue Index. In past issues these index pages have been widely separated, and it has been exceedingly difficult to locate information along these lines. We feel that this has caused delay and annoyance to readers of The Canadian Engineer, and for that reason, with the hope and the feeling that our readers will appreciate the new departure, we make the change.

BRITISH TENDERS.

It will be remembered that considerable unpleasantness was occasioned at the date of awarding the contract for the new Quebec bridge by the protest of the British tenderers that they had been unfairly treated.

Aside from the justification of the ground for complaint, a passage in the recent report of Mr. Richard Grigg, the British Trade Commissioner in Canada, deserves wide publicity, and it is hoped will be taken to heart by all public bodies in the Dominion that contemplate inviting of outside tenders. He points out that the growth of closer trade relations between Canada and the United Kingdom depends equally as much on Canadian fair dealing and support as on greater enterprise on the part of British manufacturers.

Mr. Grigg instances failure frequently made by municipal authorities in Canada to allow sufficient time to contractors in England for sending tenders, so that their power to tender effectively is virtually impossible. He goes on to say: "It has happened on many occasions that excuses have been sought and found under which the lowest British tender has not been accepted, and in one case a local producer was allowed to address the council after learning that the engineer had recommended the acceptance of a British offer."

The Trade Commissioner rightly remarks that persistance in such a policy must result in the refusal by British firms to tender for Canadian contracts. He adds that there would follow an agreement among local producers as to prices which could not be to the advantage of the Canadian taxpayer, to say nothing of the reflection upon Canada's credit and fair play in the financial centre of the Empire. Unless absolute fair dealing with invited British and foreign tenderers is made a rule, it would be infinitely preferable to limited contracts of Canadian firms.

THE INTERNATIONAL WATERWAYS COMMISSION.

The International Joint Commission, which has recently been completed by the publishing of the names of the Canadian Commissioners, is the first piece of international machinery for direct negotiations and settlement of questions that may arise between the United

States and the Dominion of Canada. Through the powers conferred upon this Commission by the treaty with Great Britain of 1909 the representatives of the United States and those of Canada may take up questions relating to the development and use of the waterways between the two countries.

The primary work of the Commission is in relation to the water boundary, not as to its location, but as to its uses. There are many plans for the use of these international waters other than for navigation, but there has been no competent authority for granting permits and at the same time properly protecting the rights of the people on either side of the international line.

There are pending schemes for developing water power in the St. Johns River, which forms the international boundary between Maine and New Brunswick; for the development of the Richelieu River; for the improvement of navigation and the development of water power in the St. Lawrence River between New York and Ontario; for the sanitary canal around the Niagara Falls on the American side; for the development of water power in the Rainy River between Minnesota and Canada; also for the development of water power in the Lake of the Woods, and uses of the water in the St. Mary River and Milk River in Montana and Saskatchewan for irrigation purposes.

There are smaller projects, but these larger schemes will furnish ample work for the Commission, and, if settled, ample justification for the creation of such an international court of arbitration.

This Commission provides for direct negotiations between Canada and the United States on all questions relating to the water boundary, and opens a way for the settlement of all other questions that may arise by the reference of these questions to that Commission.

The personnel of the Commission is as follows: The Canadian branch, Sir George Gibbons, of London; Aime Geoffrion, K.C., of Montreal, and A. P. Bornhill, St. John, N.B.; the American branch, former United States Senator Thomas H. Carter, of Montana; ex-Representative James A. Tawney, of Minnesota, and Frank S. Streeter, of New Hampshire.

It seems rather a pity that the engineering profession have not been represented on the Commission, as many of the matters with which they will deal will be matters in which engineering knowledge will be requisite. However, the work of the Commission should be very beneficial to both countries.

THE ENGINEER AS A SANITARIAN.

The idea that the engineer has responsibilities other than economic considerations in work submitted to him by clients is one that does not often strike us. In a paper read before the Cincinnati Engineers' Club Mr. Paul Hansen endeavors to show that higher aims than utilitarian consideration and desire to please one's clients should govern the engineer's designs. His paper deals only with the civil engineer, but his deductions apply equally well to other branches.

Water supply development, the installation of sewerage and sewage purification, city wastes disposal and street cleaning, the improvement of general health conditions by swamp drainage and other engineering work, and the sanitation of construction camps are a few of the different classes of work which demand the judgment of the engineer as a sanitarian.

Naturally, problems on water supply development take first place, for the reason that water supplies are of prime importance to communities of even moderate size, and because they generally involve the expenditure of very large sums of money. Again, of all engineering projects involving sanitation, water supplies are of the greatest significance to the health of communities, and, therefore, call for the staunchest attitude on the part of the engineer in the matter of insuring the purity of the water as delivered to the consumers.

No water supply system should be installed or undertaken without the most thorough and painstaking preliminary investigation, and, if the entire feasibility of the project is not fully demonstrated by such investigation, no engineer is warranted in sanctioning its installation.

With the increasing density of population, water supplies are becoming harder to control and provide. With the consideration of sewerage and sewage disposal the engineer must consider the matter of preventing objectionable contamination of streams. It in time becomes out of the question to maintain streams in their original purity, but it must be the constant care of the engineer that no stream should be so polluted as to render it unfit for a public water supply.

The matter of city wastes disposal and street cleaning has developed into a new field for the activities of engineers in which sanitary considerations are involved. The time will come soon when no large city will consider the adoption of methods of city wastes disposal and street cleaning without first securing engineering advice. Here are involved some of the most complex problems with which an engineer is likely to come in contact. All of the important developments along this line have been brought about primarily by an engineer, and it is within their province to use their influence to prevent the continuous use of primitive methods of disposal—methods which will lead to the spread of disease and contamination of air and water.

Another problem which engineers are solving in their capacity as sanitarians is the proper conduct of construction camps. A little foresight and intelligent planning, with the expenditure of very little additional money, will render construction camps both sanitary and attractive. For that reason, even on small contracts, the engineer should insert such clauses in his specifications as will insure the provision on the part of the contractor of proper sanitary conveniences for his laborers.

Along the above lines there are broad opportunities for the activities of engineers in dealing with problems that have special sanitary significance, and it may be said that the engineer here has a responsibility on himself other than the mere utilitarian ideal of economical design, for he must also consult the humanitarian aspect of each individual problem if he is to follow the highest principles of his profession and the moral dictates of his own conscience.

EDITORIAL COMMENT.

The executive of the Canadian Cement and Concrete Association are undecided whether to hold a cement show during 1912. The secretary-treasurer has sent out a circular letter to the various cement manufacturers and others to find out their feeling in the matter.

* * * *

In reviewing the History of Bridge Engineering and Design and Construction of Mill Buildings in our issue of August 31st the name of the author, Mr. Henry Grattan Tyrrell, was incorrectly spelled. The correction is here made.

* * * *

Ontario farmers are to be shown the latest development in the use of electricity. The Hon. Adam Beck has made arrangements for the purchase of a number of electrical devices which he and Chief Engineer Sothman, of the Hydro-Electric Commission, saw in everyday use in Germany during their recent investigations in that country. The farmers with small motors pumped all the water used, cut the wood, milked the cows, sowed the seed and threshed the grain. This machinery will probably be installed at the Ontario Agricultural College, where the farmers of the province will have an opportunity to see the various mechanisms in daily use.

* * * *

Conservation history was written last week by the House of Representatives of the United States and important precedents established concerning the granting to private corporations of water power rights made possible by Government work on navigable streams. For six hours the body wrangled over the Senate bill to improve navigation in the Black Warrior River, in Alabama, which proposed a grant to the Birmingham Water, Light and Power Company for a period of fifty years, all power rights resulting from the improvement.

Instead of giving the Birmingham company a fifty year lease of the power privileges resulting from the Government improvement the limit was fixed at twenty-five years, and it was stipulated that the company should pay at least $1 per horse-power per year for its privilege. Probably the most important amendment was one offered by Representative Madison, of Kansas, which prescribed that the Birmingham company shall sell its light and power directly to the consumer without the intervention of the "middleman."

CEMENT AS AN IRON PRESERVATIVE.

Tests are to be made by the Panama Canal Commission to determine the value of cement mortar, applied to iron plates by the "cement gun," as a preservative of iron. Twelve plates, 63-8 by 14 inches, have been coated with a 1 to 3 mortar of cement and sand, after they were cleaned to grey metal by the sand blast process. Six of these have been covered with a ½-inch coating, and the remaining six with a one-inch coat on one side, and a 1½-inch coat on the other. Three plates of each kind have been sent to Balboa, and three to Cristobal, where they will be kept immersed in salt water to test the mortar method of preventing corrosion. Two plates of each kind will be taken from the salt water bath at the end of three months, and one-half of the coating will be removed to determine the condition of the metal. The duration of the test for the balance of the plates will be determined later.

GENERAL NOTES.

The table shows for fifteen stations, included in the report of the Meteorological Office, Toronto, the total precipitation of these stations for August, 1911:—

	Depth in inches.	Departure from the average of twenty years.
Calgary, Alta.	4.4	+1.88
Edmonton, Alta.	4.5	+2.18
Swift Current, Sask.	2.4	+0.51
Winnipeg, Man.	2.3	—0.04
Port Stanley, Ont.	3.79	+1.26
Toronto, Ont.	2.0	—0.24
Parry Sound, Ont.	1.8	—1.20
Ottawa, Ont.	1.1	—2.10
Kingston, Ont.	3.0	+0.06
Montreal, Que.	3.7	—0.31
Quebec, Que.	2.3	—1.64
Chatham, N.B.	6.3	+2.30
Halifax, N.S.	2.6	—1.05
Victoria, B.C.	0.7	+0.11
Kamloops, B.C.	1.0	—0.03

A NEW GAS-HOLDER.

One of the largest steel tank gasholders in America has been recently completed for the Consumers' Gas Company, of Toronto. This structure has been placed in conjunction with the company's new works, located in the eastern section of the city.

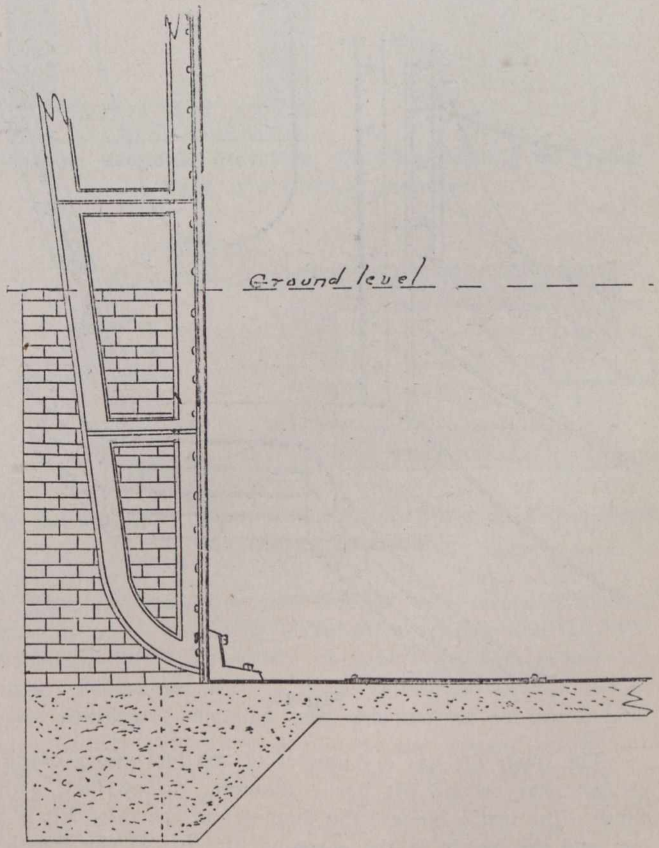


Fig 1.

This tank presents some unique features not found on the average gasholder; it is a four-lift telescopic holder of five million cubic feet capacity.

The inside diameter of the tank is 216 feet, the depth being 39 feet 9 inches; the shell of this tank is composed of eight courses of sheet steel of equal width, ranging from 1 11/16 inches to 3/8 inch in thickness.

Fig. 1 illustrates the method adopted in constructing the foundations. A concrete disk 218 feet in diameter was laid in excavation, the disk being 12 inches in thickness, excepting the outer rim, which has been thickened to 4 feet. There have been placed at twenty-four points on the disk web plate supports; these supports are at equal distance apart, and the concrete has been extended at these points, giving the appearance of a huge toothed disk.

On this disk is placed steel plate of ½ inch thickness, composed of sections having a width of 4 feet. This layer forms a ring on the outer portion and is riveted to rectangular plates, which cover the concrete disk.

At each of the twenty-four projections a cast steel angle is bolted through the wall plate to the girder, which is securely riveted to the wall plate at intervals; the brickwork which imbeds the girder is carried around the tank from the concrete bed, as shown in Fig. 2, which also illustrates the method employed in anchoring the tank frame to the girders. At the top of the tank a walk around has been constructed, this carries a substantial guard railing; this walk, or gallery, is approached by steel stairs which are carried by the steel girders to the top of the framework. A ladder has been constructed from the gallery which serves the purpose of an emergency in reaching the upper portion of the gasometer.

There are seventy-two rest blocks placed radially at the inner circumference of the tank, equally spaced, as supports for the various sections of the holder when down; these are formed of 12-inch I beams 5 feet long, and are riveted to the tank bottom.

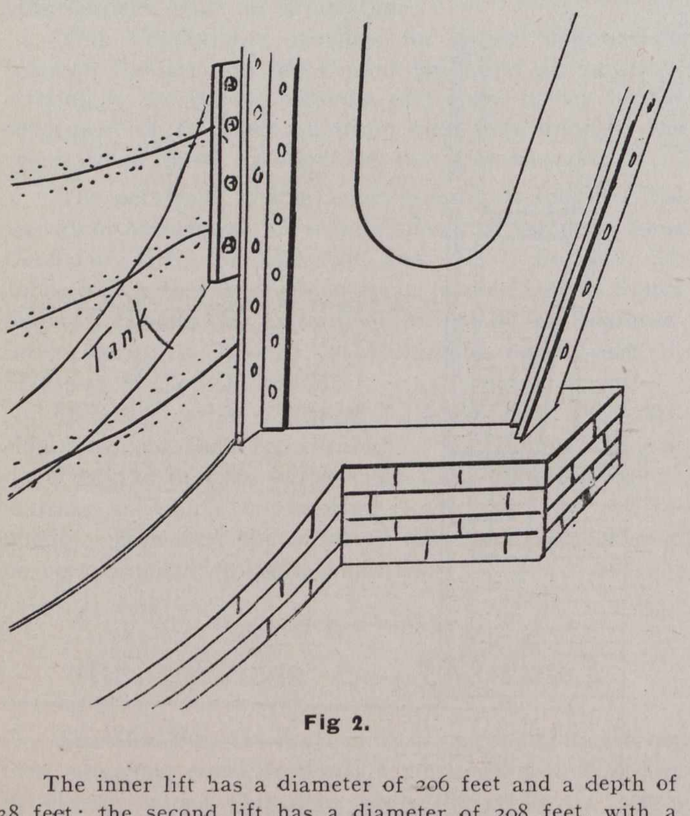


Fig 2.

The inner lift has a diameter of 206 feet and a depth of 38 feet; the second lift has a diameter of 208 feet, with a depth of 37 feet 9 inches; the diameter of the third lift is 211 feet and the height is the same as lift No. 2; the fourth or outer lift is 213 feet across, the height being the same as Nos. 2 and 3.

The inlet and outlet connections are 36 inches in diameter; these pipes are made up of ½-inch steel plate, the flanges being composed of 4 x 3 x 9/16-inch steel. The syphon pots have a capacity of 100 gallons.

Around three-fourths of the circumference of the tank there has been erected a line of standard weight wrought iron steam pipe; this pipe is 3 inches in diameter and runs in both directions around the tank; this piping is covered with asbestos of the best quality.

The roller mechanism is shown in detail in Fig. 3; there are 48 of these.

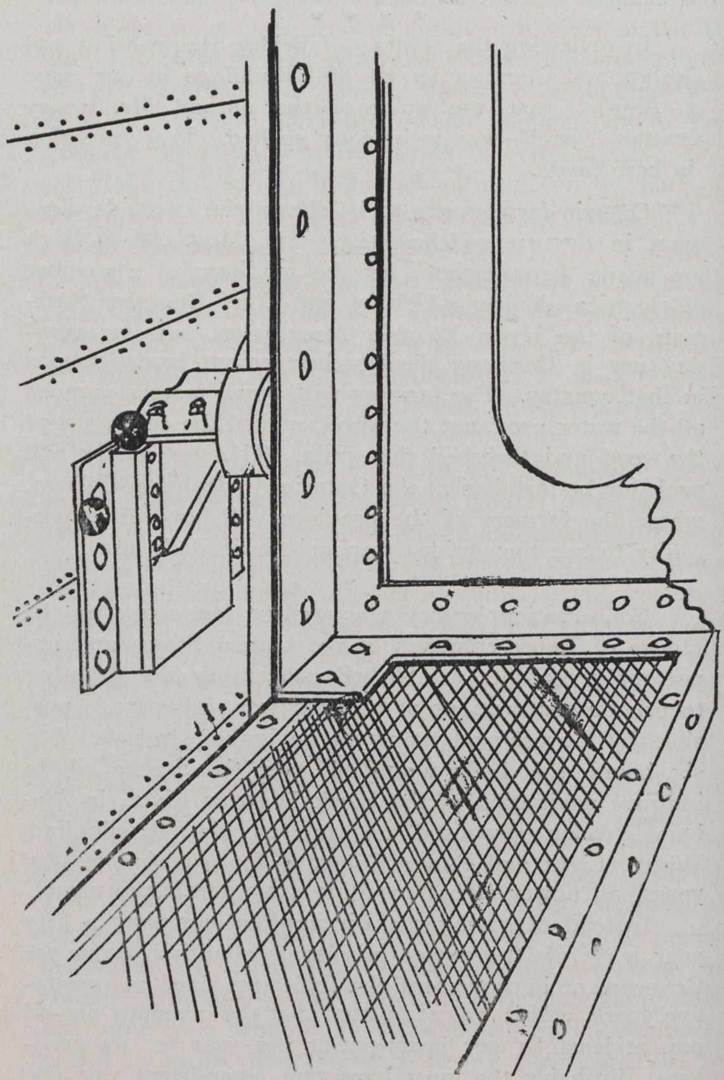


Fig. 3.

The specific gravity of the gas manufactured by the above company averages between 0.45 and 0.5, when the gasholder is filled the weight of the enclosed gas is ninety-five tons.

The weight of the tank proper is 2,160,858 pounds, the combined weight of the lifts 2,226,167 pounds, and the total weight of gasholder, including bracing girders, etc., is 6,206,538 pounds—over 3,000 tons.

POWER OF AN AIR-BRAKE.

Some idea of the power of an air-brake may be gained from the following facts: It takes a powerful locomotive drawing a train of ten passenger cars a distance of about five miles to reach a speed of sixty miles an hour on a straight and level track. The brakes will stop the same train from a speed of sixty miles an hour in 700 feet. Roughly, it may be stated that a train may be stopped by the brakes in about 3 per cent. of the distance that must be covered to give it its speed.—Daily Standard, Regina.

RESIDENTIAL SEWAGE DISPOSAL PLANTS.*

R. Winthrop Pratt, Chief Engineer, State Board of Health.

As the State Board of Health is frequently requested to give advice relative to the proper methods of disposing of sewage from individual houses, it has been thought desirable to prepare a written discussion of the general principles involved in this problem, in order that the desired information can be more readily transmitted to those interested. Furthermore, the present Ohio legislature has passed a law making it necessary that all residence as well as municipal plants be approved by the State Board of Health before being constructed; and for this reason the subject is likely to be of wider interest in this state than ever before.

Household or domestic sewage may be said to consist of discharges from the alimentary canal and kidneys, as well as of waste water from the kitchen sinks, the bath, the laundry, and house cleaning.

In houses where running water is not available it is customary to use a privy vault or dry closet for the collection of the excreta, and to dispose of the waste water, which under these conditions is small in volume, by means of a cesspool or by throwing it out upon the ground at some convenient point. Such waste water, however, is often infected from contact with diseased persons or infected clothes, and should be, therefore, as carefully disposed of as any other portion of the household sewage.

Of course, it is possible to inoffensively construct and maintain privy vaults and dry earth closets, but in the great majority of instances more or less nuisance has resulted from these. Aside from offensive odors, there is great danger in permitting an accumulation of human excrement in a more or less open vault in the vicinity of houses, for the reason that the germs of typhoid and other intestinal diseases will sooner or later be conveyed to the family food supply by means of flies or other insects, rats, or chickens.

The new state building law contains strict regulations regarding the location and construction of privy vaults. These are prohibited on premises where sewers and a water supply are available. It is the evident intent of the law to discourage the construction of vaults except where absolutely necessary, and it is forbidden to locate them: Within 2 feet of any lot line; within 20 feet of any street line or building; within 50 feet of any cistern or well; or, wherever the night soil will have to be carried through any building. The law contains rigid specifications regarding the construction of vaults and makes it necessary to use concrete or hard burned sewer brick laid in Portland cement; and in all cases the walls must extend 12 inches above the surrounding ground.

When houses have modern plumbing, so-called, the problem of sewage disposal becomes more difficult, owing to the large volume of liquid to be disposed of and the fact that the excreta are mixed with other wastes. Some idea of the volume of sewage from a household, under modern conditions may be had by comparing the old fashioned form house, supplied by a hand operated well, with an up-to-date residence where, with every flush of the water closet, nearly as much water is discharged as was under old conditions necessary for the daily needs of a family. In addition to the difficulty of handling the larger volume of sewage, there is also an increased danger of contaminating nearby wells, due to the greater facility with which polluting material is carried about when mixed with the larger volume of water. That is, instead of having, as formerly, the offensive and dangerous material concentrated in a vault or dry closet, we now have conditions where the same amount of material is likely to be distributed over a much greater range of influence.

Statistics on the daily consumption of water per capita in small villages show that this varies from 50 to 100 gallons or more. These figures, of course, include the amount used for sprinkling, watering streets, fire purposes, etc., so that they would be greater than the daily amount per capita which is changed into sewage. However, it is believed that a representative figure for the daily per capita yield of sewage, in a household of five or six persons, would be 30 or 40 gallons.

Under modern conditions, therefore, the sewage from a household may be said to consist of water contaminated by small percentages of fecal matter, urine, food refuse, soap, grease, filth from the laundry, bits of paper, matches, etc. When fresh, the sewage has but a slight odor, but upon being allowed to stand, decomposition rapidly starts and offensive odors are given off. Furthermore, on standing the coarser and heavier solid material rapidly settles to the bottom.

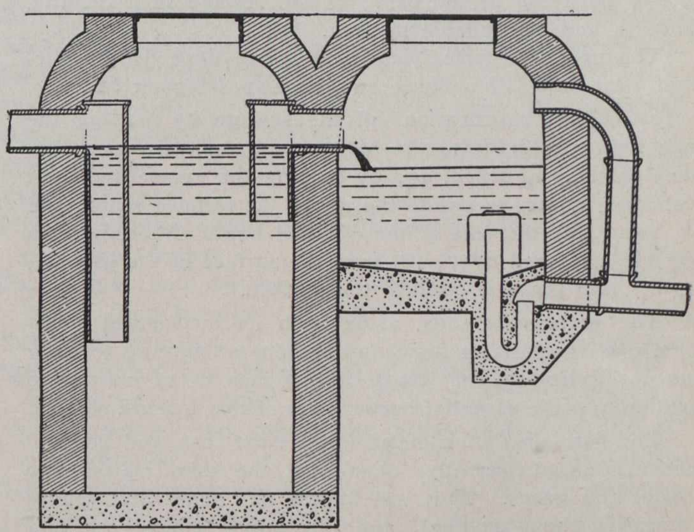


Fig. 1.—Sectional Elevation, Showing Settling or Septic Tank and Dosing Chamber.

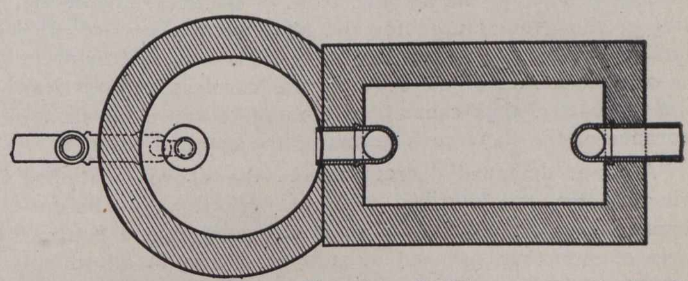


Fig. 2.—Sectional Plan, Showing Settling or Septic Tank and Dosing Chamber.

When the sewage is thus diluted, there are two ways of disposing of it, one is by means of cesspools and the other by means of scientifically designed sewage purification plants. Of course, there is some similarity between the ordinary cesspools, so-called, and the settling or septic tank, which usually constitutes a part of the sewage purification plant. Both are designed with an idea of separating the liquid and solid matter and of partially liquefying the latter. With the cesspool, however, no positive nor reliable means are provided for properly disposing of or purifying the clarified liquid effluent; whereas with a properly designed plant, the disposal of the liquid is the most essential feature of the entire problem.

The general undesirability and danger of maintaining a cesspool, especially on a small lot, is too well known to be

*Read before a Conference of Boards of Health held at Cleveland July 20 and 21, 1911.

emphasized here. If the structure be watertight the expense of frequent cleaning is great; whereas, if it be of the "leaching" variety it is a constant menace to the surrounding soil and to nearby wells.

Referring again to the new state building code, it is of interest to mention that this contains several sections regarding the construction and use of cesspools. As in the case of privy vaults it is the intent of the new law to minimize the use of cesspools; and therefore they are not allowed wherever a public sewer is accessible. Even then none can be constructed without a permit from the local board of health in a city; or the State Board of Health when installed outside of a city. In no case can a tight cesspool be located within 30 feet of any well or spring, nor a leaching cesspool within 100 feet of any dwelling or 300 feet of any source of water supply.

From the above it will be seen that although a privy vault or cesspool might be in general classed as a residence sewage disposal plant, yet the true definition of such a plant would include only a scientifically designed apparatus capable of purifying or disposing of the sewage in a definite, sanitary, and controllable manner.

The two chief principles upon which depends the successful operation of a house sewage disposal plant are:

1st. The clarification of the sewage by causing the solid matter to settle to the bottom of a tank and there become partially liquefied, and by causing the grease and light suspended matter to rise to the top in the form of scum; and

2nd. The disposal of the clarified liquid either (a) in a specially prepared filter; (b) over the surface of the ground; or, (c) into the soil beneath the surface.

The process depends, aside from its mechanical workings, upon bacterial action; and without attempting to enter into a bacteriological discussion, it may be of interest to mention that the essential bacteria are of two general classes.

The first class of bacteria inhabit the tank and perform the function of partially changing the solid matter into liquids and gases. They are known as anaerobic (those working without oxygen), and facultative (those working either with or without oxygen). The bacteria are assisted in their work by worms and other animal organisms.

The second, or the aerobic, class of bacteria inhabit the filter or the ground used for the final purification of the clarified sewage. The function of this class is to transform the organic matter of the sewage into harmless and odorless mineral matter, thus causing or tending to cause the disappearance of the dangerous germs of the original sewage.

A plant designed according to the above mentioned principles may be described somewhat as follows:—The outflowing sewage from the house is delivered into a settling basin of sufficient size and of suitable design to afford opportunity for the sedimentation of the solid matter and the rise of the grease. This basin or tank contains a constant volume which approximately should equal one or two days' flow of sewage. The inlets and outlets should be so arranged that neither the scum at the top nor the sludge at the bottom is disturbed as the sewage passes through it. The matter deposited in the bottom of the tank becomes partially reduced and passes away in the form of liquid or gas. There will be, however, a certain accumulation which must be cleaned out occasionally, probably not oftener than once a year. The tank should be ventilated through the main soil pipe of the house in the same way in which modern sanitary sewer systems are ventilated.

The clarified liquid overflowing from this tank passes into a second one adjacent thereto, called the dosing tank. Herein is placed an automatic siphon or other controlling device which holds back the flow until the sewage has reached a certain depth, at which time the entire contents of the dosing tank are discharged very rapidly. The discharge completed, the apparatus automatically prevents further outflow until the tank becomes again full. This tank serves to apply the sewage to the filter, sub-surface disposal system, or other means for final purification, to which the capacity or "dose" must bear a certain relation in order that the sewage be properly distributed.

Such distribution is essential for the reason that, if the sewage is allowed to pass on to the filter or into the "absorption system" in the same irregular way that it leaves the house, the filtering material will be constantly saturated in places and hence become clogged and foul. In other words, the filtering material must be kept clean by allowing the air to frequently penetrate it. (See Figs. 1 and 2.)

The disposal of the clarified sewage by open filters and by broad irrigation is identical, in principle, with the corresponding methods for city plants and need not be described here. Of course, these can be used only where ample land is available; and they are not suitable for built up districts, but rather for isolated houses. In any case, these methods involve exposing the unpurified sewage to the air and are, therefore, less desirable than a sub-surface system. If, however, one wishes to construct a filter bed in a concrete chamber beneath the ground, this can be satisfactorily done, though somewhat expensive, in close proximity to residences. (See Fig. 3.)

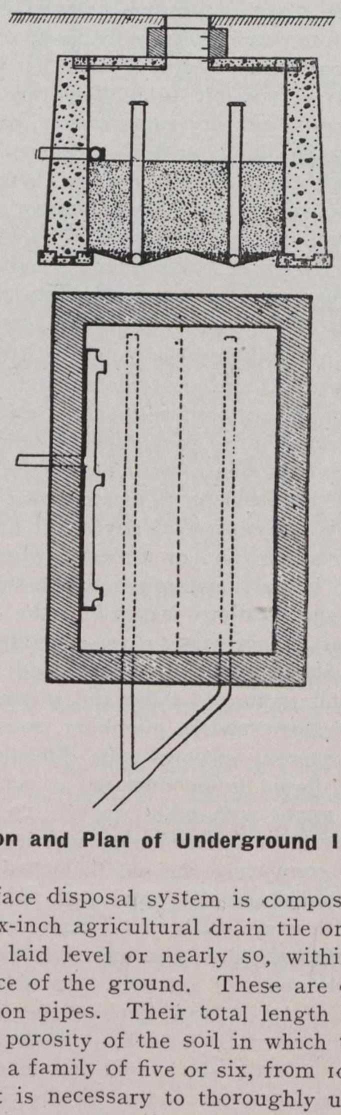


Fig 3.—Section and Plan of Underground Intermittent

The sub-surface disposal system is composed of lines of three, four, or six-inch agricultural drain tile or vitrified pipe with open joint, laid level or nearly so, within one or two feet of the surface of the ground. These are called absorption or distribution pipes. Their total length is determined primarily by the porosity of the soil in which they are placed and varies for a family of five or six, from 100 to 600 feet. In clayey soils it is necessary to thoroughly underdrain the land at a depth of 3 or 4 feet in order to render the soil dry enough to absorb the sewage, and in addition it is desirable to surround the tile with gravel, cinders or porous material. There should be, of course, no opportunity for sewage to pass directly from the absorption pipe into any of the underdrains. As mentioned above, the cubical contents of the absorption system should have a certain relation to the dosing tank in order that the sewage may be properly distributed. It is often convenient, furthermore, to divide the system into two of three portions in order that the flow may be changed from one to the other every few weeks.

There will doubtless be a certain accumulation of finely divided solid matter in the tile which may make necessary their relaying after a period of years. This, however, is a matter of small importance. The system can be placed at any convenient point and is often installed underneath the lawn or vegetablt garden without in any way showing evidences of its existence, except by assisting in the growth of vegetation.

While the general principles of the design of municipal sewage purification plants apply also to residential plants, yet there are several practical differences which should be borne in mind.

In the first place the sewage from individual houses is extremely fresh and there is no opportunity for the mechanical breaking up of the larger suspended particles as is the case when sewage flows for miles in a city water. Then there are extreme fluctuations in the rate of flow in the case of the single house, as compared to the more regular discharge from a municipality. For instance, there is rarely any flow during the night, and the flow during the day comes in sudden rushes.

The small actual size of a house sewage tank, although it may be large from the standpoint of "hours of storage," may permit a sudden inrush of sewage to stir up the entire contents, thus carrying out some solid matter and causing the filters of the subsurface system to clog. The above mentioned facts show the necessity of designing both tanks and finishing treatment on a more liberal per capita basis than is required with municipal plants.

Finally, residential plants are intended to be more automatic than municipal plants, and rarely receive regular attention, and they must, of necessity, be located much nearer to dwellings than city plants. It is necessary, therefore, to exercise much more care in design in order that no work need be done on the plant oftener than once a year, although it should be inspected every few months. Also the design should be such that the plant will create no odors even though within a few feet of a residence.

Relative to the cost of building an efficient residential sewage disposal plant for a family of five or six, this will vary greatly according to the local cost of material and labor and the character of the ground in which it is to be placed. The usual tanks with subsurface absorption system should be built in porous ground for $100 to $150; and in clay soil for $250 to $300. A plant including a covered sand filter may cost $500.

AMERICAN RAILROAD RESULTS.

The preliminary abstract of United States Railway Statistics for the year ended 30th June, 1910, has just been issued by the Inter-State Commerce Commission, and contains much interesting information. At the close of the year there was a total single track mileage of 240,400, an increase of 3,600 over that at the end of 1908-9. There was an increase exceeding 100 miles in Arizona, California, Florida, Georgia, Minnesota, Mississippi, Nevada, Oklahoma, Oregon, Texas, Washington and West Virginia. During the year companies owning 8,600 miles of line were reorganized, merged or consolidated.

At the end of the year the par value of the amount of capital outstanding according to the returns of companies was $18,417,132,200. Of this amount, $14,338,575,900 was outstanding in the hands of the public. Of the total capital outstanding, there existed as stock, $8,113,667,400, of which $6,710,168,500 was common and $1,408,488,900 was preferred; the remaining part, $10,303,474,900, represented funded debt, consisting of mortgage bonds, $7,408,183,500; collateral trust bonds, $1,153,499,800; plain bonds, debentures and notes, $933,966,700; income bonds, $290,951,300; miscellaneous funded obligations, $163,532,000, and equipment trust obligations, $353,341,600. Of the total capital stock outstanding, $2,701,078,900 or 33.29 per cent., paid no dividends. The amount of dividends declared during the year (by both operating and lesser companies) was $405,771,400, being equivalent to 7.50 per cent. on dividend-paying stock. No interest was paid on $790,499,300, or 7.94 per cent. of the total amount of funded debt (other than equipment trust obligations) outstanding.

The operating revenue (average mileage operated 237,000 miles) was $2,750,667,400, and operating expenses were $1,822,630,400. The corresponding returns for 1909 (average mileage operated 233,000 miles) were: Operating revenue, $2,418,677,500; operating expenses, $1,599,443,400. The following figures present a statement of the operating revenue for 1909-10 in detail:—

Freight revenue	$1,925,553,036
Passenger revenue	628,992,473
Mail revenue	48,913,888
Express revenue	67,190,922
Excess baggage revenue and milk revenue (on passenger trains)	14,733,680
Parlor and chair car revenue and other passenger train revenue	4,412,973
Switching revenue	26,367,214
Special service train revenue and miscellaneous transportation revenue	8,858,215
Total revenue from operations other than transportation	23,778,637
Joint facilities revenue—Dr.	572,875
Joint facilities revenue—Cr.	2,439,272
Total operating revenue	$2,750,667,435

The operating revenue stated above averaged $11,607 per mile of line.

Operating expenses, as assigned to the five general classes were:—

Maintenance of way and structures	$ 368,507,102
Maintenance of equipment	413,109,929
Traffic expenses	55,912,620
Transportation expenses	916,614,826
General expenses	68,485,956
Total operating expenses	$1,822,630,433

The foregoing operating expenses averaged $7,691 per mile of line.

The number of passengers carried was 971,683,199, and the corresponding number for the year ended 30th June, 1909, was 891,472,425, the increase being 80,210,774. The number of passengers carried one mile, as compiled for 1910, was 32,338,496,329. The corresponding return for 1909 was 3,229,173,740 less. The number of passengers carried one mile per mile of road was 138,250. The number of tons of freight shown as carried (including freight received from connections) was 1,849,900,101, while the corresponding figure for the previous year was 1,556,559,741, the increase being 293,340,360 tons. The number of tons carried one mile was 255,016,910,451. The total ton mileage as reported for the year ended 30th June, 1909, was 218,802,986,929, giving an increase in 1910 of 36,213,923,522.

PERMANENT CULVERTS.*

By W. S. Gearhart, State Highway Engineer of Kansas.

On each mile of road one or more culverts are necessary throughout the Mississippi valley to carry the water under and across the highway. The water should not ordinarily be carried across the road, however, if it cannot reach a natural water course at once.

At the present time it is not practicable nor is it necessary to gravel or macadamize all the roads, but a "junk pile" of wood and disintegrated stone or concrete, or a "scrap pile" of tin and steel for a culvert is just as much out of place and just as expensive on an earth road as on a well improved boulevard. The culvert or bridge in the lane rusts out and rots out and washes out as fast as the one on the heavily travelled road. It is not the travel in most instances that destroys the structure, but the elements.

Much as we need improved roads, we need permanent culverts more. It is more important that all the bridges and culverts be in good condition than that all the roads be kept in first class repair, for if the road is to be used at all the culverts and bridges must be kept up. It is not often that a road gets so bad that it is impassable, but this is a common occurrence with culverts and bridges. The old ford is a thing of the past and almost without exception the worst places in the road are at the culvert sites. They generally are from 2 ins. to 10 ins. above or below the road surface and often have a mud hole on either side and are in such wretched condition we would gladly drive around them if we could, and often have to do so. And many of the stone and concrete culverts are only covered sufficiently to keep them in place. They are like a series of barrels half buried in the road, no attempt being made to build approaches to them.

There are miles of road in every township in Kansas on which there has not been a dollar spent for grading or repairs in the last five years, but all of the wood culverts on these same roads have been maintained and rebuilt in that time at a cost which would have built them all of concrete or stone. At the present time we are spending more than half of the $1,500,000 taxes levied in Kansas for roads and bridges in the townships, for the maintenance and construction of the bridges and culverts under 10-ft. spans. The Missouri, Iowa, Wisconsin and Illinois highway commissions report almost as large expenditures for these structures.

The life of the most permanent road we can build of good first class brick would probably not be over thirty years and would require more or less repairs constantly. The other types of road construction which are considered more or less permanent also require constant renewing and repairing, but in the case of the bridges and culverts it is possible to construct them in such a manner as to eliminate the maintenance cost and make them everlasting; so that it is a very short-sighted policy to use any other materials than those recognized to be the most permanent.

Different state highway commissions have defined culverts as structures having spans of less than 4 ft. to 10 ft. In this discussion I assume that all structures under 10 ft. are culverts.

The culvert problem is sadly neglected even by the legislatures in most states—strange to say. And Kansas is no exception to the rule. The townships build the structures costing less than $200 as best suits the fancy of each particular board.

In my judgment, the state highway commissions have not given this important phase of the road problem a proper place in their work outside of particular pieces of demonstration roads. This is probably largely due to the relatively high cost for engineering on these small structures. I believe that until the counties have competent county engineers to take charge of this work, the state highway commissions should, if possible, hold a two or three days' demonstration school in each county at least once in two years, and that the township officials should be compelled to attend and be paid their regular wages per diem. Half of the time should be devoted to the best methods of culvert construction and the remainder to road construction and maintenance. This school should be conducted the same as the extension departments of our agricultural colleges are teaching domestic science, stock judging, dairying, crop rotation and soil fertility in their movable schools.

Centralize authority as much as we can, and still the actual doing of a very large part of the construction and maintenance of the culverts and earth roads will be in direct charge of men who are not competent to do it. We must educate them and the school will have to be taken to them.

The overseer should be hired by the year and on account of his fitness for the work instead of his political views or because he is a good fellow. When we give men an opportunity to make a living building roads and culverts and to hold their places if they do good work there will be no trouble to get competent men at a reasonable cost.

At the present time practically all of the culverts are too small to carry the water that comes to them. The matter of the required area is one that has been given very little attention. When a new culvert is to be constructed the township commissioners generally each make a guess as to the area required, and then agree by a majority vote as to what the size should be, which vote is largely determined by the amount of money that is available for a particular structure or how many of the commissioners live in that neighborhood. There is no excuse whatever for this unbusinesslike guessing method. The railroad companies have made accurate surveys of drainage areas and computed the run-off, from the maximum rainfall, per hour, and have designed their structures according to these scientific methods, and in most cases have had an opportunity to determine from practical use as to whether their computations were correct or not.

The factors entering into the problem of the probable run-off are the area of the drainage basin, the maximum rainfall per hour, the slope of the surface, the character of the soil, whether it is porous or compact, and whether it is cultivated or wooded. The accompanying table is that prepared by the engineering department of the A. T. & S. F. Railway for the approximate areas of waterways for average drainage areas in eastern Kansas and Missouri, where the rainfall is about 35 inches per year.

It will be noted that a normal drainage area containing one square mile, or 640 acres, requires 100 square feet of waterway area. These figures can be very easily kept in mind and waterways for drainage areas up to 4 square miles readily determined, even though the table containing the tabulated data is not at hand, by multiplying the area in square miles by 100. These tables contain the most reliable information yet available and since the drainage basins have been carefully surveyed and record of the maximum rainfall kept and the structures designed from this data have been in practical use for a number of years, makes

* From an address presented at the Seventh Annual Convention of the American Road Builders' Association, Indianapolis, December 6-9, 1910.

Column D = Areas drained in square miles.
Column A = Areas of waterway in square feet.

D	A	D	A	D	A
.01	2.0	4.8	443.0	60.0	1,650.0
.02	4.0	5.0	455.0	65.0	1,720.0
.04	7.5	5.5	483.0	70.0	1,780.0
.06	10.5	6.0	509.0	75.0	1,840.0
.08	13.5	6.5	533.0	80.0	1,900.0
.10	16.0	7.0	556.0	85.0	1,960.0
.15	25.0	7.5	579.0	90.0	2,015.0
.20	32.0	8.0	601.0	95.0	2,065.0
.25	38.0	8.5	622.0	100.0	2,120.0
.30	44.0	9.0	641.0	110.0	2,220.0
.40	56.0	9.5	660.0	120.0	2,315.0
.50	66.0	10.0	679.0	130.0	2,405.0
.60	74.0	11.0	710.0	140.0	2,500.0
.70	81.0	12.0	740.0	150.0	2,580.0
.80	88.0	13.0	775.0	160.0	2,665.0
.90	94.0	14.0	805.0	170.0	2,745.0
1.0	100.0	15.0	835.0	180.0	2,820.0
1.2	120.0	16.0	865.0	190.0	2,900.0
1.4	140.0	17.0	890.0	200.0	2,970.0
1.6	160.0	18.0	920.0	220.0	3,115.0
1.8	180.0	19.0	945.0	240.0	3,245.0
2.0	200.0	20.0	970.0	260.0	3,370.0
2.2	220.0	22.0	1,015.0	280.0	3,495.0
2.4	240.0	24.0	1,060.0	300.0	3,615.0
2.6	260.0	26.0	1,100.0	325.0	3,770.0
2.8	280.0	28.0	1,140.0	350.0	3,900.0
3.0	300.0	30.0	1,180.0	375.0	4,035.0
3.2	321.0	32.0	1,220.0	400.0	4,165.0
3.4	340.0	34.0	1,255.0	450.0	4,385.0
3.6	357.0	36.0	1,290.0	500.0	4,610.0
3.8	373.0	38.0	1,320.0	550.0	4,825.0
4.0	388.0	40.0	1,350.0	600.0	5,030.0
4.2	403.0	45.0	1,435.0	650.0	5,230.0
4.4	417.0	50.0	1,510.0	700.0	5,420.0
4.6	430.0	55.0	1,580.0		

such information of inestimable value and the areas of the waterways given here are as nearly correct as it is possible to learn at the present time. In the construction of new culverts these tables should be carefully consulted after the drainage area and the character of the slopes and soil have been determined. It should be remembered, however, that these waterways are for average drainage areas.

Good stone laid in cement mortar is very satisfactory either in arch or flat top slab construction for culverts. If slabs are used a 4-ft. clear span would require that the flag stones should be 12 ins. thick. Six feet is close to the safe maximum span for the flat top stone culvert. Many times stone abutments are built and a reinforced concrete slab placed on top which gives a very satisfactory structure.

In the arch construction the base of the foundations should be sufficiently wide to resist overturning and be staple under any system of loads without any consideration for the earth fills.

Plain or reinforced concrete is no doubt the best material to use for these small structures either in the flat top or arch form. The arch is sometimes objectionable in a flat country because it is found necessary in order to get a sufficient amount of water-way to make a raise in the road, which in many cases is very disagreeable. In the case of the flat top bridge the required waterway can be obtained by lengthening the span without making a hump in the road, which hump would in most cases result in a mud hole on either side of it. Where the foundations are not first class, and there is danger of the structure settling, the flat top is also to be preferred, as the forces are all vertical and the top is self-supporting. If the abutments do settle the top can be readily jacked up into place and adjusted, while in the arch form there is very little that can be done to repair injury done by settlement.

There are a number of steel collapsible forms on the market for the constructing of both plain and reinforced concrete culverts which are satisfactory. There are also adjustable, collapsible wood forms which can be used for the construction of culverts from 18 in. to 4 ft. in diameter very economically.

No culvert should be constructed having a less diameter than 15 inches and a clear roadway between the head walls should not be less than 20 feet and better 24 feet at right angles to the road. There should be ample room for teams to pass upon these small structures without stopping. Careful attention must be given to the angle at which the culvert crosses the road. So far as is possible it should be placed in the direction of the flow of the water it is designed to carry. Culverts designed merely to convey water from one side of the road to the other should never be at a right angle to the road. Much trouble in cleaning out clogged culverts and frequent expensive repairs to the road may be avoided by placing the culvert at an angle of from 30 to 60 degrees. No culvert is complete, regardless of the material used in the barrel, without head walls and wing, both on the upstream and downstream ends to hold the fill and force the water through the opening instead of under it and around it. The downstream end fails first and a curtain wall should be constructed at both ends of the culvert extending down at least 2½ feet below the bed of the stream, having a thickness of not less than 12 inches and extend the entire width of the culvert to prevent the water from undermining the structure. These curtain walls should be used whether the culvert is floored or not.

Concrete is the only building material we have that gets stronger with age and requires no painting, repairs or renewals and is everlasting.

The failures in concrete work are largely due to inexperienced foremen and lack of proper inspection of the proportioning and mixing of the materials and placing and caring for the concrete until it has hardened.

To obtain first-class concrete it is necessary to use good materials and the work must be in charge of a thoroughly competent man. If the road overseer is employed by the year, as suggested, he can build these culverts in the late summer and early fall by day labor. All the money will then remain in the immediate neighborhood and the home laborers will do better work, for they will have a personal interest in the structure, and there will be no incentive for the foreman to skimp or slight his work.

Road officials need not fear being criticised and should not hesitate to spend the township funds for permanent culverts, as the people are thoroughly aroused on this question and are ready to adopt concrete and stone to take the place of the temporary wood and other structures. No difference how indifferent they may be about road improvements, they are ready to relegate the old wood culvert to the "scrap pile" and put in structures that are permanent.

If all road officials will begin now to put in all concrete or stone culverts in place of the wood and other temporary ones in five years every culvert in every township in the country will be a permanent structure. If necessary the townships would be justified in voting bonds to build these culverts of concrete or first-class stone, for they are permanent structures. The future generations might possibly have to help pay for some culverts, but it would not be necessary for them to build any.

BRITISH STANDARD FOR REINFORCED CONCRETE CONSTRUCTION.

(Continued from Last Week).

13. **Testing.**—Before the detailed designs for an important work are prepared, and during the execution of such a work, test pieces of concrete should be made from the cement, sand, and aggregate to be used in the work, mixed in the proportions specified. These pieces should be either cubes of not less than 4 in. each way, or cylinders not less than 6 in. diameter, and of a length not less than the diameter. They should be prepared in moulds, and punned as described for the work. Not less than four cubes or cylinders should be used for each test, which should be made 28 days after moulding. The pieces should be tested by compression, the load being slowly and uniformly applied. The average of the results should be taken as the strength of the concrete for the purposes of calculation, and in the case of concrete made in proportions of 1 cement, 2 sand, 4 hard stone, the strength should not be less than 1,800 lbs. per sq. in. Such a concrete should develop a strength of 2,400 lbs. at 90 days.

Loading tests on the structure itself should not be made until at least two months have elapsed since the laying of the concrete. The test load should not exceed one and a half times the accidental load. Consideration must also be given to the action of the adjoining parts of the structure in cases of partial loading. In no case should any test load be allowed which would cause the stress in any part of the reinforcement to exceed two-thirds of that at which the steel reaches its elastic limit.

METHODS OF CALCULATION.

Data.

1. **Loads.**—In designing any structure there must be taken into account:—

(a) The weight of the structure.

(b) Any other permanent load, such as flooring, plaster, etc.

(c) The accidental or superimposed load.

(d) In some cases also an allowance for vibration and shock.

Of all probable distributions of the load that is to be assumed in calculation which will cause the greatest straining action.

(i) The weight of the concrete and steel structure may be taken at 150 lbs. per cu. ft.

(ii) In structures subjected to very varying loads and more or less vibration and shock, as, for instance, the floors of public halls, factories, or workshops, the allowance for shock may be taken equal to half the accidental load. In structures subjected to considerable vibration and shock, such as floors carrying machinery, the roofs of vaults under passage ways and courtyards, the allowance for shock may be taken equal to the accidental load.

(iii) In the case of columns or piers in buildings which support three or more floors, the load at different levels may be estimated in this way. For the part of the roof or top floor supported, the full accidental load assumed for the floor and roof is to be taken. For the next floor below the top floor 10 per cent. less than the accidental load assumed for that floor. For the next floor 20 per cent. less, and so on to the floor at which the reduction amounts to 50 per cent. of the assumed load on the floor. For all lower floors the accidental load on the columns may be taken at 50 per cent. of the loads assumed in calculating those floors.*

Beams.

2. **Spans.**—These may be taken as follows:—For beams, the distance from centre to centre of bearings; for slabs supported at the ends, the clear span + the thickness of slab; for slabs continuous over more than one span, the distance from centre to centre of beams.

3. **Bending Moments.**—The bending moments must be calculated on ordinary statical principles, and the beams or slabs designed and reinforced to resist these moments. In the case of beams or slabs continuous over several spans or fixed at the ends, it is in general sufficiently accurate to assume that the moment of inertia of the section has a constant value.

Where the maximum bending moments in beams or floor slabs continuous over three or more equal spans and under uniformly distributed loads are not determined by exact calculation, the bending moments should not be taken less than $+\frac{wl^2}{12}$ at the centre of the span and $-\frac{wl^2}{12}$ at the intermediate supports.

When the spans are of unequal lengths, when the beam or slab is continuous over two spans only, or when the loads are not uniformly distributed, more exact calculations should be made.

If the bending moments are calculated by the ordinary theory of continuous beams, it should be remembered that the supports are usually assumed level, and if this is not the case, or the supports sink out of level, the bending moments are altered.

4. **Stresses.**—The internal stresses are determined. as in the case of a homogeneous beam, on these approximate assumptions:

(a) The coeffiient of elasticity in compression of stone or gravel concrete, not weaker than 1:2:4, is treated as constant, and taken at one-fifteenth of the coefficient of elasticity of steel.

				Lb. per sq. in.
Coefficient for concrete	=	Ec	=	2,000,000
Coefficient for steel	=	Es	=	30,000,000

$$Es = 15.$$
$$Ec = 15.$$

It follows that at any given distance from the neutral axis, the stress per sq. in. on steel will be fifteen times as great on concrete.

(b) The resistance of concrete to tension is neglected, and the steel reinforcement is assumed to carry all the tension.

(c) The stress on the steel reinforcement is taken as uniform on a cross-section, and that on the concrete as uniformly varying. In the case of steel of large section it may be necessary to consider the stress as varying across the section.

5. **Working Stresses.**—If the concrete is of such a quality that its crushing strength is 1,800 lbs. per sq. in. after 28 days as determined from the test cubes made in accordance with Clause 13, and if the steel has a tenacity of not less than 60,000 lbs. per sq. in., the following stresses may be allowed:

*In the case of many warehouses and buildings containing heavy machines it is desirable not to make any reduction of the actual loads.

	Lbs. per sq. in.
Concrete in compression in beams subjected to bending	600
Concrete in columns under simple compression	600
Concrete in shear in beams	60
Adhesion * or grip of concrete to metal	100
Steel in tension	16,000
Steel in compression—15 times the stress in the surrounding concrete.	
Steel in shear	12,000

When the proportions of the concrete differ from those stated above, the stress allowed in compression on the concrete may be taken at one-third the crushing stress of the cubes at 28 days as determined above.

If stronger steel is used, the allowable tensile stress may be taken at one-half the stress at the yield point of the steel, but in no case should it exceed 20,000 lbs. per sq. in.

Beams with Single Reinforcement:

Beams with single reinforcement can be divided into three classes:—

(a) Beams of T form in which the neutral axis falls outside the slab.

(b) Beams of T form in which the neutral axis falls within the slab.

(c) Rectangular beams.

The equations found for (a) are general equations, from which the equations for (b) and (c) may be deduced.

In the calculation of all beams, the area upon which the ratio of tensile reinforcement is taken is considered as a rectangle of breadth equal to the greatest breadth of the beam and of depth equal to the greatest effective depth of the beam.

In designing beams where the rib is monolithic with a slab, the beam may be considered to be of T form. The slab must first be calculated and designed having its own reinforcing bars transverse to the rib. The whole of the slab cannot in general be considered to form part of the upper flange of the T beams. The width, b, of the upper flange may be assumed to be not greater than one-third the span of the beams, or more than three-fourths of the distance from centre to centre of the reinforcing ribs, or more than fifteen times the thickness of slab. The width b of the rib should not be less than one-sixth of the width b, of the flange.

(a) Beams of T section where the neutral axis falls outside the slab.

In this case the small compression in the rib between the underside of the slab and the neutral axis may be neglected. In a homogeneous beam the stresses are proportional to the distances from the neutral axis. In a discrete beam, such as a beam of concrete and steel, on account of the greater rigidity of steel, at a given distance from the neutral axis the stress in the steel will be m times as great as in concrete.

Hence:—

$$\frac{mc}{t} = \frac{n_1 d}{d(1 - n_1)} = \frac{n_1}{1 - n_1}$$

$$\frac{c}{t} = \frac{n_1}{m(1 - n_1)}.$$

The mean compressive stress in the flange is and the total compression is

$$bds \frac{c}{2} \cdot \frac{2n - ds}{n}$$

The area of reinforcement $At = rbd$ and the total tension is

$$trbd$$

Equating total compression and total tension

$$bds \frac{c}{2} \cdot \frac{2n - ds}{n} = trbd$$

$$\frac{c}{t} = \frac{2rn_1}{(2n_1 - s_1)s_1}.$$

Equating these two values for $\frac{c}{t}$

$$\frac{n_1}{m(1 - n_1)} = \frac{2rn_1}{(2n_1 - s_1)s_1}$$

$$n = \frac{s_1^2 + 2mr}{2(s_1 + mr)}.$$

The value of the lever arm is

$$d - \frac{ds}{3} \cdot \frac{3n - 2ds}{2n - ds}$$

The compressive resistance moment of the beam is

$$Rc = cbdds \frac{(s_1^3 + 4mrs_1^2 - 12mrs_1 + 12mr)}{6(s_1^2 + 2mr)}$$

The tensile resistance moment is

$$Rt = tbd^2 \frac{(s_1^3 + 4mrs_1^2 - 12mrs_1 + 12mr)}{6m(2 - s_1)}.$$

To obtain stresses in the concrete and steel equal to c and t respectively, r must have a value

$$\frac{2mcs_1 - mcs_1^2 - ts_1^2}{2mt}$$

When r exceeds the value given by this equation, the equation to Rc must be used in determining the moment of resistance. When r is less than the above value the equation to Rt must be used.

The following equation gives the value for r, which causes the neutral axis to be at the underside of the slab:—

$$r = \frac{s'^2}{2m(1 - s_1)}$$

(b) When the neutral axis falls within the slab, or is at the bottom edge of the slab, the equation for values of n_1, Rc, and Rt can be simplified, and become

$$n = \sqrt{(m^2r^2 + 2mr)} - mr.$$

To obtain stresses in the concrete and steel equal to c and t respectively

$$r \text{ must equal } \frac{mc^2}{2t(mc + t)}$$

(c) For rectangular beams not of T form, the equations given for T beams under (b) apply.

The ratio of reinforcement may be taken on any other suitable sectional area if the formulæ are modified in accordance.

Slabs Supported or Fixed on More Than Two Sides.

It does not appear that there is either a satisfactory theory or trustworthy experiments from which the strength of rectangular slabs supported or fixed on all four edges can be determined. [**Appendices to the report give a statement of some rules which have been used in determining the strength of slabs.**]

Shear Reinforcement.

It is always desirable to provide reinforcement to resist the shearing and diagonal tension stresses in reinforced concrete beams. The diagonal tension stresses depend on the vertical and horizontal shear, and also on the longitudinal tension at the point considered. As the longitudinal tension in the concrete at any given point is very uncertain, the amount and direction of the diagonal tension cannot be exactly determined.

It is the general practice to determine the necessary reinforcement by taking the vertical and horizontal shearing only into consideration.

The following equations may be used to determine the necessary resistance to shearing.

When S, the total shear in lb. at a vertical section, does not exceed 60ba, no shear reinforcement is required.*

When S exceeds 60ba, vertical shear members may be provided to take the excess and proportioned by the following rule:—

$$\frac{As \, . \, ss \, . \, a}{p} = S - 60ba$$

or

$$As = \frac{(S - 60ba)\ p}{a\ ss};$$

where s^s is the unit resistance of the steel to shearing, and p is the pitch, or distance apart of the vertical shear members or groups of shear members, of area As.

In the case of T beams b^s, should be substituted for b.

In important cases, when extra security is required, the resistance of the concrete to shear, represented by 60ba, should be disregarded.

When the shear members are inclined at an angle of about 45° to the horizontal, the area As may be decreased in the proportion of $\frac{1}{\sqrt{2}}$.

These equations, though based on somewhat uncertain assumptions, give reasonable results. But experience shows that:—

(a) In general, floor slabs require no special reinforcement against shearing, and that the bending up of alternate bars near the end is sufficient.

(b) In beams, especially in T beams, shearing reinforcement should be provided at distances apart not exceeding the depth of the beam.

(c) It is desirable to bend up one or more of the bars of the tension reinforcement near the supports. When bent at an angle of about 45° the effect of this may be taken into account in the manner set out above; when bent at a small angle to the horizontal the effect is very indeterminate.

(d) As the resistance of the shear members to the pull depends on the adhesion and the anchorage at the ends, it is desirable to use bars of small diameter, and to anchor the stirrups at both their ends. In all cases the stirrups must be taken well beyond the centre of compression.

---

*The value of Sp is shown in the appendix to be $\frac{B_1 - B_2}{a}$

Pillars and Pieces Under Direct Thrust.

Definition.

The length is to be measured between lateral supports (neglecting ordinary bracketing).

The effective diameter of a pillar means the least width and should be measured to the outside of the outermost vertical reinforcement.

The effective area of a pillar means the area contained by the outermost lateral reinforcement, and should be measured to the outside of the outermost vertical reinforcement.

Loading and Length of Pillars:—

If the load is strictly axial the stress is uniform on all cross-sections.

Lateral bending of the pillar as a whole is not to be feared, provided:—

(a) That the ratio of length to least outside diameter does not exceed 18.

(b) That the stress on the concrete does not exceed the permissible working stress for the given pillar.

(c) That the load be central.

(d) That the pillar be laterally supported at the top and base.

Construction.

Lateral reinforcement properly disposed raises the ultimate strength and increases the security against sudden failure, by preventing the lateral expansion of the concrete and the sudden disruption of the pillar.

Practical considerations lead to the addition of longitudinal bars, and the formation of an enveloping network of steel.

The total cross-sectional area of the vertical reinforcement should never be less than 0.8 per cent. of the area of the hooped core.

There should be at least six vertical bars when curvilinear laterals are used, and four for square pillars having rectilinear laterals.

In the case of rectangular pillars in which the ratio between the greater and the lesser width (measured to the outside of the vertical bars) exceeds one and a half the cross-section of the pillars should be subdivided by cross-ties; and the number of vertical bars should be such that the distance between the vertical bars along the longer side of the rectangle should not exceed the distance between the bars along the shorter side of the rectangle.

The most efficient disposition of the lateral reinforcement would appear to be in the form of a cylindrical helix, the pitch or distance between the coils being small enough to resist the lateral expansion of the concrete.

(Continued Next Week).

The Canadian Northern Railway Company has at present actually under contract 1,823 miles of railway in Canada, and as soon as the location surveys in British Columbia are completed the mileage will be increased to 2,215. This development is remarkable. It means that before the close of the present year the company will have under construction a mileage nearly if not quite equal to one-sixth of the present railway mileage of Canada.

RAILROAD AND COMPANY EARNINGS.

Railroad earnings for week ended August 31st:—

	1910.	1911.	Increase or decrease.
C. P. R.	$2,965,000	$3,329,000	+ $364,000
G. T. R.	1,408,594	1,442,953	+ 34,359
C. N. R.	354,700	460,900	+ 106,200
T. & N. O.	44,831	62,016	+ 17,185
Halifax Electric Ry.	7,130	8,532	+ 1,401

Rairoad earnings for August:—

	1910	1911.	Increase or decrease.
C. P. R.	$8,926,000	$10,073,000	+ $1,147,000
G. T. R.	3,885,049	4,502,674	+ 617,625
C. N. R.	1,093,000	1,420,650	+ 327,650
T. & N. O.	126,418	173,203	+ 46,784
Halifax Elec. Ry.	22,780	25,592	+ 2,810

Earnings of the International Transit Company for the twelve months ending June 30 last have been published, and show increases over the preceding year. Gross earnings have increased 33 per cent., and operating expenses only 16 per cent, with the result that the net earnings now total $36,966, being over two and a half times bond interest. The figures are as follows:—

Gross earnings	$112,588
Operating expenses	75,622
Net earnings	$36,966

WORLD'S PRODUCTION OF PIG IRON.

Messrs. James Watson & Company, of Glasgow, Middlesborough, Liverpool, and Swansea, have issued the following figures showing the world's production of pig iron in 1910:—

	1910—Tons.
United States	27,298,545
Germany	14,793,325
Great Britain	10,216,745
France	4,032,459
Russia (estimated)	2,956,000
Austria and Hungary	1,990,684
Belgium	1,803,500
Sweden	604,300
Spain	425,000
Canada	740,210
Italy	343,600
Japan (estimated)	162,000
India	35,933
China	120,000
Mexico	45,000
New South Wales	40,487
Total	65,607,788

The total for 1910 shows an increase of 5,242,008 tons as compared with 1909, and an increase of 17,433,000 tons as compared with 1908.

PERSONAL.

Mr. A. N. Molesworth, district engineer of District D of the National Transcontinental Railway, with headquarters at Cochrane, Ont., it is announced, has resigned. A successor has not yet been appointed.

Mr. Carl Allen has been appointed by City Engineer Rust as resident engineer in charge of the new intake pipe laying. Engineer Allen had charge of the construction of the water tunnel under Toronto Bay, which was completed recently.

J. C. Dufresne, M.C.M.I., A.M. Can. Soc. C.E., has resigned his position as hydrographic engineer to the water branch of the Department of Lands, Province of British Columbia, and is starting a general consulting and supervising engineering practice, dealing particularly with irrigation projects. His office and headquarters will be at Penticton, B.C.

Mr. A. T. Ker, of the Department of Railways and Canals, Ottawa, has been appointed by Judge Mabee, chairman of the Railway Commission, to the position of advisory engineer for Alberta and British Columbia. Mr. H. A. Drury, of Winnipeg, formerly covered all the region west of Lake Superior. He will continue to act in an advisory capacity to the board for Manitoba and Saskatchewan. Mr. Ker will make his headquarters in Calgary.

Mr. J. D. Evans has been appointed resident engineer for J. G. White and Company on the Canadian Light and Power Company's works, and supervising engineer and superintendent of construction for the Montreal Street Railway Company. He has had considerable experience in various branches of engineering and construction work, and has been in charge of such works in several of the South American republics as well as in the United States and Canada. Previous to coming to Montreal Mr. Evans was in charge of the engineering and construction work of the Buffalo, Lockport and Rochester Interurban Railways.

Mr. Richard F. Williams, M.E., of Montreal, has accepted the assistant management of the Pittsburg district for Manning, Maxwell and Moore, the well-known machinery supply house. For the past two and one-half years Mr. Williams has been with the Canadian Fairbanks-Morse Co., and as manager of their machine tool and woodworking machinery departments he has been very successful. For six years Mr. Williams was with the American Locomotive Co., at Schenectady, and with the Montreal Locomotive Works as chief engineer. He has had excellent experience with F. E. Reed, of Worcester, manufacturer of machine tools, and as foreman of the repair shops at the Carnegie Steel Co., at Pittsburg. He is a graduate of Worcester Polytechnic Institute and did post-graduate work in electrical engineering.

COMING MEETINGS.

SOCIETY OF CHEMICAL INDUSTRY, CANADIAN BRANCH.—Sept. 21, 22, 23. Toronto Dr. A. McGill, Ottawa, President; Alfred Burton, Toronto, Secretary.

MINING AND METALLURGICAL SOCIETY.—The first meeting of the New York section for the year 1911-12 will be at the Engineers' Club, New York, Tuesday evening, Sept. 12.

INTERNATIONAL MUNICIPAL CONGRESS AND EXPOSITION.—Sept. 18-30. Chicago, Ill. Curb M. Treab, Secretary, Great Northern Building, Chicago, Ill.

FOURTH ANNUAL GOOD ROADS CONGRESS.—Sept. 18-Oct. 1. Chicago, Ill. J. A. Rountree, Secretary, Birmingham, Ala.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—Sept. 26-29. Grand Rapids, Mich. A. Prescott Folwell, Secretary, 239 West Thirty-ninth Street, New York City.

AMERICAN ASSOCIATION FOR HIGHWAY IMPROVEMENT.—Nov. 20-24. First Annual Convention, Richmond, Va. Logan Waller Page, President, United States Office of Public Roads, Washington, D.C.

AMERICAN ELECTROCHEMICAL SOCIETY.—September 21-23. Twentieth general meeting, Toronto, Ont.

AMERICAN PEAT SOCIETY.—Sept. 21-23. Fifth annual meeting, American House, Kalamazoo, Mich. Julius Bordollo, Secretary, Kingsbridge, N.Y.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

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

14355—July 26—Authorizing C.N.O.R. to cross public road in Lot 44, Con. 1, Twp. of Camden, County of Addington, Ontario.

14356—July 22—Authorizing C.N.Q.R. to construct bridge over Rouge River, Parish of St. Andrew, County Argenteuil, Quebec.

14357—July 15—Approving C.N.O.R. station building plans for Belleville, Ontario.

14358—July 21—Authorizing C.N. Alberta Railway to cross public road between Secs. 25, Twp. 54, R. 3, west 5th Meridian, and Sec. 30, Twp. 54, R. 2, west 5th Meridian, Alberta.

14359—Juy 21—Extending until 23rd December, 1911, time for completion of spur by C.P.R., New Westminster District, B.C.

14360—July 25—14361—July 24—Approving by-laws of Nelson & Fort Sheppard Railway and Red Mountain Railway, authorizing Herbert A. Jackson to prepare and issue tariffs of tolls for carriage of freight.

14362—July 21—Directing Napierville Junction Railway to file plans with Board within 30 days from date of Order for station building at Delson Junction, said station to be constructed within 90 days from date of approving order. Complaint, W. A. Stewart, Napierville, and village of St. Cyprien, P.Q.

14363—July 21—Directing C.P.R. to construct crossing over its railway in S.W. ½ of Sec. 12, Twp. 21, R. 1, west 5th Meridian, Alberta.

14364—July 20—Approving by-law of V.V. & E. Railway authorizing H. A. Jackson to prepare and issue tariffs of tolls (freight).

14365—July 22—Authorizing G.T.P. Branch Lines Company to cross with its Prince Albert Branch three highways in Province of Saskatchewan.

14366—July 18—Authorizing G.T.P. Branch Lines Co. to cross with its Calgary Branch five highways in Province of Alberta.

14367—July 20—Approving location and plans of G.T.P. station at Zenata, in Sec. 22, Twp. 20, R. 1, west 2nd Meridian, Saskatchewan.

14368—July 24—Authorizing G.T.P. Branch Lines Co. to cross with its Regina-Boundary Branch six highways in Province of Saskatchewan.

14369—July 22—Authorizing G.T.R. to construct bridge carrying Patten Street over its tracks at Grimsby, Ont.

14370—July 24—Authorizing G.T.R. to use and operate four bridges on E. Div.

14371—July 22—Authorizing C.P.R. to construct three bridges on Northwest Branch and Kingston and Pembroke Railway.

14372—July 22—Authorizing C.P.R. to construct spur in Lot 26, Block "E" City of Calgary, for George H. Archibald & Co.

14373—July 22—Authorizing C.P.R. to construct its Moose Jaw Northwesterly Branch across highways from mileage 243.35 to 266.37, 25 highways in all. Sask. and Alberta.

14374—July 25—Authorizing C.P.R. to reconstruct bridge at mileage 20.0 on Eastern Division, Brockville Subdivision.

14375—July 24—Slightly amending Order 14088, of June 26, 1911.

14376—July 24—14377—July 20—Approving location of plans of C.P.R. stations at Moore Park on McGregor-Varcoe Branch, Manitoba and at Abbotsford, British Columbia.

14378—July 21—Relieving C.P.R. from further protection crossing between Cons. 2 and 3, Twp. of Lobe, County of Middlesex, Ont.

14379—July 22—Authorizing G. B. & S. R. (C.P.R.) to divert public road allowance between Cons. 7 and 8, Twp. of Eldon, County Victoria, Ont.

14380—July 24—Authorizing South Ontario Pacific Railway Company for authority to construct its Guelph Junction to Hamilton Branch across 7 highways from mileage 3.98 to 9.75, Ontario.

14381—July 25—Authorizing C.P.R. to construct spur for W. Hunt, at mileage 83.54 Portal Subdivision, near Weyburn, Sask.

14382—July 24—Approving by-law of Bedlington & Nelson Railway authorizing Herbert A. Jackson to prepare and issue tariffs (freight) of tolls.

14383—July 27—Removing speed limitation of ten miles per hour by C.P.R. in Municipality of St. Antoine, Riviere du Loup, P.Q.

14384—July 22—Authorizing the C.N.R. to construct its line of railway across public road between Secs. 8 and 7, Twp. 5, R. 6, W. 2nd M.

14385—July 18—Authorizing the British Yukon Rly Co., the British Columbia Yukon Rly. Co., the Pacific and Arctic Rly. and Nav. Company, and the Dawson Board of Trade or other shippers affected, if they so desire, to supplement their case by such evidence, facts, or figures, as they deem proper; and relieving said companies from filling joint tariffs prescribed under Order dated January 18th, 1911.

14386—May 16—Declaring, upon the application of the British American Oil Co., that the legal rate chargeable by the C.P.R. on carload shipments of crude oil from Stoy, Ill., to Toronto, Ont., was the fifth class joint through rate.

14387—May 16—Declaring, upon the application of the Canadian Oil Coy., that the legal rate chargeable on petroleum and its products, in carloads, from certain Ohio and Pennsylvania points to Toronto and other Canadian points were the fifth class joint through rates.

14388—July 27—Authorizing the C.P.R. and G.T.R. to operate the interchange track between the said companies, in the town of St. Mary's.

14389—July 25—General Order re track scale weights.

14390—July 15—Approving locations of G.T.P. stations (8), in the Western Provinces.

14391—July 27—Approving of the standard plan of the C.N.R. overhead farm road bridge to be used on its eastern lines.

14392—July 26—Authorizing the G.T.P. Branch Lines Co. to construct its Calgary Branch, across the highway in the S.W. ¼ of Sec. 18, Twp. 31, R. 23, west 4th. M., Alta.

14393—July 26—Authorizing the G.T.P. Branch Lines Co. to construct its Calgary Branch across six highways in the Province of Alberta.

14394—July 27—Approving, upon the application of the G.T.P., the plan showing interlocking signalling system to be installed in the bridge over the Kyax River, B.C.

14395—July 24—Approving revised location G.T.P. station at Elie.

14396—July 25—Approving location G.T.P. station at Oban, Sask., and rescinding Order No. 13923, in so far as it relates to approval of said station at Oban.

14397—July 25—Approving location of G.T.P. Branch Lines Co.'s six stations in the Western Provinces.

14398—July 15—Approving location of G.T.P. Branch Lines Co.'s six stations in the Western Provinces.

14399—July 24—Approving location of G.T.P. Standard Station No. 1, to be erected at Nestor, Sec. 13, Twp. 48, R. 14.

14400—July 25—Authorizing the Vancouver Power Co. to cross the tracks of the New Westminster & Southern Rly Co., and the Vancouver, Victoria and Eastern Rly. and Navigation Co., in Dis. Lots 2 and 3, Group 2, New Westminster District.

14401—July 24—Approving new station at Bridgeford, Sask., C.P.R.

14402—July 27—Approving revised location of C.P.R. main line, Waldo Branch, between mileage 9.7 and mileage 11.33, Lot 132, Kootenay District, B.C.

14403—July 24—Approving revised location of C.P.R. station at Val Moran, County Terrebonne, Que.

14404—July 25—Approving proposed change in location of C.N.R. station at Long Swamp, Que.

14405—July 26—Authorizing the C.P.R. to construct, maintain and operate industrial spur for J. A. Lougheed, being an extension of Tees and Persse's spur in Block 65, N.W. of corner of Second Street West and Ninth Avenue, Calgary, Alta.

14406—July 27—Authorizing the Georgian Bay & Seaboard Rly. Co. to divert road allowance between Twps. Eldon and Mariposa, Co. Victoria, at mileage 59.94; and to construct railway across the new road, as shown on plan.

14407—July 27—Authorizing the South Ontario Pacific Rly. Co. to carry the tracks of its Guelph Junction to Hamilton Line, at mileage 15.37 from Guelph Junction, across the tracks of the Hamilton to Sarnia Line of the G.T.R., Lot 27, Con. 1, Twp. W. Flamboro, County Wentworth, Ont.

14408—July 27—Granting leave to the C.N.R. to open for the carriage of freight traffic its line of railway between Delisle and MacRorie on the Delisle Branch.

14409—July 27—Approving revised location of the C.N.O.R. (Toronto-Ottawa Division), east of Sydenham, Twp. of Loughborough, County Frontenac, mileage 164.31 to mileage 165.56 from Toronto.

14410—July 27—Authorizing the C.N.R. to open for the carriage of freight traffic its line of railway from Calder to Reihn, and limiting speed of trains to eighteen miles an hour.

14411—July 27—Approving revised location of the C.N.O.R. (Toronto-Ottawa Division) line of railway at Buck Lake, Twps. Storrington and Bedford, County Frontenac.

14412—July 27—Approving Standard Mileage Tariff, C.R.C. No. 172, of the United States Express Co.

14413—July 19—Approving Standard Mileage Tariffs, C.R.C. Nos. 1363, 1364, and 1365, to take effect the 1st September, 1911, of the Canadian Express Co.

14414—July 19—Approving Standard Mileage Tariff, C.R.C. No. 376, of the American and National Express Companies, to take effect the 1st September, 1911.

14415—July 19—Approving Standard Mileage Tariff, C.R.C. No. 96 of the Pacific Express Co., to take effect the 1st September, 1911.

14416—July 19—Approving Express Standard Mileage Tariff, C.R.C. No. 5, to take effect the 1st September, 1911, of the Alberta Railway and Irrigation Co.

14417—July 19—Approving Standard Mileage, C.R.C. No. 270, of the Great Northern Express Co., to take effect September 1st, 1911.

14418—July 19—Approving Standard Mileage Tariffs, C.R.C. Nos. 2582, 2583, 2584, 2585, 2586, and 2587, to take effect September 1st, 1911, of the Dominion Express Co.

14419—July 19—Approving Standard Mileage Tariffs, C.R.C. Nos. 723, 725, and 726, of the Canadian Northern Express Co., to take effect September 1st, 1911.

14420—July 26—Authorizing the G.T.P. Branch Lines Co. to cross with its Melville-Regina Branch main line of C.P.R. in east half Sec. 23, Twp. 17, R. 20, west 2nd M., Sask. Interlocking plant to be installed.

14421—July 31—Relieving the Windsor, Essex and Lake Shore Rapid Rly., for the present, from speed limitation at crossing of North Talbot Road, Twp. Sandwich South, and from providing a watchman at said crossing.

14422—July 28—Authorizing the G.T.R. to rearrange and construct its most southerly railway track crossing the highway known as the Seventh Line Road, town of Oakville, Ont.

14423—July 27—Approving location and detail plans of the G.T.R. Co.'s proposed new station at Winona, Ont.; authorizing G.T.R. to construct additional track across public road between Lots 4 and 5, Twp. Saltfleet, County Wentworth, and a branch line of railway commencing at a point in its station yard at Winona, thence extending to the spur track of the Hamilton, Grimsby and Beamsville Electric Railway Co.

14424—July 28—Authorizing G.T.R. to construct and operate siding into premises of W. S. Morrison on Lot 20, 11 Con., Twp. of McMurrich, Dist. Parry Sound, Ont.

14425—July 28—Authorizing G.T.R. to construct and operate siding into the premises of J. P. Dupuis, Montreal, P.Q.

14426—July 28—Authorizing the G.T.R. to construct and operate siding into premises of C. C. Morrison, Norwich, Ont.

14427—July 31—Authorizing the G.T.R. to use and operate bridges Nos. 15 and 16 over St. Lawrence River at mileages 53.63 and 54.12.

14428—July 28—Authorizing G.T.R. to construct and operate additional track across St. Annes and Bourdages Streets, St. Hyacinthe, Que.

14429—July 31—Authorizing the G.T.R. to reconstruct bridge over Trout Creek, near St. Mary's Station, on the 15th District, Middle Division of its line.

14430-31-32-33—July 25—Temporarily approving, pending final determination by the Board, the agreements of the Bell Telephone Co. with Dr. E. J. Foster; La Compagnie De Telephone De Beauce (Inc.); Laurentide Telephone Company (Inc.); and La Compagnie De Telephone St. Maurice Et Champlain (Inc.).

14434—July 25—Approving location C.N.R., mileage 255.73 to 260.03, Province of Alberta.

14435—July 28—Authorizing C.N.R. to construct across public road between Secs. 2 and 11, Twp. 60, R. 25, west 4th M., Alberta.

14436—July 27—Approving of plans of station building at Shannonville, Ont., Can. Nor. Ont. Rly.

14437—July 27—Approving revised location C.N.O.R. Co's. line through Twps. McGregor and McTavish, mileage 15.75 to 24.75, east from Port Arthur, and mileage 552.6 to 543.6 from Sudbury.

14438—July 28—Authorizing C.N.R. to construct across public road between Secs. 11 and 14, Twp. 60, R. 25, west 4th M., Alberta.

14439—July 29—Approving C.N.O.R. plan of freight yard at Trenton, Ont.

14440—July 28—Authorizing C.N.R. to construct across and divert east and west road allowance, Secs. 10 and 15, Twp. 65, R. 22, west 4th M., Alberta.

14441—July 28—Authorizing C.P.R. to construct bridge No. 27.34, Cartier Subdivision, Lake Superior Division.

14442—July 24—Authorizing C.P.R. to construct and operate two spurs for the City of Winnipeg on Lot D.G.S. 50 St. John.

14443—July 31—Authorizing C.P.R. to construct and operate spur for F. B. Hartney, West Toronto, Ont.

14444—July 25—Authorizing C.P.R. to construct and operate spur for Messrs. Nicholson & Bain, situated in Lots 41 and 40, Block 69, City of Calgary.

14445—July 26—Authorizing the C.P.R. to construct and operate spur for the Provincial Lumber and Supply Company, on its property on Lots 17, 18, 19, 20, 21, 22, 23, 24, and 25, in Block 231, Calgary, Alta.

14446—July 31—Authorizing the C.P.R. to close portion road allowance along South Boundary Sec. 27, Twp. 32, R. 17, west 2nd M., Province of Saskatchewan; replace same by a road diversion, and cross said diversion at mileage 46.01.

14447—July 29—Authorizing C.P.R. to construct bridge at mileage 31.2 at Elmira, Twp. of Woolwich, County of Waterloo.

14448—July 31—Approving plan of clearance between C.P.R. Co.'s main line and No. 1 track at overhead bridge at Brown Street, West, Fort William, Ont.

14449—July 29—Authorizing C.P.R. to construct and operate spur into the premises of the City of Toronto, situated between Perth and Symington Avenue.

14450—July 31—Authorizing C.P.R. to construct and operate industrial spur for the Dominion Bridge Company in S. ½, Lot 5, Twp. of Gloucester, County of Carleton, Ont.

14451—July 28—Authorizing the C.P.R. to construct bridge 62.8 over Thames River, Windsor Subdivision, Ontario Division.

14452—July 31—Authorizing Can. Nor. Alta. Rly. to construct across and divert North and South Road Allowance between Secs. 32 and 33, Twp. 54, R. 1, west 5th M., St. Albert Westerly Line.

14453—July 31—Approving by-law No. 7, passed at a meeting of the directors of the Crow's Nest Southern Rly., held at Vancouver, B.C., July 12th, 1911.

14454—July 24—Authorizing the S.O.P.R. to construct across York Road, by an undercrossing, at mileage 15.77, Hamilton, Ont.

14455—July 25—Authorizing the S.O.P.R. to construct its Guelph Junction to Hamilton Branch across highways at mileage 0.42 and mileage 1.39; to divert the highway at mileage 1.31, Twp. of Nassagawoya, County of Halton.

14456—July 24—Approving G.T.P.R. Standard Station No. 1, to be erected at Exira, Sec. 6, Twp. 12, R. 11, W.P.M.

14457—July 24—Approving G.T.P.R., location Standard Station No. 1, at Lerose, Sec. 11, Twp. 27A, R. 14, west 2nd M.

14458—July 27—Authorizing G.T.R. to construct and operate connection between its main line from Orillia to Midland and its Wye Bridge cut off, at junction near Old Fort Station.

14459—July 29—Approving by-law of New Westminster Southern Rly., passed at a meeting at New Westminster, B.C., July 21st, 1911.

14460—July 28—Approving by-law of Victoria Terminal Rly. and Ferry Co. passed at a meeting held at Seattle, Wash., July 14th, 1911.

14461—July 28—Approving by-law of Victoria and Sydney Rly. Co., Co., passed at a meeting held at Seattle, Wash., July 14th, 1911, authorizing Herbert A. Jackson to prepare and issue tariffs of tolls in respect to freight traffic.

14462—July 11—Directing, on complaint of the village of St. Pierre, Province of Quebec, that foot crossing at St. Alexandre Street, across G.T. & M.P.I.R., be open for pedestrians only; that footpath from Dominion Car and Foundry Works be closed; that farm crossing at Second Avenue, Parish of Lachine be made regular highway crossing; that Simplex Street be made regular highway crossing; that town of Lachine have leave to convert Tenth Avenue into a public crossing, and that crossing at Notre Dame Street, town of Lachine be converted into regular highway crossing.

14463—August 1—Authorizing G.T.R. to construct bridges at Jameson, Dunn, Dowling Avenues, Toronto, Ont.

14464—August 1—Authorizing G.T.R. to construct and operate sidings into the premises of the Golden Lake Lumber Company on Lot No. 10, Twp. of South Algoma, County of Renfrew.

14465—July 29—Directing C.N.O.R. to make certain changes in respect to bridge in Township of East Whitby, Ont., so as to allow for road traffic and free flow of water of creek in same township.

14466—July 17—Authorizing C.P.R. to construct and operate spurs for A. Bowerman and Cushing Bros., Saskatoon, Sask.

14467—August 3—Approving G.T.P.R. Co's. Cutknife Branch, mileage 14.66 to mileage 41.45.

14468—August 3—Granting leave to G.T.P. Branch Lines Co. to carry traffic over its Melville-Regina Branch from Edgerly to Regina.

14469—August 4—Approving C.N.R., location mileage 49.94 to mileage 60.45, Saskatchewan, Twps. 50-51, R. 20-21, west 3rd M.

14470—August 2—Authorizing C.P.R. to reconstruct bridge at mileage 95.15, Lake Superior Division, Soo Branch.

14471—July 31—Approving C.N.R., location through Twps. 60-66, R. 25 to 22, west 4th M., mileage 46.68 to 93.40, Alberta.

14472—August 2—Authorizing C.N.O.R. to construct across public road between Lots 361 and 360, Con. 1, Twp. of Chatham, County of Argenteuil, Quebec.

14473—August 2—14474—August 1—Authorizing C.N.O.R. to construct railway across Point Anne Road, Lots 20-21, Point Anne Con., Twp. Thurlow, County of Hastings; and across public road between Lots 430 and 436, Con. 1, Twp. of Chatham, County of Argenteuil, Quebec.

14475—August 1—14476-77—July 31—14478—August 2—Authorizing the Can. Nor. Alta., Rly. to construct its St. Albert Westerly Line across two crossings on Lac Ste. Anne Trail, and two public roads.

14479—August 1—Extending time within which interlocking plant be installed by G.T.R. west of Fergus until 31st October, 1911.

14480—August 2—Authorizing the G.T.P. B.L. Co. to cross 14 highways with its Prince Albert Branch in the Province of Saskatchewan.

14481—August 2—Authorizing G.T.P. B.L. Co. to cross with its Calgary Branch 7 highways in the Province of Alberta.

14482—Not issued.

14483—August 2—Authorizing G.T.P. B.L. Co. to construct its Cutknife Branch across 10 highways between mileages 1 and 14.7, Sask.

14484—August 2—Authorizing G.T.P.R. to construct and operate spur for Edmonton Portland Cement Company, Secs. 6 and 7, Twp. 53, R. 19, west 5th M., Alberta.

14485—August 2—Authorizing G.T.P. B.L. Co. to divert 3 highways on its Prince Albert Branch at mileage 78.3, 94.6 and 107.3.

14486-87—August 2—Authorizing G.T.P. B.L. Co. to construct its Moose Jaw Branch across highway, mileage 1.1, and across and divert highway, mileage 2.1; and across 9 highways, mileages 3.1 to 11.2, Sask.

14488—August 9—Approving portion location C.P.R. Kerrobert-Northeasterly Branch for distance of 20 miles from point at or near Kerrobert, Sask.

14489—August 1—Amending Order No. 13880, dated June 10th, 1911, approving location Calgary Branch of G.T.P. B. L. Co., and directing said company to file new plans to be subject to clause 20 of agreement between C.P.R. and G.T.P.

14490—August 1—Approving revised location G.T.P. B.L. Co., Calgary Branch, mileages 163.5 to 181.74, Dist of South Alberta, Alta., subject to terms of agreement to cross the irrigation ditches of the C.P.R.

14491—August 1—Authorizing G.T.P. B.L. Co. to use and occupy lands of the C.P.R. for its Tofield-Calgary Branch location, mileages 150 and 190, and revised location, mileage 163.97, subject to terms of agreement between G.T.P. and C.P.R.

14492—August 3—Rescinding Order of the Board No. 14215, dated June 29th, 1911, requiring C.P.R. to stop its morning and night trains at Gauthier's Siding, Que.

14493—July 28—Approving plan of clearance for the G.T.R. of its standard round house doors on its line of railway.

14494—August 3—Approving revised location of the C.N.O.R., mileage 1.81 to mileage 7.85 from Hawkesbury.

14495—August 4—Approving proposed Supplement No. 2 to Canadian Classification No. 15. (Canadian Freight Association, Apln.).

14496—July 18—Approving temporary station location, C.P.R Ottawa-Prescott Branch, at mileage 9.4 from Ottawa.

14497—August 4—Authorizing C.P.R. to construct and operate an industrial spur for Bishop Construction Company in Lot Cadastral No. 637, Parish of St. Laurent, County of Jacques-Cartier, Que.

14498—August 3—Authorizing C.P.R. to construct its Estevan-Forward Branch across 20 highways, mileage 0.49 and mileage 19.386, and to cross and divert 2 highways, mileages 0.94 and 3.064

14499—August 9—Authorizing C.P.R. to cross, with extra track, 7 highways from Smith's Falls to Bathurst, mileage 1.43 to mileage 9.64.

14500—August 9—Authorizing G.T.P. Branch Lines Co., and C.P.R., to operate their trains over interlocking plant at Alix, Alberta, without being brought to a stop.

14501—August 9—Authorizing the G.T.P. Branch Lines Co., to operate trains over the tracks of the C.P.R. at Yorkton, District of Assiniboia, Sask.

14502—August 9—Authorizing G.T.R. to re-construct bridge at milepost 89.39, 0.63 miles south of Richwood station, Ontario.

14503—August 9—Authorizing G.T.P. Branch Lines Co., to cross Pheasant Hills Branch, C.P.R., at Balcarres, District Assiniboia, Sask., and requiring installation of interlocking plant.

14504—August 8—Authorizing opening for traffic Craven-Colonsay Branch, (C.P.R.), mileage 49.7, between Colonsay and Imperial, Sask.

14505—August 8—Authorizing opening for traffic Kimball Branch, Alberta Ry. & Irrigation Co., from Rayley, South, 8 miles.

14506—August 8—Authorizing the C.N.R. Co., to open for traffic its Rossburn Extension, from Rhein to Hamton.

14507—August 8—Authorizing the Algoma Eastern Ry. Co., to divert the road at mileage 22.98 on its railway.

14508—August 8—Authorizing the Toronto Eastern Railway Co. to construct its tracks across the tracks of the Oshawa Electric Ry. Co., at Simcoe St., Oshawa, Ont.

14509—August 8—Authorizing the Toronto Eastern Ry. Co. to construct spur across the tracks of the Oshawa Electric Ry., to carriage factory, Oshawa, Ontario.

14510—August 4—Authorizing C.P.R. Co. to construct third track on north side present tracks, between Angus Shops and Mile End, city of Montreal.

14511—August 9—Authorizing C.P.R. to construct spur (within three months from date of Order) for Burns and Jordan, near Wardner, Province of British Columbia.

14512—August 8—Authorizing the C.P.R. to construct and operate spur for Cornellier and Joly, Delorimier Ward, Montreal, near Mile End station.

14513—August 4—Approving revised location C.P.R. main line as now constructed through part of the town of Kamloops, B.C., and authorizing the crossing of Lorn Street with said change of location.

14514—August 9—Authorizing the C.P.R. Co. to construct bridge 5.9 over Twelve Mile Creek on its Guelph Junction-Hamilton Branch.

14515—August 9—Authorizing C.P.R. to construct and operate spur into the premises of the Dominion Gypsum Company, St. James, Winnipeg.

14516—August 9—Authorizing C.P.R. to construct and operate spur for O. Martineau and Fils, Ltd., St. Denis Ward, Montreal, P.Q.

14517—August 9—Authorizing C.P.R. to construct bridge 27.4 on its St. Stephen Branch, Atlantic Division.

14518—August 5—Approving location C.N.R. Co.'s line, mileage 0.00 to mileage 41.71, Saskatchewan.

14519—August 8—Authorizing the C.N.O.R. Co. to construct its railway across Riviere Des Prairies (West Channel), Parish of Dorathee, County of Laval, at mileage 39.6, from Hawkesbury.

14520—August 8—Authorizing the C.N.O.R. to connect its tracks with the lines and tracks of the Central Ontario Ry. Co., at Trenton, Ontario, mileage 104.4 from Toronto.

14521—August 5—Approving revised location C.N.O.R. (Sudbury-Port Arthur line), mileage 536.00 to mileage 517.73, from Sudbury Jct., (mileage 32.4 to mileage 50.6 east of Port Arthur).

14522—August 5—Authorizing the C.N.O.R. to construct its lines and tracks across highway, between Lots 24 and 25, Con. 4, Twp. of Bastard, County of Leeds.

14523—August 5—Authorizing the C.N.R. to construct its Vegreville-Calgary Branch over tracks of the C.P.R. main line by means of overhead crossing in N.E. ¼ Sec. 36, Twp. 23, R. 1, west 5th Meridian, Alberta.

14524—August 8—Approving, temporarily, G.T.P. Standard Freight Mileage Tariff, C.R.C., No. 8, pending enquiry, by the Board, into rates charged in British Columbia.

14525—August 4—Extending, until the 15th June, 1912, the time in which the G.T.P. Branch Lines Co., install interlocking plant where it crosses the Arcola Branch of C.P.R. at Griffin, Sask.

14525—August 4—Extending until June 15, 1912, time for installation of interlocking plant by G.T.P. Branch Lines Co., across C.P.R. at Griffin, Saskatchewan.

14526—August 8—Authorizing G.T.P. Branch Lines Co. to cross and divert five highways on its Battleford Branch, Saskatchewan.

14527—August 5—Authorizing G.T.P. Branch Lines Co. to cross with its Biggar-Calgary Branch the Lacombe Branch of the C.P.R. at Druid, Alta. Interlocking plant to be installed.

14528—August 5—Extending until 1st October, 1911, time for installation of interlocking plant by G.T.P. Branch Lines Co. across C.N.R. at Dana, Sask.

14529—August 5—Authorizing G.T.P. Branch Lines Co. to cross 18 highways on its Cutknife Branch, mileage 22.6 to 39.7, Saskatchewan.

14530—August 8—Approving location and plans of new G.T.R. station at Thorndale, Ontario, on Middle Division, 15th District.

14531-32—August 9—14533—August 3—Authorizing G.T.R. to construct spurs as follows:—Into premises of St. Lawrence Flour Mills Co., Lachine Canal Bank, Montreal, P.Q., for Muskoka Wood Manufacturing Co., Huntsville, Ont., for Ham & Nott Co., Brantford, Ontario.

14534—August 14—Approving location of G.T.P. Branch Lines Co. Brandon Branch, mileage 0 to mileage 18.36, Dist. of Brandon, Manitoba.

14535—August 15—Authorizing M.C.R. to operate its trains over drawbridge and crossing of N. St. C. and T. Ry. without being brought to a stop; account interlocking plant completed.

14536—August 11—Authorizing C.P.R. (G. B. & S. Ry.) to cross highways between Cons. 4 and 5, Township of Ops, Ont., by means of undercrossing.

14537-38—August 12—Authorizing C.P.R. to construct extra track across road allowance on west boundary of Sec. 2, Twp. 8, R. 21, west Principal Meridian, Manitoba, lying north of Winnipeg to Souris Branch C.P.R. across, to construct extra track across Main St., Minnedosa, Man.

14539—August 12—Authorizing C.P.R. to construct seven bridges on its Atlantic, Eastern, Ontario, Alberta, Divisions.

14540—August 12—Authorizing C.P.R. to construct spur into premises of A. W. McGregor and Alexander Martin, city of Regina, Sask.

14541—August 14—Authorizing C.P.R. to construct bridge 14.9 near Cooksville, London S.D., Ontario Division.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, C. H. Rust; Secretary, Professor C. H. McLeod.

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

TORONTO BRANCH—
96 King Street West, Toronto. Chairman, H. E. T. Haultain; Secretary, A. C. D. Blanchard,, City Hall, Toronto. Meets last Thursday of the month at Engineers' Club.

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

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

OTTAWA BRANCH—
Chairman, A. A. Dion, Ottawa; Secretary, H. Victor Brayley, N. T. Ry., Cory Bldg.

MUNICIPAL ASSOCIATIONS.

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

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

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

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Mayor Reilly, Moncton; Hon. Secretary-Treasurer, J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. E. McMahon, Warden, King's Co., Kentville, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Hopkins, Saskatoon; Secretary, Mr. J. Kelso Hunter, City Clerk, Regina, Sask.

CANADIAN TECHNICAL SOCIETIES.

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

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

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

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

BUILDERS, CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

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

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

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

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

CANADIAN FORESTRY ASSOCIATION.—President, Geo. Y. Chown, Toronto; Secretary, James Lawler, 11 Queen's Park, Toronto.

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

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

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. Frank D. Adams, McGill University, Montreal; Secretary, H. Mortimer-Lamb, Windsor Hotel, Montreal.

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

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

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

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

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

DOMINION LAND SURVEYORS.—President, Thos. Fawcett, Niagara Falls; Secretary-Treasurer, A. W. Ashton, Ottawa.

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

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, W. B. McPherson; Corresponding Secretary, A. McQueen.

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

ENGINEER'S CLUB OF TORONTO.—96 King Street West. President, Killaly Gamble; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

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

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

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

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

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

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, S. Fenn; Secretary, J. Lorne Allan, 15 Victoria Road, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, W. H. Pugsley, Richmond Hill, Ont.; Secretary, J. E. Farewell, Whitby.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. Whitson; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

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

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

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Alfred T. de Lury, Toronto; Secretary, J. R. Collins, Toronto.

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

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

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

WESTERN CANADA RAILWAY CLUB.—President, Grant Hall; Secretary, W. H. Rosevear, 199 Chestnut Street, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.